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NOTES.

Industrial Fatigue.

OUR knowledge of the inefficiency of overtime is rapidly increasing in these times of stress, and it is to be hoped that we shall act without delay upon the information so far acquired. The latest report on the subject is by Dr. STANLEY KENT, and gives some interesting information. One of the subjects with which Dr. KENT deals is that of the power of recovery. This is determined by the general physical development of the individual, the state of health and nutrition, and also by freedom from "staleness" and fatigue. Thus it is that the power of recovery is greater at the beginning of a period of labour than at the end, and this fact applies to the week as well as to the day. Consequently, if the day is lengthened by overtime, or if a week's work is lengthened by interfering with the week-end rest, this results in still more rapid production of fatigue and its still less perfect recovery. It follows that a point is quickly reached beyond which an increase in the hours of work can no longer be efficient. Moreover, the rate of output varies with the time of day. It is often found to be lowest in the early morning period and at the beginning of the week; also in the period of overtime at the end of the week. On the other hand, psychical influence cannot be disregarded. Thus, the output on Saturday, in spite of great fatigue, is often high, due to the anticipation of a week-end rest.

SOME interesting figures are given by Dr. KENT on the effect of shortened hours. Thus a group of workers showed an absolute increase of over 5 per cent. of output as a result of a diminution of 16½ per cent. of the length of the working days. Dr. KENT also calls attention to the fact that increased resistance to fatigue follows improved feeding. This is undoubtedly a direction in which improvement is desirable. Generally it may be said that the investigations by Dr. KENT and others have sufficiently proved the fact that overtime beyond a limited extent can only do harm. We think, therefore, it is time that some action was taken by the Government to put matters on a more rational basis. Only the other day we were surprised to read that work is carried on in the Army Clothing Department on Sundays, for which double the rate of pay is given. It is fairly obvious that such a policy not merely leads to greater cost, but also to the purchase of inefficiency. Economy is only desirable if it leads to a more efficient all-round result. We venture to suggest that if Sunday work were entirely abandoned it would not only lead to a considerable saving of expenditure, but to improvement in the week's output by those at present engaged on munitions.

◆

The Board of Trade and Electric Lighting Orders.

OWING to the war the carrying through of new schemes for electric light and power are necessarily in abeyance at the present time, and nothing is being done even in the carrying out of extensions, except those which are absolutely necessary, or in the obtaining of new Provisional Orders. We have on previous occasions pointed out that, although actual construction in the case of those new schemes and extensions which are not urgent cannot be carried out at the present time, it is nevertheless highly desirable that the preliminary work, such as the drawing up of specifications and the carrying through of the Parliamentary and legal formalities, should be completed so that when peace comes the actual work of construction can be carried through with the least possible delay. We are glad to see that the Board of Trade is now taking this view of the matter, and that a letter, which will be found elsewhere in our present issue, has been addressed to the President of the Society of Parliamentary Agents, stating that the Board will be prepared to entertain applications for Provisional Orders in the ensuing session, when it can be shown that the establishment of works under the scheme proposed will be proceeded with as soon as practicable after the termination of war. It is pointed out that the Board will have particular regard to the consideration as to how far the exercise of powers will provide an outlet for labour and the utilisation of plant and machinery which have been provided for the purposes of the war, and attention is also called to the fact that it is undesirable that proposals put forward should provoke serious opposition or prove unduly costly at the moment.

Metal Slot Wedges in Induction Motors.

ELSEWHERE is given an abstract of an article on this subject by Mr. B. B. RAMEY. The purpose of the article is to indicate the effect on motor performance of different types of wedges and slots. It is shown that although the metal-wedged slot construction does not give as low magnetising current and iron loss as the semi-enclosed slot construction, it does give lower values than the open slot and at the same time maintains the advantages of the open slot in ease of winding and repair. The author shows that the metal-wedged slot construction gives a certain flexibility in design, and opens up possibilities for working the active material more efficiently than is possible with open slots, while at the same time all the mechanical advantages of the open slot construction are retained. Although designers aim at securing low values of magnetising current and leakage in order to obtain satisfactory constants it is well to remember that to the manufacturer and to the user ease of construction and repair are equally important. In the majority of cases it is unwise to sacrifice mechanical simplicity in endeavouring slightly to improve the electrical performance of a machine. Mr. RAMEY'S article can be recommended to designers and others who are likely to have to look up the subject.

◆

Hydro-Electric Station on the Pescara River. Referring to our article on this subject in our issue of Sept. 8, we are asked to state that the generators, exciters, transformers, switchgear and outgoing lines of this station were designed and manufactured by the Tecnomasio Italiano Brown Boveri.

"Faraday House Journal." In addition to a good deal of matter of interest to "Faradians" the current "Journal" contains an article of general interest by Dr. A. Russell, entitled "Notes on Electrical Engineering." A new method of harmonic analysis is described and notes are given on the theory of the dynamo and on the size of the power stations.

Periscopes on Railway Signal Stations. On one of the [illegible] a large periscope has been installed in order to enable the signalman to survey a section of the line which is not visible in direct view owing to the obstruction of a neighbouring building. The idea will probably be applied in other places where the view is obstructed. But although the periscope has come into public notice only since the war began, the periscope is by no means new even in connection with railway work. According to the "Railway Gazette," an arrangement of [illegible] was [illegible] 40 years ago at the Hole in the Wall [illegible] at Victoria Station.

Hydro-Electric Progress in Norway.—According to "Engineering," the [illegible] Power Co. has decided to exploit [illegible] at [illegible], which will have a [illegible] of [illegible] h.p. It is proposed to erect a [illegible] with a [illegible] of which [illegible] will be [illegible]. There is [illegible] of taking up the manufacture of [illegible]. [illegible] to be taken in hand at [illegible] in addition to [illegible] arranged.

Belt Conveyors. [illegible] about [illegible] coal [illegible] travelling [illegible] "Engineering Magazine," [illegible]

Another Electric Battleship.—According to "Engineering News," contracts have recently been let for electric propulsion machinery for the U.S. ss. "Tennessee," a super-dreadnought now under construction. This action may be regarded as a result of success with the U.S. collier "Jupiter" and the battleship "California." There will be in the "Tennessee" two steam-turbine electric generating units aggregating 33,000 H.P. and feeding four 6,700 H.P. motors, each connected to a propeller. Smaller turbine sets will drive the auxiliaries and furnish light and power throughout the ship. There will be several hundred motors, doing all work from anchor raising to steering. Electricity will be used for cooking, ice making, &c.

Munitions Order.—The Minister of Munitions has required all persons, firms and companies engaged in the manufacture of cranes, aerial ropeways, capstans, conveyers, grabs, elevators, hoists, lifts, runways, shear legs, transporters, travellers or winches, whether operated by steam, electric, hydraulic, pneumatic or hand power, not to carry out, without a permit issued under his authority, in any factory, workshop or other premises, any work consisting of the manufacture, assembling or erection of any of the above-mentioned articles, except under (*a*) orders received from or in connection with work for the Admiralty or War Office; (*b*) orders of a value not exceeding £50 required for war work; (*c*) orders which have already been sanctioned by the Ministry of Munitions of Class "A" work.

Geared Turbo-Generators.—According to "The Engineer," geared turbine units are to replace the direct-connected turbines of the new United States destroyers "Henley" and "Mayrant." The Navy Department has adopted geared turbines, it is understood, because they are lighter and take up less space than direct-connected units, are better mechanically because of their small size, and require less steam at all speeds, and especially at cruising speeds. This reduces the fuel consumption and increases the steaming radius, which is an important feature. The machinery will consist of two complete expansion geared turbine units of the impulse reaction type, and two geared cruising units. It is to be installed in the same engine room space, and to connect with the existing propeller shafting, and drive the propellers at the same speed as formerly.

Air-Blast Alternating Current Rectifier. A very simple and ingenious method of rectifying high-tension alternating currents by means of an air blast has been assigned to the International Precipitation Co., of Los Angeles (Cal.), under United States patent 1,188,597. Wolcalt and Rieber propose to surround a rod electrode, spaced from a co-operating disc electrode, with an air blast at a pressure of about 10 lb. to the square inch. By directing the air blast along the path of the discharge the inventors maintain that an alternating-current at as much as 50 000 volts can be wholly rectified. It is also found, the inventors state, that by regulating the air pressure it is possible to secure any desired amount of rectification. It also becomes possible to rectify both halves of an alternating current wave, and to obviate entirely all expensive equipment of vacuum tubes and the like.

Tractive Resistance of Roads. A comparison of the tractive resistance exerted by different road materials to the passage of motor wagons has been undertaken by Prof. A. E. Kenelly and Mr. O. R. Schurig. The results of these tests appear in the "Transactions" of the American Institute of Electrical Engineers for June. The tractive resistance varies according to the speed, but assuming a speed of 20 km. (12·4 miles) per hour urban pavement materials can be classified in the following order of desirability: (1) Asphalt, (2) wood block, (3) hard smooth macadam, (4) brick block, (5) granite block with cement filled joints, (6) cinder, (7) gravel, (8) granite block with sand filled joints. It is interesting to note that increasing the gross weight of the vehicle by 12 per cent. had no appreciable effect on the tractive resistance of smooth roads in good condition, but on rough roads a distinct increase in tractive resistance was recorded.

Separation of Neon from the Atmosphere. A process for separating neon from other similar gases derived from the atmosphere, particularly helium, has been patented by M. Geo. Claude. The production of liquid air on a large scale has made possible the generation of nitrogen, argon, helium and neon in commercial quantities, but the separation of the three latter constituents is more troublesome. The process of M. Claude makes use of a sealed tube, in which large carbon electrodes are inserted. This is filled with the gases to be treated and an electric discharge is passed through the mixture, when the foreign gases are absorbed, leaving nearly pure neon. The minimum surface area of the electrodes is given as 1·5 sq. dcm. per ampere. A comparatively large area is desirable, as neon is absorbed very much more slowly than the other gases. Neon is extremely permeable to electric discharges and has found application in the tubes used as detectors of Hertzian waves. It has also been employed by M. Claude in the form of luminous tubes for lighting purposes.

Disabled Sailors and Soldiers.—The classes organised at the Northampton Polytechnic Institute by the Institution of Electrical Engineers in co-operation with the London County Council for the purpose of giving a preliminary training to disabled sailors and soldiers as electricity sub-station attendants are about to be resumed. Up to the present some 40 men have been admitted to the course, of whom 25 have been placed in electricity supply undertakings, the remainder having either found other situations or been unable to complete their course. The courses are free to the men, and the work consists of demonstrations and exercises in the first principles of electrical engineering and of physics, practical work in the electrical and physical laboratories, and demonstrations in the power house of the Northampton Institute. By the courtesy of some of the London supply companies visits are also paid in the last week of the course to sub-stations and generating stations in the London district, and instruction is given by the men in actual charge of the stations. A third batch of 20 men will begin their course about the middle of October, and will be ready to take up employment as probationers about the middle of November. Engineers having vacancies which could be offered to these men are requested to communicate with Dr. R. Mullineux Walmsley, Principal of the Northampton Polytechnic Institute, Clerkenwell, London, E.C., who will also be pleased to send application forms for admission to the courses, with full particulars, to disabled sailors or soldiers wishing to join.

Provisional Electric Lighting Orders.—As stated in our last issue, the Board of Trade have decided to reconsider their attitude towards applications for provisional electric lighting orders. The change of policy is announced in a letter from the Harbour Dept. of the Board to the President of the Society of Parliamentary Agents. This letter, which is dated Sept. 20, reads as follows :—

> I am directed by the Board of Trade to state that they have under consideration your letter of Sept. 8, submitting on behalf of the Society of Parliamentary Agents certain representations for a modification of the notice issued by the Board last year to the effect that application for provisional orders would not be entertained except in cases when extreme urgency existed.
>
> The Board realise that the position has altered since the issue of the notice in question, particularly in the direction indicated in the circular letter issued by the Local Government Board on Aug. 28 last, and in these circumstances the Board of Trade will be prepared to entertain applications for provisional orders in the ensuing session when it can be shown that the establishment of works under the schemes proposed will be proceeded with as soon as practicable after the termination of the war. In determining whether an application shall be allowed to proceed the Board will have particular regard to the considerations as to how far the exercise of the powers will provide an outlet for labour or for the utilisation of plant and machinery which have been provided for the purposes of the war.
>
> The Board will be prepared to consider proposals before any expenditure is incurred in respect of the publication of notices, &c., and to intimate whether, in their view a *prima facie* case has been made out for the promotion of the application subject to consideration of objections. The Board are, however, of opinion that it is undesirable that proposals shall be put forward which are likely to provoke serious opposition or to prove unduly costly to promote. I am to add that the policy of the Board in dealing with these applications may be subject to further modification in the event of a change in the general situation due to the war.—(Signed) C. Hipwood.

OBITUARY.

William M. Kent.—With regret we announce the death, after a short illness, of Mr. William Morrey Kent, of the Commercial Cable Co. Originally in the service of the Post Office and the Direct United States Cable Co. at Liverpool, he joined the Commercial Cable Co. at its inception in 1884, and after holding responsible positions at Liverpool, Manchester and Bradford, he came to London in 1897, where he endeared himself to everyone in the cable world by his unfailing courtesy and charm of manner. At the early age of 57 he leaves a blank which it will be difficult to fill. Mr. Kent was also a director of the Direct West India Cable and Halifax & Bermudas Cable Companies.

Killed in Action.—The following deaths in action are reported :

Second-Lieut. J. R. Moore (Connaught Rangers), who was killed on Sept. 9, was in his 21st year. He was in the service of the British Westinghouse Electric & Mfg. Co. at Trafford Park prior to the war.

Capt. Hugh Petley (London Regiment), aged 28, who was killed on Sept. 18, was the only son of the late Mr. Edmund Petley, late secretary of the Amazon Telegraph and Chili & Ecuador Telephone Companies.

Lieut. Edwin Schonfield (London Regiment), aged 26, who has been killed, was engaged in the office of his father's firm, A. Schonfield & Co., dealers in electrical supplies, Glasgow, until he volunteered for military service immediately after the outbreak of the war.

Lieut. Cyril A. C. Aitkens (R.E.), previously reported missing as from July 10, was afterwards reported to have died on that day. He was formerly engaged at the North-Eastern Marine Engineering works, on the Tyne, subsequently joined the Tyne Electrical Engineers, and served at the front as signalling officer. He was 23 years of age.

APPOINTMENTS VACANT AND FILLED.

Wigan Corporation invite applications for the position of borough electrical engineer and manager. Salary £400 per annum. Applications to the town clerk, Mr. Wm. Hy. Tyrer, Municipal Offices, King-street West, Wigan, by Oct. 19. *See also an advertisement.*

An engineer-in-charge is required for period of the war by Hammersmith Borough Council. Salary £3. 5s. per week. Applications to the engineer and manager of the electricity department, Mr. G. G. Bell, 85, Fulham Palace-road, London, W. *See an advertisement.*

A switchboard attendant is wanted by Stoke-on-Trent Corporation. Applications to the borough electrical engineer (Mr. C. H. Yeaman), St. Peter's-chambers, Glebe-street, Stoke-on-Trent. *See advertisement.*

A works electrician is required for the electricity department of the municipality of Port Elizabeth, South Africa. Wages 12s. per day. Applications to the agents of the municipality, Messrs. Davis & Soper (Ltd.), 54, St. Mary Axe, London, E.C. *See also an advertisement*

Wolverhampton Guardians require a chief engineer for their poor law institution, to take charge of electric lighting and other machinery. Salary, £125, with house, &c. Applications (on forms to be obtained from the Clerk) by first post, Oct. 10.

Mr. E. Grime, of Leyton, has been appointed station superintendent at Barking electricity works.

ARRANGEMENTS FOR THE WEEK.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Officer for the Week.—Platoon Commander J. O. Cheadle.

Next for Duty.—Platoon Commander A. Gerard.

Monday, Oct. 9.—Technical for Platoon No. 9, at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.25 to 8.

Tuesday, Oct. 10.—School of Arms, 6 to 7; Lecture, "Organisation and Discipline," 7.15, Company Commander A. Hynam; Range Practice.

Wednesday, Oct. 11.—Instruction Class, 5.45; Platoon Drill, Platoon No. 1; Range Practice.

Thursday, Oct. 12.—Platoon Drill, Platoon No. 7; Range Practice.

Friday, Oct. 13.—Technical for Platoon No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.25 to 8.25.

Saturday, Oct. 14.—General Parade 2.45, Uniform, for drill.

Sunday, Oct. 15.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway) Booking Office, 8.45 a.m. Uniform, haversacks, water bottles. Midday ration to be carried. Railway vouchers will be provided.

Musketry.—For all companies, see Notice and Table A and B at Headquarters.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

THE MATHEMATICAL DESIGN OF TRANSFORMERS.*

BY PROF. DAVID ROBERTSON, D.SC.

(*Concluded from p. 926. Vol. LXXVII.*)

8. COMPARISON OF TYPES. SINGLE PHASE.

Subject to the limitations discussed in connection with the assumptions made, and to the fact that, because a smaller transformer will, as a rule, get hotter than a larger one having the same losses, we may have to spend part of the saving obtained by employing a better type in reducing the losses and getting a higher efficiency, we can make the following general statements as to the different types available for single-phase working if we require to get the same efficiency with each. There is also a further modification for those types which do not permit as good space-factors as the others.

In all cases except that of the ring-coil type, rectangular coils are cheaper than circular or square coils. Without allowing for their better iron space-factor, the difference in favour of the best shape of rectangular coil as compared with circular ones is about 3 per cent. for the three-limb three-phase transformer, 5 per cent. for the core and shell types, and 9 per cent. for the ring-core types. The best ratio of depth to width of the iron core varies extremely little for different conditions. It is 2·2 for the core, shell and ring-core types, and 2·05 for the three-limb three-phase type.

An examination of Fig. 3 shows that the types may be divided into two groups, one containing the shell and ring-coil types, and the other the core, ring-core and simple types. The vertical distance between the curves in one group is practically constant within the practical limits of specific cost ratio, showing that the ratios of the cost functions for those in one group are practically fixed.

The core and shell types cost almost the same when the costs per unit of gross volume of the copper and iron spaces are alike (**m** = 1). With dearer iron space (**m** < 1) the core type is inherently cheaper; but with dearer copper space (**m** > 1) the advantage lies with the shell type. The difference amounts to about 10 per cent. for **m** = 0·1 and **m** = 2·5. Although the copper costs considerably more than the iron, it has usually a much smaller space-factor, with the result that the specific cost ratio does not often differ sufficiently from unity to make the saving in material by using one type in preference to the other of very great moment. The choice between them should, therefore, be settled entirely from practical considerations such as convenience of manufacture, mechanical strength, &c.

The ring types are appreciably cheaper if the same space-factor be obtained, the difference being over 10 per cent. for the square rings and more for the less practical circular rings. Difficulties of construction arise in the ring-core types (Faraday, Burnand), while in the circular ring-coil type (the original Berry type) there is the [illegible] that the iron space cannot be well filled unless an impracticably large number of different widths of sheet is employed. The [illegible] type as made by the General Electric Company of America gets over the difficulty by cutting down the cross-section of the central core, thereby still further reducing the amount of material required for a given efficiency. In addition to being a more [illegible] than the square ring-core (Burnand) type, it is also [illegible] cheaper when **m** exceeds unity.

9. COMPARISON OF TYPES. POLYPHASE.

[illegible] transformers may be made by combining core or shell [illegible] one above the other, tandem fashion. The relative [illegible] are exactly the same as for single-phase transformers. The cost function of a two-phase transformer [illegible] and that of a three-phase transformer [illegible] single-phase transformers of the same type [illegible]. In the latter case two complete three-phase [illegible] would require exactly [illegible] four single-phase transformers (three in [illegible]). The usual three-limb type of three-phase transformer [illegible] a bank of single-phase [illegible] allowing one spare in each case, [illegible] in each case. Actually, [illegible] three-phase [illegible] the single-phase [illegible] thermal limit the [illegible] higher efficiency. [illegible] can

be shown by the adoption of separate transformers when allowance is made for spares.

There is also a symmetrical type of three-limb three-phase transformer having the centres of the coils placed at the corners of an equilateral triangle. But this is an expensive type, for in addition to its being difficult to construct its effective flux density is only $1/\sqrt{3}$ times the actual density owing to the difference in phase between the fluxes in the two halves of the core.

The three-limb type of two-phase transformer is hopelessly out of the running as compared with the tandem types or banks of single-phase transformers.

10. COMPARISON OF MATERIALS.

Near the usual values of the specific cost ratio the logarithmic curves of the minimum cost function have a slope not far from $\frac{1}{2}$. Consequently we do not make much error in assuming that this function is proportional to the square root of **m**. By doing so we can make tolerably accurate comparisons between one material and another irrespective of the type of transformer or its size. If we make this assumption we can write :—

For a given efficiency

$$£=(£/£_O)\cdot c_I\sigma_I L_O^3 \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

$$\propto \left(\frac{c_C\sigma_C}{c_I\sigma_I}\right)^{\frac{1}{2}}\cdot c_I\sigma_I\cdot\frac{L_L^3}{(\sigma_I\sigma_C)^{\frac{3}{2}}} \quad . \quad . \quad . \quad . \quad . \quad (24)$$

$$\propto \frac{c_I^{\frac{1}{2}}c_C^{\frac{1}{2}}}{\sigma_I\sigma_C}L_L^3 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

$$=\text{a constant if } L_L^6\cdot c_Ic_C/(\sigma_I^2\sigma_C^2) \text{ is constant.} \quad (26)$$

Allowing for the fact that a higher efficiency is necessary with the better material if the temperature rise is to be the same, it can be shown that :—

For a given temperature rise

$$£\propto c_I^{\frac{1}{4}}c_C^{\frac{1}{4}}L_L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

$$=\text{constant if } c_Ic_CL_L^4 \text{ is constant.} \quad . \quad . \quad . \quad . \quad . \quad (28)$$

Applying these formulæ to compare different thicknesses of sheet and allowing for the reduced space-factor with thinner sheets we find that at 50 cycles per second there is no advantage in reducing Stalloy below 20 mils. This agrees exactly with the experience of the makers. With Lohys it is worth while to use the thinnest obtainable sheets of about 12 mils.

Stalloy sheets 20 mils thick at a flux density of 0·645 millivolt-second per square inch (1 microvolt-second per square millimetre, or 10,000 C.G.S.) give a loss of 0·235 watt per cubic inch, while 15 mils Lohys gives 0·385. These give iron-loss coefficients of 0·566 and 0·925 watt-inch per (microvolt-second)^2. Taking the resistivity of copper, hot and including an allowance for skin effect, as 0·9 microhm-inch, we get a loss-length of 3·21 mils for Stalloy, and 4·10 for Lohys.

Thus, for equal efficiencies, Stalloy would have to cost more than, $(4{\cdot}10/3{\cdot}21)^6$ or 4·33 times Lohys before it would really be the more expensive material for this purpose. For a given temperature rise the figure is $(4{\cdot}10/3{\cdot}21)^2$ or 1·63.

Let us see how aluminium would do in place of copper. We shall make a rather greater allowance for skin effect, as the conductors will be thicker, and take the resistivity, hot, at 1·60 microhm-in. With Stalloy, this gives a loss-length of 4·29 mils at 50 cycles per second, against 3·21. Since $(4{\cdot}29/3{\cdot}21)^2=1{\cdot}8$ and $(4{\cdot}29/3{\cdot}21)^6=5{\cdot}7$, aluminium must cost less than about half its volume of copper if it is to compete with it for transformer windings on a temperature basis, or than one-sixth on an efficiency basis. In other words, the price of aluminium per pound would have to be less than 185 per cent. and 58 per cent. respectively of that of copper. It will be noticed that the price is already sufficiently low to permit of its use when temperature rise is the primary criterion.

11. WINDING EQUATIONS.

The primary has to carry the exciting current in addition to the load current, but the secondary requires extra turns to make up for the voltage drop. Putting one of these against the other, we shall not be far wrong if we take half the ampere turns and half the cross-section of copper for each. The actual number of turns will require slight adjustment afterwards to get exactly the right voltage ratio. For our preliminary design we may thus put

$$N_1I_1=\tfrac{1}{2}I\,S=\tfrac{1}{2}\left(\frac{P}{\rho_cL}\right)^{\frac{1}{2}}S=\tfrac{1}{2}\left(\frac{P_cS}{\rho_cL}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad (29)$$

$$\therefore N_1=\frac{1}{2I_1}\left(\frac{P_cS}{\rho_cL}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

$$N_2=\frac{1}{2I_2}\left(\frac{P_cS}{\rho_cL}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

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* [illegible] "Journal" of the Institution of Electrical Engineers, Vol. LIV., pp. [illegible]

And, for sandwiched coils,

$$S_{w_1}=S_c/(2N_1).\quad S_{w_2}=S_c/(2N_2).\quad .\ .\ .\ .\ .\quad (32)$$

With concentric coils, 56 per cent. of the total copper section should be given to the outer coil. If it is the primary, we have

$$\left.\begin{array}{l}\text{Outer coil } S_{w_1}=0\cdot56 S_c/N_1\\ \text{Inner coil } S_{w_2}=0\cdot44 S_c/N_2\end{array}\right\}\quad .\ .\ .\ .\ .\ .\quad (33)$$

12. EXAMPLES OF DESIGN.

Suppose that we require a core transformer with rectangular coils for 100 kv.-amperes at 5,000/220 volts, 20·3/455 amperes, at 50 cycles per second, with copper and iron losses 750 watts each. We shall estimate the space-factors in the iron and copper spaces at 0·80 and 0·35 respectively, and take the loss-length at the value given in the table, namely, 3·30 mils. Then

$$L_o=\frac{\Sigma IE\times L_L}{\sqrt{(P_I P_C)}\sqrt{(\sigma_I\sigma_C)}}=\frac{201\cdot5\text{ kw.}\times3\cdot30\text{ mils}}{750\text{ watts}\times\sqrt{(0\cdot80\times0\cdot35)}}=1\cdot68\text{ in.}$$

For this type of transformer the round numbers 10, 5, 10/3 and 7·5 are almost exactly correct for L_{CS}/L_O, $2\,l_{CS}/L_O$, l_{IS}/L_O and L_{IS}/L_O with the proportions involved, which are not far from the cheapest ones for the usual values of the specific cost ratio.* Employing these numbers, we get

Distance between yokes $=L_{CS}=10\,L_O=16\cdot8$ in.
Distance between cores $=2\,l_{CS}=5\,L_O=8\cdot4$ in.
Width of core $=l_{IS}=(10/3)L_O=5\cdot6$ in.
Depth of core $=L_{IS}=7\cdot5\,L_O=12\cdot6$ in.
Net section of iron $=S_I=0\cdot80\times5\cdot6\times12\cdot6=56\cdot5$ sq. in.
Net section of copper $=S_C=0\cdot35\times16\cdot8\times8\cdot4=49\cdot4$ sq. in.
Length of iron $=L_I=33\cdot4+16\cdot8+22\cdot4=72\cdot6$ in.
Length of copper $=L_C=25\cdot2+11\cdot2+12\cdot6=49\cdot0$ in.
Net volume of iron $=V_I=56\cdot5\times72\cdot6=4{,}100$ cubic in.
Net volume of copper $=V_C=49\cdot4\times49\cdot0=2{,}420$ cubic in.

$$\text{Turns in primary}\ =N_1=\frac{1}{40\cdot6}\left\{\frac{750\times49\cdot4}{0\cdot90\times10^{-6}\times49\cdot0}\right\}^{\frac{1}{2}}=714.$$

$$\text{Turns in secondary}=N_2=\frac{1}{910}\left\{\frac{750\times49\cdot4}{0\cdot90\times10^{-6}\times49\cdot0}\right\}^{\frac{1}{2}}=31\cdot9.$$

Section of primary conductor $=S_{W1}=49\cdot4/1428$
$=0\cdot0346$ sq. in.
Section of secondary conductor $=S_{W2}=49\cdot4/63\cdot8$
$=0\cdot774$ sq. in.
Current density $=I''=20\cdot3/0\cdot0346=455/0\cdot774$
$=588$ amperes per square inch.

$$\text{Flux density}=B_m=\frac{5{,}000\text{ volts}}{222\text{ per sec.}\times714\times56\cdot5\text{ sq. in.}}.$$

$=0\cdot560$ millivolt-second per square inch.
$=8{,}680$ lines per square centimetre.
Specific iron loss $=P_I/V_I=0\cdot184$ watt per cubic inch (Fig. 4).
Iron loss $=P_I=0\cdot184\times4{,}100=755$ watts.
Copper loss $=P_C=0\cdot9\times10^{-6}\times(588)^2=750$ watts.

In this case the check results are very close indeed to our requirements, because the flux density happens to come very near to that for which the assumed loss-length is exactly right. The copper loss will always come quite right, for the winding formulæ divide up the given copper in such a way as to give the specified loss with the given currents. To show the effect of the variation of the loss-length, let us take two other examples with the same dimensions, but one with the iron loss only 500 watts and the copper loss 1,125 watts, while the other has these values interchanged. These have the same geometrical mean as before, and, since the aggregate volt-amperage is not sensibly different, would have given the same fundamental length if we took the same loss-length, and so ought to fit into the same carcase if our theory had been exact. Working out the things which are different, we get

	Low.	High iron loss.
Turns in primary $=N_1$	$=874$	582.
Turns in secondary $=N_2$	$=39\cdot0$	26·0.
Section of primary conductor $=S_{w1}$	$=0\cdot0282$	0·0424 sq. in.
Section of secondary conductor $=S_{w2}$	$=0\cdot623$	0·949 sq. in.
Current density $=I''$	$=720$	480 amperes per sq. in.
Flux density $=B_m$	$=0\cdot456$	0·685 m.v.s. per sq. in.
	$=7{,}080$	10,600 C.G.S.
Specific iron loss $=P_I/V_I$	$=0\cdot130$	0·262 watt per cub. in.
Iron loss $=P_I$	$=534$	1,070 watts.

It will be noticed that the low iron loss checks out about 7 per cent. greater than what was wanted, while the high one is about 5 per cent. too small. The correct values of the loss-length at the flux densities of these two examples are 3·4 and 3·2 mils respectively, instead of the 3·3 mils assumed. To comply with the conditions specified, the dimensions would have to be raised in the former case and lowered in the latter by about 3 per cent., making a change of nearly 10 per cent. in the weight. We thus see that it is considerably more expensive to reduce the iron loss than to reduce the copper loss, because of the variation of the loss-length with flux density.

The method is equally applicable to transformers with a number of distinct windings, to auto-transformers and to choking coils. It is only necessary to know the aggregate load actually carried by all the windings (taking the maximum on each if they are not simultaneously loaded) and the total losses. The modifications required in the winding equations are obvious. In the case of the choking coil a gap must be placed in the magnetic circuit, conveniently a wooden or fibre distance piece, sufficient to bring up the exciting current with the rated voltage to the required current rating.

13. BEST DISTRIBUTION OF THE LOSSES.

The examples in the last section illustrate a point which is worth emphasising. With given total losses, the geometrical mean loss is greatest when they are equally divided between the copper and the iron. Consequently, if our assumptions were exactly true, the smallest transformer with a given efficiency would be obtained with equal division of the losses. Actually, the variation of the loss-length shifts the cheapest point in the direction of greater iron losses, so that, as the examples show, it is cheaper to reduce the copper loss than the iron loss.

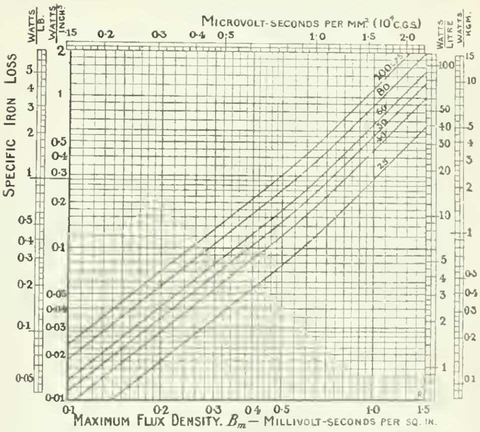

FIG. 4.—SPECIFIC IRON LOSS WITH SANKEY'S "STALLOY" IRON, 20 MILS THICK.

Commonly, transformers are designed to have the iron losses less than half the full-load losses, with the object of reducing the energy lost during the 24 hours, which has the further advantage on a peaky load that the transformer is cooler after an interval of light load than it would be with greater iron losses. A saving of energy does not, however, necessarily mean a saving of money, but might lead to the reverse if the capital outlay necessary to obtain the saving is too great. In the extreme case of a hydro-electric station not requiring storage there is no appreciable difference between the total annual cost of supplying a 24-hour load (iron loss) and one which lasts only during the time of the peak load (copper loss), because the whole expense is made up of capital charges which depend on the maximum demand. In such a case the transformer should be designed to give the highest efficiency under peak-load conditions.

The case of a steam station is somewhat different, but even there the capital charges form a very important part of the total cost. High copper losses also mean a high voltage drop on unity power factor.

14. ADVANTAGES OF THE METHOD.

Most of the former writers on the subject have taken the product of the current and flux densities as the basis of their work, and some have even gone so far as to eliminate the losses, which may quite reasonably be supposed known, by expressing them in terms of the unknown current and flux densities. The present method reverses

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* The exact values of these coefficients for $x=3$, $y=3/4$ and $z=9\cdot4$ are 10·06, 5·03, 3·35, 7·54. The cost function is

$$£/£_0=1{,}101-1{,}483\,m,$$

which practically agrees with the minimum when $m=1$, and exceeds it by less than 3 per cent. within the limits $m=1/2$ and $m=2$.

this latter process, and, in addition to being more rational, it leads to the following advantages :—

1. The effects of the following items on the cost are separated from one another, so that each may be discussed without reference to the others—output, losses, quality of the materials and frequency, space-factors, actual and relative costs of the materials, type of transformer, proportions of the transformer.

2. Consequently the relative values of different materials, different types, and different proportions with any one type can be settled once for all.

3. The fundamental length can be at once obtained from the given data.

4. The dimension coefficients by which the fundamental length must be multiplied to get the main dimensions of the transformer whether it is decided to work to standard proportions or to take the cheapest for each case, have been or can be worked out once for all, so that the designer has only simple slide-rule operations to perform.

5. The only "trial and error" involved is that required by the estimate of suitable space-factors, and by the uncertainty as to the correct loss-length when the flux density is low.

The Paper concludes with four appendices, of which the first two show the application of the author's method to finding the best proportions of the Berry types of transformer; the third deals with the best distribution of copper between concentric coils, and the last gives tables of numerical data for the designing of all the usual types of transformers.

SUSTAINED RADIO FREQUENCY HIGH VOLTAGE DISCHARGES.*

BY HARRIS J. RYAN AND ROLAND G. MARX.

Summary.—It is shown that radio frequency corona brushes are maintained at low voltages and are destructive of insulation. The power factor is low, but the losses caused are very great. The sustained radio frequency voltage required to cause discharge may be as low as one-third of the audio-frequency voltage.

INTRODUCTION.

Little is known of the relation between discharge distances and voltages of the various sorts which arise. The evidence so far accumulated indicates that for given values of maximum voltage the discharge distances are almost independent of the characteristic variation of the voltage whenever the critical corona voltage is higher than the discharge voltage. It indicates, too, that the discharge distances are dependent upon the characteristic variation of the voltage whenever the critical corona voltage is below the discharge voltage. In regard to the latter condition, this evidence indicates further that the discharge distance will be longest when the voltage source or transient is most sustained, or when its frequency is the highest or when both of these characteristics are present. It follows that discharge distances should be found a minimum for low frequency high voltage and a maximum for sustained high (or radio) frequency high voltages. It thus appears that voltages which can be formed by accident may discharge through greater distances and do more damage than the same values of voltages as used in most commercial work.

DISCHARGE INTO THE ATMOSPHERE FROM A SINGLE ELECTRODE.

One terminal of a sustained high frequency high voltage source was grounded, the other was a 1 in. copper tube capped with a hollow copper sphere 2 in. in diameter. This spherical end of the high voltage terminal was mounted properly remote from all grounded objects. When a voltage of 50,000 at 88,000 sustained cycles was applied a dry red wood stick was brought near to the sphere and then removed. A spark passed from the sphere to the stick and immediately grew into a heavy brush discharge. It consisted essentially of an active mass of darting streamers. The character of this mass varied from that of a modified arc flame at the base to the familiar brush discharge at the extremities. We were then able to determine with a fair degree of approximation, our measurement correct to within 10 per cent., that the rate of energy supply to the discharge from the generator was about 1 kw. It is characteristic of the high voltage radio frequency discharge that it consumes a large amount of power, and if that power is not available, a discharge will not develop. It may start to develop and one can see some brush momentarily and [illegible] [illegible] discharge. [illegible] discharge [illegible] effect [illegible] be produced [illegible] places of [illegible] available. The discharge [illegible] place [illegible] was rather bright [illegible] produced a [illegible] [illegible] and was not accompanied by the familiar odor of ozone that is formed by the less violent audio frequency or intermittent radio frequency discharges. It is easily blown about by air currents. It may be blown by the breath from place to place on the ball. It can be fanned with a hat from the ball back along the 1 in. conductor, and put out as it is driven into the region of lower capacity in the vicinity of the conductor, that is, where the fields are less intense and where the energy cannot be delivered at the rate that the flame or the discharge requires.

A modification of the above experiment was arranged to enhance the flame-like portion of this discharge, and to eliminate most of the "brush" part. A circular metal disk 16 in. in diameter, provided with a 3 in. hole at its centre, and with ¼ in. guard tubing facing all edges, was hung centrally over, and about 3 in. above the 2 in. sphere terminal by means of non-conducting supports. The flame, though very strong, gives off no great amount of luminous radiation. The voltage and frequency were the same as before, viz., 50,000 and 88,000. The temperature of this flame was high. It melted quartz, rapidly disintegrated a tungsten lamp filament, and formed a bead on the end of a Nernst lamp filament. The metal of the electrodes was not greatly heated, and little or no metallic vapour appeared to enter the arc stream.

This flame discharge is not stable under all conditions. For example, when the inductance and capacity of the disk were increased by placing in contact with it one end of an insulated 1 in. copper tube 4 ft. long, the flame discharge was no longer quiet and stable, but became noisy and snappy, tending to develop into an intermittent disruptive discharge. The flame became unstable also when the electrode gap length of the arc generator was too short in adjustment.

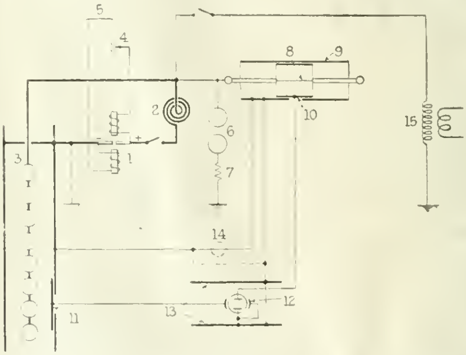

FIG. 1.—DIAGRAM OF CONNECTIONS FOR SUSTAINED RADIO FREQUENCY CORONA INVESTIGATION.

1. Arc Generator.
2. Air Inductance.
3. Air Condenser.
4. Resistance.
5. To 1,200 volt D.C. Supply.
6. Sphere Gap Voltmeter.
7. Carborundum Resistance.
8. Corona Wire.
9. Cylinder.
10. Potential Tapping Cylinder.
11. Potential Tapping Plate.
12. Cyclograph Quadrants.
13. Guard Plates.
14. Carbon Lamp Resistance.
15. 60-cycle High-voltage Transformer.

It appeared to be identical with the flame-like portion of the heavy brush discharge already referred to. Time did not permit a study of the extent to which the combustion of nitrogen was taking place in the flame. It seems as though something of the sort is occurring for the reason that ozone is not in evidence when this discharge occurs.

The ability of the radio frequency brush to produce thermionic conduction through glass, porcelain, quartz and all similar refractory insulations is perhaps its most remarkable property. This is illustrated by bringing any mass of high grade electrical porcelain near to or in contact with the sustained radio frequency electrode. In an actual case, the electrode was a ⅛ in. aluminium tube laid in the top groove of a 33 kv. porcelain line insulator that was itself placed on an insulating support and mounted remote from all objects of opposite or ground potential. On the application of 35 kv. at 200,000 cycles, the air between the tube and insulator was overstressed, small flame discharges conducted the insulator charging currents to the porcelain surface where one or more brilliant hot spots would appear in about 30 seconds.

SUSTAINED RADIO FREQUENCY CORONA ABOUT A WIRE.

The general arrangement of the equipment employed for the sustained radio frequency corona study is shown in the diagram of Fig. 1. The corona was formed around a number 19, B. & S. gauge clean copper wire held axially in a galvanised iron cylinder, 15 in. in diameter and 35 in. long. 12 in. of the wire at the centre of the cylinder were normally left clear, and the remainder was shielded by two brass tubes 1/16 in. in diameter. A third tube ½ in. in diameter was arranged to slip over the central portion of the wire, and shield that when desired. In this manner the corona could be suppressed, or it could be allowed to develop by removing the copper tube from the wire, and thus greatly increasing the stress on the atmosphere adjacent to the wire (because of the smallness of the wire circumference). We could thus check up the accuracy of the cathode ray power measuring meter.

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* Abstract of a Paper read before a joint meeting of The Institute of Radio Engineers and The American Institute of Electrical Engineers.

Various voltages up to about 30 kv. (root-mean-square) were impressed on the wire at sustained radio frequencies of 88,000 and 188,000 cycles per second; also at 60 cycles per second for comparisons. The appearance of the coronas at radio and audio frequencies differed greatly, while those at the two radio frequencies differed only slightly. That is to say, the enormous difference in corona at radio frequencies and at audio frequencies such as 60 cycles, is a difference that has come about perhaps gradually on the way up from 60 cycles to some such value as 50,000 cycles. At all events, to double, or a little more than double, the frequencies when one is operating at a frequency of as high as 80,000 cycles, produces very little effect on the character of the phenomenon. The radio frequency corona appeared very active, it was quite brilliant and noisy and gave off an appreciable amount of heat. At 30 kv. the average diameter of the radio frequency corona was about 2 in., whereas that at the audio frequency appeared to be less than ⅛ in

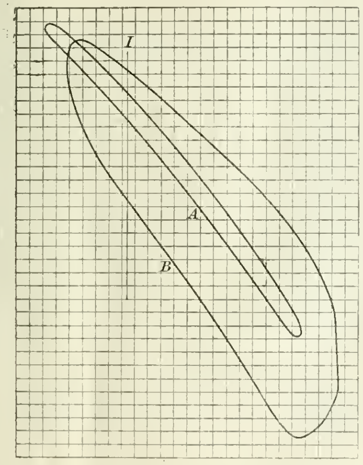


Fig. 2.

A. 187,600 cycles, 17·6 K.V. B. 60 cycles, 18·7 K.V.

Some observations were made to determine the relative values of the voltages required to start corona about the wire at 188,000 cycles and at 60 cycles. All voltages were determined with the same 5 in. spherical gap. Attention is called to the lack of information that we have as yet in regard to the standardisation of these gaps.

Cyclograms were taken of the energy consumed per cycle in the corona about the wire at 60, 88,000 and 188,000 cycles and at voltages ranging from 15,000 to 20,000 to determine the relative power factors and the wave forms of the currents flowing from the wire. The cathode ray tube was used in taking these cyclograms. The details of the method used have been given in a previous Paper. The actual arrangement of the cyclograph with its voltage and current condensers as used in the present work is given in the diagram of Fig. 1. Various trials were made to determine that the cyclograph gave true indications within its limits of action when high frequency high voltage was used. These trials were as follows: When the wire at Number 8, Fig. 1, was screened from corona formation by sliding the ½ in. brass tube over it, the cyclogram would close up into a right line loop without area. Thus arranged, by inserting an ordinary incandescent lamp at Number 14 the cyclogram would open so as to enclose a large elliptical area. Again using the radio frequency high voltage, the effect in the results due to the hysteresis or other loss in the glass of the cathode ray tube was found to be negligible by noting that a no-area cyclogram obtained with all four quadrants mounted on the exterior wall of the tube remained as such when all conditions continued the same except that one pair of quadrants was mounted within the tube.

With the aid of the lantern, enlarged images of these cyclograms were thrown upon a sketching board and tracings carefully made. Fig. 2 was engraved from these tracings. The distortion noted is due to the fact that the only suitable tube available for this sort of work was one of small size. To obtain sizeable cyclograms, it was necessary to permit some distortion in their lower portions. They are instructive, however, for they show that the radio frequency corona current wave suffers less distortion than the corresponding audio frequency corona current wave. They also show, under the conditions present, that the power factor of the radio frequency corona current was about one-quarter of the power factor of the corresponding audio frequency corona current.

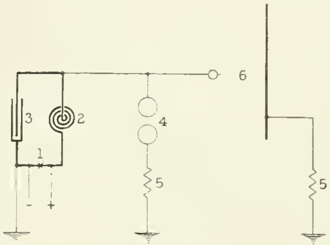


Fig. 3.—Diagram of Connections for Point to Plate Discharge.

1. Arc Generator.
2. Air Inductance.
3. Air Condenser.
4. Sphere Gap Voltmeter.
5. Carborundum Resistance.
6. Point to Plate Gap.

Discharge Between Blunt Point and Plate.

A needle point is promptly melted and burned by radio frequency brush discharge. Only blunt points can be used, therefore, to determine the radio frequency high voltages required to discharge across given distances when one electrode is or both electrodes are in corona. The scheme employed in this set of determinations is shown in Fig. 3 for the radio frequency or audio frequency discharges, and in Fig. 4 for combined audio and radio frequency discharges.

The blunt pointed electrode connected to the high frequency source was a square-ended piece of copper wire of 0·081 in. diameter, projecting axially from the main radio frequency high voltage electrode, constituted as before of a 1 in. copper tube ended with a 2 in. copper sphere. A galvanised iron sheet, 3 ft. square, was used as the grounded electrode. Carborundum resistances were employed at strategic points to avoid short-circuiting the machines that supplied the arc generator with continuous-current. The 5 in. sphere gap at Number 4, Fig. 3, was used to measure all voltages. The sustained radio frequency voltages that produced discharges between the point and plate also produced at slightly lower values heavy brushes that extended from the blunt point most of the distance to the plate. In fact, the discharges seemed to occur only when the brushes appeared to have fully bridged the space between the electrodes. Facilities were lacking for the measurement of the large amounts of power that were evidently consumed in these brushes.

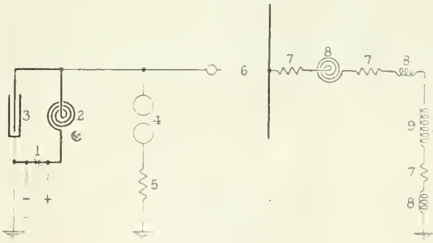


Fig. 4.—Diagram of Connections for Discharge with Combined Radio and Audio Frequency Voltage.

1. Arc Generator.
2. Air Inductance.
3. Air Condenser.
4. Sphere Gap Voltmeter.
5. Carborundum Resistance.
6. Point to Plate Gap.
7. Carborundum Protective Resistance.
8. Protective Air Inductance.
9. 60-cycle High-voltage Transformer.

The 60-cycle voltage source was substituted for the arc generator in this sustained radio frequency point to plate discharge equipment shown in Fig. 3; and voltage discharge distance measurements were then made to compare with the corresponding sustained radio frequency discharge distance measurements. Likewise for comparison a few determinations were made of the radio and audio cycle voltages required to discharge from the same blunt point to a similar blunt point in lieu of the galvanised iron plate.

The results obtained for the audio and radio frequency discharges are charted in Fig. 5, and for the composite discharge values produced by the simultaneous application of sustained radio frequency voltage from earth to the blunt point and of 60-cycle voltage from earth to the plate are given in the accompanying table. Two forms of discharge occurred and are designated "spark" and "arc" discharge. The former occurred at a somewhat lower voltage than the latter. The spark functioned to discharge the main condenser of the radio frequency generator and the arc to short-circuit the 60-cycle and 1,200 volt direct current sources. The sums, equivalents and differences recorded also in the table and the values at corresponding differences charted in Fig. 6 assist one to understand the parts that each voltage took in forming the composite discharges.

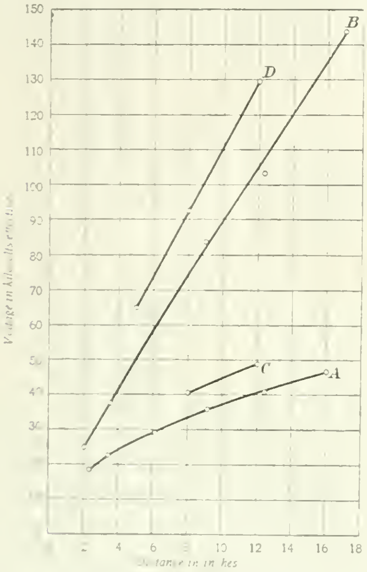
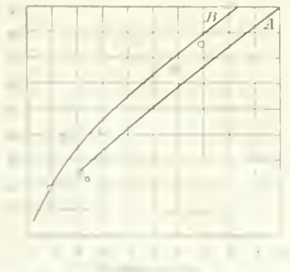


Fig. 5. Point Discharge.

A. Point to Plate, 88,000 cycles. C. Points, 88,000 cycles.
B. Point to Plate, 60 cycles. D. Points, 60 cycles.
Note.—Radio [illegible] sphere gap voltmeter calibration used in all cases.



[illegible]

[illegible] 1·5 [illegible] required to discharge 15 in. from the blunt point to the plate, [illegible] of 88,000 cycles. An increase [illegible] 60 cycles was required for an increase of 1 in. in the 15 in. discharge gap, while the corresponding increase at 88,000 cycles was only 1·5 kv. In other words, as the length of a 15 in. point to plate gap is increased the amount of increase of 88,000 cycle discharge voltage is one-fifth of that required at 60 cycles.

Table.—*Combined Radio Frequency and Audio Frequency Voltages Point to Plate Discharge.*

1 Gap distance in inches.	2 Radio frequency voltage in kilovolts.	3 Audio frequency voltage for spark discharge.	4 Audio frequency voltage for arc discharge.	5 Sum of the R. F. and A. F. voltages.	6 Discharge gap equivalent to radio frequency voltage.	7 Difference, column 6 subtracted from column 1.
5	28·7	...	...	...	...	...
5	...	...	51	...	...	...
5	21·2	22	...	43	2·6	2·4
5	21·2	...	22	43	2·6	2·4
5	22·4	23·5	...	46	2·9	2·1
5	22·4	...	24·5	47	2·9	2·1
5	26·4	12·5	...	37	4·1	0·9
5	26·4	...	18·5	45	4·1	0·9
12	42·9	...	...	...	...	...
12	...	...	105	...	...	...
12	29	...	75	104	5·1	6·9
12	31·8	...	65	97	6·2	5·8
12	37·5	33	...	70·5	9·0	3·0
12	37·5	...	41	78·5	9·0	3·0
12	40·3	21·5	...	62	10·5	1·5
12	40·3	...	38	73	10·5	1·5

Radio Frequency Voltages at 88,000 cycles. All voltages in terms of 5 in. gap; the calibration being taken as kilovolts (effective) = 2 + 45·5 × (gap distance in inches).

The composite discharge distances due to the combination of audio and radio frequency voltages are virtually the sum of the distances through which the individual voltages discharge. In the table, column 2, the radio frequency voltages alone would have discharged the distances given in column 6, which, when subtracted from the actual discharge distances in column 1, give the distances in column 7 as the added discharge distances due to the audio frequency voltages in column 4. These audio frequency voltages and the added discharge distances they caused are charted in Fig. 6. For comparison the A.I.E.E. standard needle gap voltage discharge curve and the 60-cycle point to plate discharge curve of Fig. 5 are also charted as curves "B" and "A" in Fig. 6. It is thus seen that the added discharge distances due to the superimposed audio frequency voltage are practically the same as the corresponding discharge distances produced by the identical audio frequency voltages acting alone.

PRESSURE OIL FILM LUBRICATION.*

BY H. T. NEWBIGIN, A.M.I.C.E.

The primitive form of journal bearing is merely a hole bored in the frame of a machine in which a shaft revolves, and the primitive thrust bearing is only a collar or shoulder on a shaft to prevent it moving endways.

Without lubrication a bearing will not run without excessive wear, and without artificial cooling no bearing with oil lubrication will run continuously if the temperature rises above 150° F., because at about this temperature most oils begin to carbonise. The efficiency of a bearing must, therefore, be such that the temperature due to the heat generated by its friction, minus that dissipated by radiation and conduction, does not exceed this figure.

In order to reduce the friction between two rubbing surfaces it is necessary to put something between them, and bearings may be classed into those in which this is a hard material, such as steel balls or rollers, or a viscous substance like oil or grease.

The first class consists of highly specialised machine parts designed to utilise to the greatest advantage the rolling action of balls or rollers in reducing friction, and their design is evolved from a study of this action. On the other hand, the second class in general consists merely in applying a lubricant to the primitive forms. They are not designed to utilise the action of the lubricant on any special principle. Ball and roller bearings have attained to a remarkable degree of perfection, and they are admirably suited for bearings in which the loads to be carried are comparatively light, or in which the motion is intermittent, but they are not suited to carry heavy continuous loads, especially at high speeds.

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* Abstract of a Paper read before Section G of the British Association at Newcastle.

In ball bearings the steel balls make point contact with hardened steel races, and the balls tend to flatten at the point of contact. Under excessive continuous loads this slight deformation of the balls causes their outer surface to shell off, the chips get under the other balls and ultimately destroy the construction of the bearing. The life of the balls is limited, frequent renewals are necessary, and to effect these renewals it is essential to dismantle the bearing.

In roller bearings the rollers make (or are supposed to make) line contact with the housing and with the shaft. Although they are able to carry heavy loads, it is very difficult to maintain correct alignment, and any slewing of the rollers sets up a heavy end thrust against the cage in which they work. Furthermore, as the rollers bear directly on the shaft, the constant rolling action tends to laminate the surface and so wear it away. In roller thrust bearings it is necessary to make the rollers conical, and as they therefore have a heavy radial thrust this type of bearing is not much used.

The great advantage of both ball and roller bearings is their low starting friction; for this reason they are especially suitable for intermittently moving machinery, but less so in the case of continuously running machinery.

It is with the second class of bearings—those in which the surfaces are separated by a fluid such as oil in the case of high-speed and grease in the case of slow-speed bearings—that this Paper is more immediately concerned.

The action of a lubricant is twofold: It first of all alters the nature of the rubbing surfaces, thereby reducing friction; but under favourable conditions it also automatically generates a high-pressure oil film between the surfaces, entirely eliminating metallic contact, and thereby enormously reducing the friction. This is what is now called "pressure oil film lubrication." It occurs to a limited extent in most journal bearings, but does not occur in ordinary collar thrust bearings.

The phenomenon of pressure oil film lubrication was first noticed by the late Mr. Beauchamp Tower during the course of a series of tests he made in conjunction with the Institute of Mechanical Engineers in 1883 and 1885. He found, while experimenting with a journal bearing, that under certain conditions the rotation of the shaft was capable of dragging the oil adhering to it in between the surfaces to such an extent as to force the surfaces apart with a high-pressure oil film, and that the highest pressure in this oil film was about twice the average pressure. He also found that the highest pressure was on the longitudinal centre line of the brass and a little forward of the sectional centre line in the direction of rotation, and that from this point the pressure fell to zero around the edges of the brass. A bearing under these conditions runs with very much less friction than under any other, and will carry a much higher load.

Following on Tower's experiments, the late Prof. Osborne Reynolds, F.R.S., in a Paper read before the Royal Society in 1886 on "The Theory of Lubrication," showed that the friction under the circumstances was merely that due to the viscous flow of the oil, and he showed how, by calculation based on the theory of viscous flow, a pressure curve may be obtained which closely approximates to that obtained experimentally by Tower.

From the practical point of view the most important things that he showed were:—

Firstly, that in order to obtain a pressure oil film between lubricated surfaces the surfaces must have a slight inclination to each other, with the opening at which the oil enters greater than that at which it leaves. Or, in other words, that the oil film must be wedge shaped.

Secondly, that in the case of a journal bearing the wedge form of the oil film occurs naturally, due to a slight shifting of the centre of the shaft in relation to the centre of the brass.

Thirdly, that such a wedge-shaped oil film cannot occur in a collar-thrust bearing: hence their inefficiency and low carrying capacity.

It was left to an Australian engineer and mathematician, Mr. A. G. M. Michell, of Melbourne, to complete and apply Reynold's theory.

In a Paper published in "Zeitschrift für Mathematik und Physik" in 1905, on "The Lubrication of Plane Surfaces," he gave the complete mathematical solution of Reynold's theory as applied to plane rectangular surfaces. And on the assumption that the thickness of the oil film at the entering edge is twice as great as at the leaving edge, he showed how lines of equal pressure within the film can be plotted, and how the centre of resultant pressure can be determined for plane rectangular surfaces of varying proportional cross dimensions. He also demonstrated practically that a rectangular block pivoted at its point of resultant pressure will automatically assume an angle to an opposing lubricated surface, depending on the speed of rubbing, viscosity of the oil and pressure. On this principle he founded his now well-known thrust bearing.

The result of Mr. Michell's work has been to enable lubricated thrust and journal bearings to be designed in accordance with the principles of oil film lubrication. The essential feature of the Michell bearings is the subdivision of the stationary surface into a number of blocks or pads, each pivoted at its back, and so free to assume a slight angle with its contacting surface.

The importance of efficiency in machinery is not merely a question of economy of power or fuel, it also controls the practicability of a design and the design of bearings is an example of this. For example, in the design of a large multi-collar thrust bearing, he has given a shaft of a certain diameter, revolving at a certain speed, and which has to withstand a certain thrust. The resistance to turning will be about 0·03 of that thrust, and the greatest load that the bearing surfaces will carry with safety is about 50 lb. per square inch.

In order to bring the pressure down to this figure he may either use a few collars of large diameter or a number of collars of small diameter. If he does the former, he increases the radius at which the friction acts, and so the power absorbed and the heat generated, and if he does the latter it becomes increasingly difficult to maintain an equal distribution of the load among the collars, especially under the variations of expansion due to the heat generated when the bearing is at work. Furthermore, whatever compromise he makes, there comes a point beyond which the size, load and speed cannot be increased, because, owing to the high coefficient of friction, the heat is generated more quickly than it can be dissipated by radiation and conduction, even with the aid of water cooling. This point was reached in the case of the thrust bearings in geared turbine-driven vessels.

The Michell thrust bearing, which goes to the root of the matter, and is designed from the point of view of the action of the lubricant in automatically generating a pressure oil film between the surfaces, has formed a complete solution of the difficulty. It has a coefficient of friction of about 0·0015 as against 0·03, and carries 200-300 lb. per square inch with a much greater factor of safety than the primitive form has at 50 lb.

In one form of marine thrust block the friction is about one twenty-fifth of that in the multi-collar type.

Upwards of 800 Michell thrust bearings are now running in this country alone, in sizes varying from 1 in. to 15 in. diameter of shaft, and larger sizes are in the course of construction. The use of them is radiply becoming the standard practice in steam turbine work. The same principle is now being applied to journal bearings.

In lubricated journal bearings of the primitive type (as already stated) the phenomenon of pressure oil film lubrication occurs naturally, due to the slight shifting of the centre of the shaft in relation to the centre of the brass, but its occurrence is much less marked in the case of bearings of large diameters. But by subdividing the circumferential surface into a number of segments, each of which is pivoted at its back and thereby free to form an independent pressure oil film between its rubbing surface and the shaft, the number of the pressure oil films can be increased, so that the full projected surface of the bearings become effective for carrying load and the brake surface is eliminated. The friction is thus reduced, the load carrying capacity increased and the bearing shortened.

THE AIR-GAP FIELD OF THE POLYPHASE INDUCTION MOTOR

BY F. T. CHAPMAN, D.SC.

(*Concluded from page 938, Vol. LXXVII.*)

SUMMARY OF CONTENTS.

V.—Oscillograms Illustrating Parts II., III. and IV.
VI.—Conclusion and Table of Air-gap Dispersion Coefficients.

V.

32. The following oscillograms illustrate the nature of the flux in the air-gap and the effects due to saturation and rotor currents which have been discussed in the previous sections. They were obtained by means of the four-pole motor already referred to (Section 26) which had 36 semi-closed slots in the stator and 41 nearly closed slots in the rotor; the stator carried a full-pitch winding of chain type, the rotor a squirrel-cage winding.

A number of special test windings were placed in various positions on stator and rotor. The first group of these windings consisted of several four-pole single slot windings fixed to the wooden wedges which closed the slots and wound in adjacent sets of slots. By connecting these windings separately to the oscillograph the manner in which the flux wave varied from point to point could be studied, and by connecting adjacent windings in opposition the rate of variation of the flux in the intermediate teeth could be investigated. A 12-pole single-slot winding was also fixed on the stator with its conductors in the openings of the centre slots of all the phase groups, this winding was non-inductive to all fields in which the number of poles was not divisible by three, and was employed for studying the third multiple field due to saturation.

An approximate 20-pole winding was arranged on the rotor by connecting in series 20 conductors in the openings of alternate slots. The distance from one conductor to the next was thus 2/41 of the rotor circumference instead of 1/20 as required by an exact 20-pole winding. This winding was connected to the oscillograph circuit through slip-rings. The E.M.F. generated in it by any one of the multiple fields of the stator, when the rotor is running at synchronous speed, is proportional to the amplitude of that field multiplied by the factor corresponding to it which is given in Table X. below. This Table also gives the frequencies of the E.M.F.s when the main supply is at 50 cycles per second.

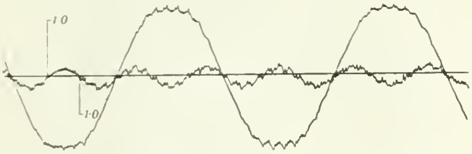


Fig. 16.—E.M.F.s in 4-pole and 12-pole Test Windings.

Terminal voltage=40·2 per phase. Frequency=50. No load. Maximum air-gap density=29,600 lines per square inch.

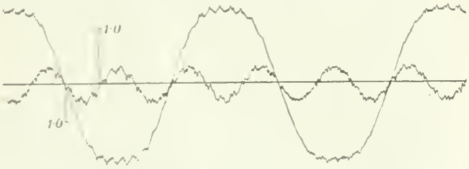


Fig. 17.—E.M.F.s in 4 pole and 12-pole Windings.

Terminal voltage=46·4 per phase. Frequency=50. No load. Maximum air-gap density=33,800 lines per square inch.

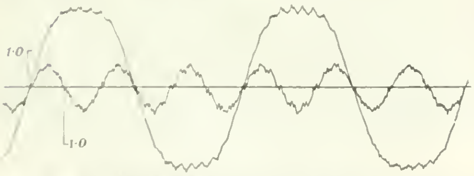


Fig. 18.—E.M.F.s in 4-pole and 12-pole Windings.

Terminal voltage=49·6 per phase. Frequency=50. No load. Maximum air-gap density=34,920 lines per square inch.

Table X.

Order of multiple field	1	5	7	11	13	17	19	23	25	35
E.M.F. factor	0	21·7	1·1	1·11	1·27	1·13	0·21	0·27	3·2	3·02
Frequency	0	300	300	600	600	900	900	1,200	1,200	1,800

The curves of Figs. 16, 17 and 18 were obtained by connecting a four-pole test winding lying in the centre slots of one phase group to one element of the oscillograph and the 12-pole winding to the other. The motor was running light in each case under the conditions stated below the curves. These oscillograms show the growth of the triple field as the saturation of the iron increases.

The conditions of Fig. 19 are similar to those of the preceding figures except that the motor is loaded; the density in the iron is approximately the same as in Fig. 17, but the triple wave is smaller and its position with respect to the fundamental is changed.

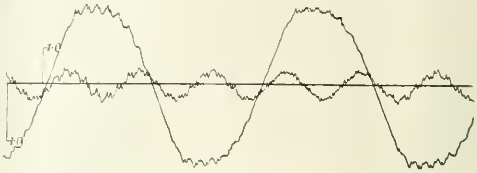


Fig. 19.—E.M.F.s in 4-pole and 12-pole Windings.

Terminal voltage=48 per phase. Frequency=50. Full load. Maximum air-gap density=34,000 lines per square inch.

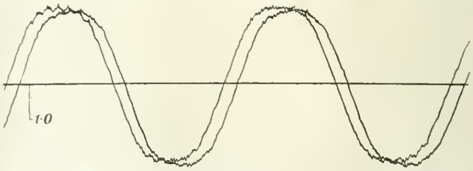


Fig. 20.—E.M.F.s in 4-pole Windings in Adjacent Sets of Slots.

Voltage per phase=43·6. No load. The winding with the earlier E.M.F. is in the centre slots of phase groups, the other winding in side slots.

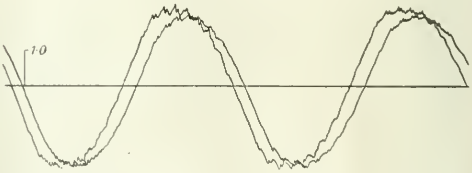


Fig. 21.—Windings as for Fig. 20.

Voltage per phase=44. Full load.

Figs. 20 and 21 show the E.M.F.s in adjacent four-pole test windings, the earlier wave was obtained from a winding in the centre slot of a phase group, and the difference between the two, due to the backwards rotating 12-pole field (Sec. 28) can be detected. Figs. 22 and 23 are in marked contrast to 20 and 21. They were obtained from the same windings, but one end ring had been removed from the rotor, which was stationary. The ripples due to the rotor multiple fields are now absent, but

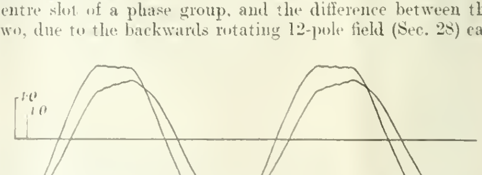


Fig. 22.—Windings as for Figs. 20 and 21. Rotor End Ring Removed, Rotor Stationary.

Volts per phase=40·5. Frequency=50.

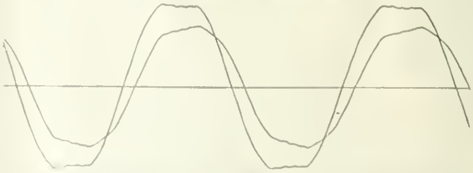


Fig. 23.—Windings as for Figs. 20–22. Rotor End Ring Removed, Rotor Stationary.

Volts per phase=4[illegible]·4. Frequency=50.

there is a fifth harmonic which is due to a four-pole field rotating at five times synchronous speed and corresponding to a harmonic in the wave of the alternator supplying the power. The damping effect of the rotor on such fields is evident on comparing these two sets of figures.

Figs. 24, 25, 26 and 27 were obtained by joining up the four-pole windings in pairs in opposition and connecting them to the two elements (A and B) of the oscillograph as shown in Fig. 23a. A resistance was connected in one circuit in order to definitely change the scale for one pair of windings. An oscillogram was then taken (Fig. 24); the connections were changed to those shown dotted and the next oscillogram (Fig. 25) taken. Thus the large wave of Fig. 24 is the small one of Fig. 25. At no load the fluxes in adjacent teeth are nearly equal and the phase differences are practically uniform. Figs. 26 and 27 taken with load on the machine show marked differences in both respects as predicted at the end of Sec. 29.

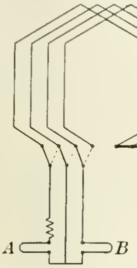


Fig. 23a.—Connections for Figs. 24, 25, 26 and 27.

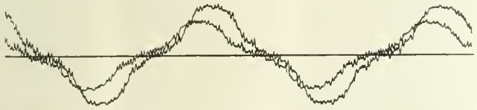


Fig. 24.—Rate of Change of Flux in Adjacent Teeth (to different scales). Motor Running Light.

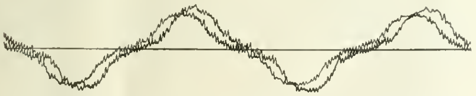
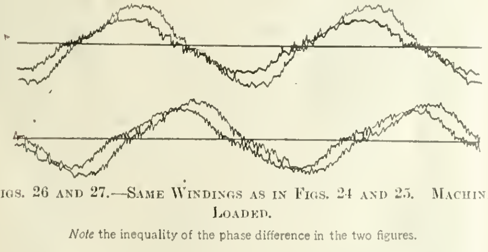


Fig. 25.—Rate of Change of Flux in Adjacent Teeth.

The smaller curve of this figure and the larger one of Fig. 24 refer to the same tooth. *Note* the approximate equality of the phase difference in the two figures.

The remaining figures were taken by means of the 20-pole rotor winding. Nos. 28, 29, 30 and 31 were obtained with one end ring removed, and the rotor driven by external means at a speed slightly below synchronism. It may be observed from these oscillograms that the fifth field does not increase in the same proportion as the terminal voltage for the reasons explained in Part IV., in fact, there is no appreciable difference in the amplitude of the 300-cycle wave between Figs. 28 and 29. The most important E.M.F.s of other frequencies are due to the seventeenth and thirty-fifth fields respectively, each of which is accentuated in this machine by the stator slot openings; these E.M.F.s increase steadily as the terminal E.M.F. increases in spite of increasing saturation, and this fact is in accordance with the conclusions of Part IV. (*see* Table VII.)



Figs. 26 and 27.—Same Windings as in Figs. 24 and 25. Machine Loaded.

Note the inequality of the phase difference in the two figures.

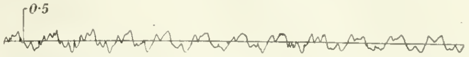


Fig. 28.—E.M.F. in 20-pole Rotor Winding. End Ring Removed. Rotor Driven by External Means.

Terminal voltage per phase=32.

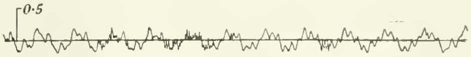


Fig. 29.—E.M.F. in 20-pole Rotor Winding. End Ring Removed.

Terminal voltage per phase=37·5.

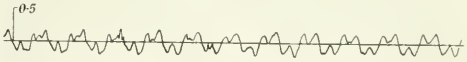


Fig. 30.—E.M.F. in 20-pole Rotor Winding. End Ring Removed.

Terminal voltage per phase=43·5.

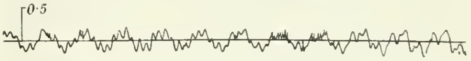


Fig. 31.—E.M.F. in 20-pole Rotor Winding. End Ring Removed.

Terminal voltage per phase=49.

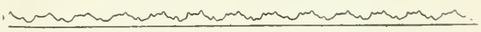


Fig. 32.—E.M.F. in 20-pole Winding. Squirrel Cage Complet

Terminal voltage per phase=37. No load. Current per phase=4·3 amperes.

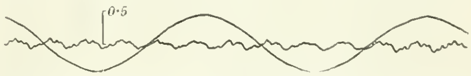


Fig. 33.—E.M.F. in 20-pole Winding. Squirrel Cage Complete.

Terminal voltage per phase=40. No load. Current per phase=4·6 amperes. Large wave=terminal E.M.F. per phase.

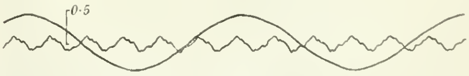


Fig. 34.—E.M.F. in 20-pole Rotor Winding. Motor Loaded.

Terminal voltage 37·5. Current per phase 8 amperes.

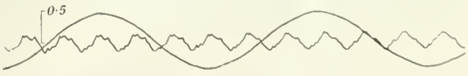


Fig. 35.—E.M.F. in 20-pole Winding. Motor Loaded.

Terminal voltage=37·5. Current per phase 10 amperes.

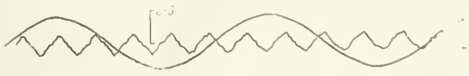


Fig. 36.—E.M.F. in 20-pole Rotor Winding. Motor Loaded.

Terminal voltage per phase 37·5. Current per phase 12 amperes.

The curves of Figs. 32, 33, 34, 35 and 36 were taken with the rotor winding complete; they show the growth of the fifth harmonic to be practically proportional to the stator current when the motor is loaded, and therefore justify the employment of a constant value for λ' over the working range. A comparison of Fig. 32 with Fig. 28 shows the damping effect which the rotor currents exert on these fields.

These experiments were made in the Electrical Laboratory at Faraday House, and the author desires to express his obligation to Dr. Russell for the facilities which were placed at his disposal.

VI. Conclusion.

33. We may summarise the results of the previous sections as follows :—

(1) The circle coefficient as defined in equation (53) may be expressed in the form $\sigma=(1-\lambda_1')(1+\lambda_2')(1+\lambda_1)(1+\lambda_2)-1$, or approximately $\sigma-\lambda_1'-\lambda_2'+\lambda_1-\lambda_2$, where the coefficients λ_1' and λ_2' take account of the air-gap dispersion in stator and rotor respectively, and λ_1 and λ_2 include the remaining dispersion.

(2) When the effects of saturation in the iron and of the reaction of the rotor currents may be neglected, the values of λ' are given rigorously by the simple expressions shown in equations 63, 64 and 65. Numerical values for these quantities are given in columns headed (A) in the tables below; these are the maximum possible values which λ' may have.

(3) A squirrel-cage secondary winding, by damping the multiple fields which the primary winding tends to produce, decreases the coefficient of air-gap dispersion for that winding. Columns headed (B) in the tables below give values of λ' appropriate to this case, calculated on the basis of a squirrel-cage winding with 10·25 slots per pole. The values in these columns may be taken to represent the maximum reduction which the rotor reaction is likely to effect.

Table XI.—*Three-phase Windings.*

Slots per pole. q.	Slots per pole per phase m.	Reduction in span b.	Q.	K_{m_1}.	λ'. No saturation. Two- or three-phase rotors. (A)		λ'. With saturation. Two- or three-phase rotors. (C)	
						Squirrel-cage rotors. (B)		Squirrel-cage rotors. (D)
3	1	0	1·333	1·000	0·097	0·043	0·097	0·043
6	2	0	1·166	0·966	0·029	0·022	0·028	0·022
6	2	1	1·083	0·933	0·024	0·019	0·023	0·019
9	3	0	1·136	0·960	0·014	0·012	0·012	0·011
9	3	1	1·099	0·945	0·012	0·010	0·010	0·009
12	4	0	1·125	0·958	0·0089	0·0069	0·0076	0·0067
12	4	2	1·048	0·925	0·0073	0·0067	0·0065	0·0064
15	5	0	1·120	0·957	0·0065	0·0046	0·0056	0·0043
15	5	2	1·069	0·936	0·0043	0·0039	0·0039	0·0038
18	6	0	1·117	0·956	0·0052	0·0037	0·0046	0·0035
18	6	3	1·040	0·923	0·0029	0·0027	0·0026	0·0026
21	7	0	1·116	0·956	0·0044	0·0033	0·0040	0·0031
21	7	3	1·058	0·932	0·0023	0·0020	0·0020	0·0020
[illegible]	[illegible]	0	1·111	0·955	0·0021	0·0007	0·0021	0·0007
[illegible]	[illegible]	[illegible]	1·045	0·922	0·00026	0·0001	0·00023	0·0001

Table XII.—*Two-phase Windings.*

Slots per pole. q.	Slots per pole per phase m.	Reduction in span b.	Q.	K_{m_1}.	λ'. No saturation. Two- or three-phase rotors. (A)		λ'. With saturation. Two- or three-phase rotors. (C)	
						Squirrel-cage rotors. (B)		Squirrel-cage rotors. (D)
[illegible]	[illegible]	0	[illegible]	[illegible]	0·047	[illegible]	0·040	0·024
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	0·024	0·031	[illegible]
[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	0·017	0·028	0·016
8	[illegible]	[illegible]	[illegible]	[illegible]	0·018	0·014	0·017	0·014
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·012	0·022	0·012
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·0096	0·014	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·010	0·018	0·010
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

USE OF METAL SLOT WEDGES IN INDUCTION MOTORS.*

BY BLAINE B. RAMEY.

Summary.—The purpose of this article is to give in brief a clear understanding of the effect on motor performance of different types of wedging and slot construction. Where mathematical derivations and technical explanations are necessary, these are given as concisely as possible.

As electrical apparatus of the rotating type has developed through various stages to the present design there has been a general tendency towards the use of open slots in both the stationery and rotating members (the latter in phase-wound rotors only), which permits the use of form-wound or pulled coils, which can be inserted in the slots as a unit and also readily removed. The use of metal wedges in open slots, however, practically realises the advantages possessed by partially closed slots, and at the same time does not materially alter the advantages of the open-slot construction. Slots with metal wedges, with fibre wedges and with partially closed top are illustrated in Fig. 1 (*a*) to (*d*). The metal wedges are insulated from the teeth, and as now perfected are beyond criticism from the operating and commercial standpoints. When used they become practically a part of the core, so far as maintenance and operation of the motor are concerned, but are readily removable when necessary.

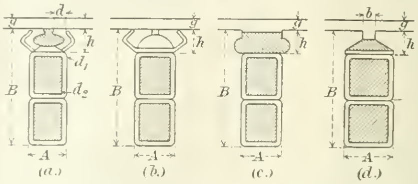


Fig. 1.—Typical Slot Arrangements.

(*a*) Three-piece metal wedge in open slot (the outside members are of steel and the centre member of brass). (*b*) One-piece slotted steel wedge in open slot. (*c*) Open-slot fibre wedge. (*d*) Partially-closed slot, fibre wedge.

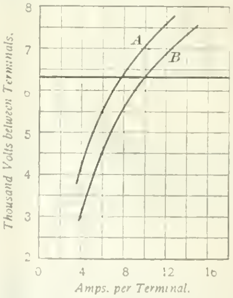


Fig. 2. Magnetising Current.

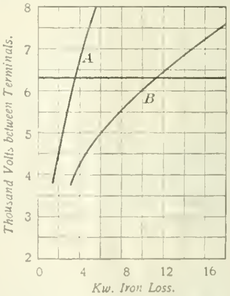


Fig. 3.—Core Loss.

Test results on 150 H.P. three-phase 25-cycle 6,300-volt 720 revs. per min. induction motor.

A—Magnetic slot wedge (cast-iron and special metal).
B—Fibre slot wedge.

Effect on Motor Performance.—The main characteristics in induction motor performance are efficiency, power factor, torque and heating, and all four are modified by the use of metal wedges.

A comparison of test data on the same motor with fibre wedges and with metal wedges is given in the table. Figs. 2 and 3 show respectively a comparison of magnetising current and iron loss on

Table *Test Data of Induction Motors.*

	Open slot.	Metal wedged slot.
Magnetising amperes per terminal	20·8	17·1
Iron loss (watts)	1,779·0	913·0
Locked amperes	742·0	684·0
Locked watts	126·0	98·0
Reactance in ohms per phase	0·151	0·171
Full-load power factor	95·2	96·0
Full-load efficiency	87·5	90·8
Pull out torque	4·1 F.L.T.	3·56 F.L.T.
Starting torque	2·36 F.L.T.	1·76 F.L.T.

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* Abstract of an article from the "Electric Journal."

another motor, with fibre wedges in one case and with a one-piece wedge of cast iron and special metal in the other. The metal wedges reduce the magnetising current and iron loss, thereby increasing the power factor and efficiency, the latter being affected by both reductions. Also there is a slight reduction in both pull-out and starting torque, but not to values that are objectionably low. The torque could be increased again by using less turns in the primary, thereby decreasing the leakage, and by a little more resistance in the secondary. Since the magnetising current and core loss are already reduced, the margin in power factor and efficiency is quite large, and these changes can be made without reducing either of these characteristics to an undesirable value.

Magnetising Current.—Other things remaining equal, the magnetising current varies directly as the ampere-turns necessary to produce the required flux. Of the total ampere-turns of the motor, that component which represents the ampere-turns necessary to force the flux across the air-gap usually represents the major portion, and also is the only one which is affected by a change in slot wedges. The effective air-gap is dependent upon the actual air-gap and the gap factor. The latter is composed of two parts, that due to the secondary slot opening and that due to the primary slot opening. With the same secondary slot, the gap factor will then be dependent only on the nature of the primary slot. The gap factor for either primary or secondary is figured from the actual air-gap, the slot pitch and the slot opening in accordance with a modification of Carter's* fringing factor formula. The gap factor varies with these items in such a way that the slot with the largest opening at the air-gap has the largest gap factor—that is, it is in effect the same as having a larger air-gap.

In Fig. 1, (a), (c) and (d), assume the same number of slots and same air-gap, and let s represent slot pitch, b slot opening and g air-gap. The major dimensions of the slots in the three figures are the same—viz., $A=0{\cdot}3$, $B=1{\cdot}5$, $s=0{\cdot}8$, $g=0{\cdot}05$, $h=0{\cdot}125$ Let $b=0{\cdot}184$ for (a), 0·3 for (c) and 0·125 for (d). Then for the three cases the gap factors are: For (a), 1·11; for (c), 1·255, and for (d), 1·053. The value of $b=(A-d)$ from experience and test results. The steel portions of the wedge seems to be only half as effective as would be expected at first glance. This is due to the fact that the steel wedge is not as efficient as a tooth tip which is punched as a part of the tooth, because considerable magnetic reluctance is introduced by the paper insulation between the steel wedge and the tooth proper. The results above obtained indicate that the gap factor for the metal wedge slot will be less than for the open slot, but not quite as small as for the partially closed slot. The values of the magnetising currents in the three cases will be in the same order. This explains the lower magnetising current for metal wedges as against fibre wedges in Fig. 2. Also the higher power factor means a lower full-load current and less primary copper loss, which helps towards higher efficiency.

Iron Loss.—The iron loss is composed of primary tooth loss, loss in the primary core and loss in the surface of the rotor. The dimensions of core and teeth being the same, the first two items will not be appreciably affected by the nature of the slot opening. The last item, however, is affected considerably by the slot opening. The flux in passing out of the teeth at the air-gap tends to form in tufts at the tooth tips, giving a higher density over the surface of the tooth than in the space opposite the slot opening. This produces variations or pulsations in flux at a frequency corresponding to the number of slots in the primary, which appear as a wave of high frequency superimposed on the fundamental wave of the rotating field of the motor, as shown in Fig. 4. This wave is an even harmonic of varying amplitude, apparently composed of two odd harmonics. A beating action is produced, and the high-frequency wave will reverse every half cycle of the fundamental flux wave. These high-frequency flux pulsations tend to create losses in the rotor surface, for they result in rapid magnetising and demagnetising of the iron of the rotor. This results in hysteresis loss of a considerable amount, since the hysteresis loop is displaced from its normal axis.† Furthermore, the increased frequency and amplitude of the pulsations result in higher losses. This frequency will be the same for the three types of construction when the number of slots is the same. The amplitude, however, will be different, as will be explained later. The fringing of the flux tends to smooth out these variations or decrease the amplitude, but the fringing has less effect with a greater slot opening and has no effect on the frequency. With the same number of slots and the same slot width for the various slots represented in Fig. 1, the flux densities over the tooth surface will be different. With the dimensions assumed above for these slots, the tooth width at the surface of the primary is, for (a), 0·616; for (c) 0·5 and for (d) 0·675. The flux density in the tooth face will, therefore, be greater for the open slot than for either the metal wedge slot or partially closed slot. Taking this, together with the fact that the fringing is not as effective to smooth out the variations in the flux on the open slot as on the other two types, it is evident that the variations in flux density are greater, and consequently the surface loss is higher with the open slot. In other words, the action of the metal wedge (and the tooth tip on the partially closed slot) is to make the flux distribution in the air-gap more uniform than is the case with the open slot, and, since the pulsations are not as great, the surface iron loss produced is less. The partially closed slot, of course, shows a greater reduction in iron loss than the metal wedge slot, all of which accounts for the test results in Fig. 3 showing considerably more iron loss for the open slot than for the metal wedged slot.

Leakage Flux.—The third and last item to consider is the effect on the leakage flux, which is composed of five parts, namely, that around the primary slot, the secondary slot, the primary end connections, the secondary end connections, and that between primary and secondary, known as zigzag leakage. In the case of wound secondaries there is a sixth part, known as belt leakage, but this is usually inconsiderable, and will not be considered here, as it is not dependent upon the primary slot construction. The latter fact is also true of the secondary slot, and the primary and secondary end connection leakage, which eliminates them from consideration, leaving only the primary slot and zigzag leakages to be considered.

The Primary Slot Leakage is directly proportional to the slot factor (among other items), but these other items will be the same, assuming the electrical and mechanical dimensions of the motor to be the same. The slot factor, however, will be different for different slot construction, but is independent of the other dimensions of the machine Therefore, other conditions remaining the same, the relations of the slot factors to each other for the various slot constructions will show the relation of the primary slot leakages to each other.

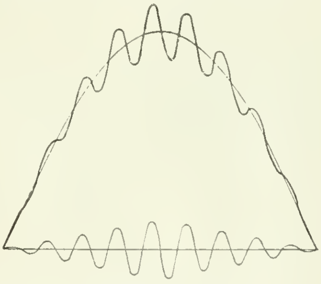

Fig. 4.—Effect of High-frequency Flux Pulsations on Fundamental Wave.

It is known from experience with the type of wedge shown at (a) in Fig. 1 that the slot factor for the portion of the slot to the bottom of the wedge is 0·937 for $A=0{\cdot}3$. That due to insulation at d_1 and d_2 is three-eighths of the total insulation divided by the slot width $=0{\cdot}066\div0{\cdot}3=0{\cdot}220$, assuming the total insulation depth $=0{\cdot}176$ in. In this it is assumed that the insulation at the top of the slot is one-quarter of the total insulation, which is theoretically correct, although practically there is a little more due to the lapping of the slot cells at the top.

That due to the copper is, of course, the total copper depth divided by three times the slot width $=1{\cdot}34$. Therefore the total slot factor $=0{\cdot}937+0{\cdot}220+1{\cdot}34=2{\cdot}497$.

For (c), Fig. 1, the factor for the portion of the slot to the top of the coil insulation will be the depth to the top of the coil divided by the slot width $=0{\cdot}417$.

That for the insulation and copper will be the same as for (a), Fig. 1. Therefore the total slot factor $=0{\cdot}417+0{\cdot}220+1{\cdot}34=1{\cdot}977$.

For (d), Fig. 1, although the insulation is usually heavier and the copper space less, these will be assumed the same as the other two, which will not be appreciably in error. Then the slot factor for these two parts will be the same as for the other two slots. That for the part of the slot down to the top of the coil insulation will be the depth to the tapered part of the tooth tip divided by the slot opening, plus the depth of the tapered part of the tooth tip divided by the average of the width of slot and slot opening $=0{\cdot}5+0{\cdot}294=0{\cdot}794$. Then the total slot factor $=0{\cdot}794+0{\cdot}220+1{\cdot}34=2{\cdot}351$.

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* "Electrical World and Engineer," October 30, 1901.

† "Proceedings" of Am. Inst. E.E., October, 1915.

This shows that, of the three slot constructions considered, that with the metal wedge has the highest slot factor, even higher than the partially closed slot, and consequently it has the greatest primary slot leakage.

Zigzag Leakage.—The other portion of the leakage reactance that is affected by the slot construction is the zigzag leakage. There are a number of items upon which it is dependent, but, as before, all of these items but one will be the same for the same mechanical and electrical dimensions of the motor. This other item—namely, the effective air-gap—will be different for the different slot constructions, although the various dimensions of the motor are the same. The zigzag leakage is inversely proportional to the effective air-gap, so the slot construction that gives the largest effective air-gap will have the lowest zigzag leakage.

Referring again to the section devoted to magnetising current, it will be noted that the open slot has the largest gap factor, with the metal wedge slot next and the partially closed slot next in order. The effective air-gap will have the same relation, since the effective air-gap is the product of actual air-gap and the gap factor. Therefore the open slot will have the smallest zigzag leakage, with the metal wedge slot next and the partially closed slot next in order.

Summing up the total leakage flux, it will be noted that the open slot has the smallest leakage, with the metal wedge slot and the partially closed slot following, the order in this case being doubtful without more detailed calculation. It is known, however, from tests that the partially closed slot has a greater leakage than the metal wedge slot, other things being equal.

Since the metal wedge slot has more leakage flux or reactance than the open slot, it will have greater impedance, the resistance being the same, and consequently less current will flow for a given voltage and less wattage will be obtained. This accounts for the results indicated in the table. With less current flowing for a given voltage there will be less torque, as the torque will vary directly as the current. Therefore the higher leakage flux accounts for the lower torque obtained with the metal wedged slot construction as against the open slot.

Conclusion.—From the data given and the foregoing discussion it will be seen that, while the metal wedged slot construction does not give as low magnetising current and iron loss as the partially closed slot, it does give lower values than the open slot. At the same time it maintains the advantages of the open slot in ease of winding and repair. The leakage flux is higher and the torques lower, but with the margin to spare in both magnetising current and losses as mentioned it is possible to reduce the number of turns per coil and perhaps increase the size of conductor in the metal wedged slot. By this means it is possible, while maintaining a high power factor, to obtain still higher efficiency (at higher loads at least) than with the open slot construction. Also the torque of the open slot construction can probably be equalled. Or, if desired, with the turns per coil the same as on the open slot motor, a larger air-gap can be used with the metal wedged slot construction, maintaining the same power factor as with the open slot construction and gaining some in efficiency and torque, due respectively to less iron loss and less leakage. The metal wedged slot construction thus gives a certain flexibility in design, so far as performance is concerned, and opens up possibilities for working the active material more efficiently than is possible with the open slot construction, while at the same time all the advantages of the open slot construction are retained.

A NEW METHOD OF GRADING SUSPENSION INSULATORS.*

BY R. H. MARVIN.

[illegible]—Attention is drawn to the known disadvantages of the [illegible] distribution of voltage in long strings of discs. The general theory, showing how the distribution is determined by the various capacities of the units, is given. It is shown how the distribution can be improved by grading or varying the internal capacity of the units. The proposed method of grading consists in [illegible] that metal rings on the [illegible] around the cap and stud respectively, the porcelain disc being designed for this purpose. A simple method of measuring the voltage distribution is described using a sample needle gap. The results of tests with and without grading are given, the graded strings showing a decidedly better distribution of voltage.

A number of plans for improving the voltage distribution along a string of suspension insulators have been suggested. These all consist in varying the electrical characteristics of the successive units in a definite manner, and a string of insulators so arranged is said to be graded. The object of this Paper is to describe a new method of grading, and to show some results obtained with it.

Before proceeding it is advisable to give a brief discussion of the fundamental principles involved in grading a suspension insulator.

Theory of Grading.—The distribution of the impressed voltage along a string of units is determined by the relations among the four groups of capacities involved. (1) The capacity through the porcelain between the cap and stud of each unit, which may be called the internal capacity; (2) the capacities between the metal fittings and the earth or grounded objects; (3) the capacity from a metal fitting on one portion of the string to any other portion of the string; (4) the capacity between the metal fittings and the line wire. In theoretical discussions only the first two groups are usually considered, but experiments indicate that the others have an appreciable effect.

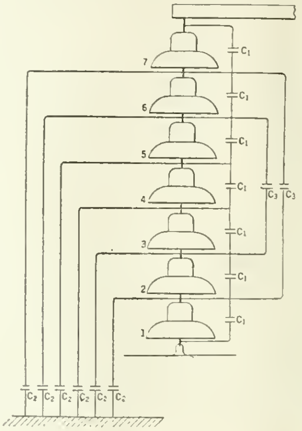

FIG. 1.

Considering the first three groups only, the capacitances in a string of units may be represented as in Fig. 1. For the sake of clearness, only part of the capacities between the various parts of the string are shown.

It is readily seen that the current to charge all the capacities C_1, C_2 and C_3 must pass through the internal capacity C_1 of unit No. 1. The internal capacity C_1 of unit No. 2, has to supply current to the succeeding C_1 capacities, but has a smaller number of C_2 and C_3 capacities to charge. Consequently the first unit has a higher voltage across it than the second. The same reasoning applies to the other units. It appears, therefore, if we neglect the C_3 capacities, that No. 7, the grounded unit, will have the lowest voltage across it. The capacities C_3 tend, however, to make the voltage across the middle unit the lowest, so that the total result is that one of the units near the grounded end, and not the grounded unit, has the lowest voltage across it. This will be seen in the experimental curves to be described later.

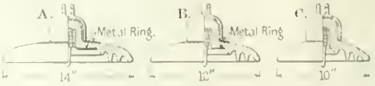

FIG. 2.

The principle of grading consists in varying the internal capacity C_1 from unit to unit, so that the voltage across each unit is kept as nearly as possible the same. This means that the unit next to the line must have the greatest internal capacity, C_1, and successive units, decreasing amounts.

Method of Grading Adopted.—To obtain the necessary variation in the capacity from cap to stud, sheet metal rings are placed around the cap and stud where it is desired to increase the internal capacity. By varying the width of these rings, the capacity can be varied over a considerable range. Of course, the external capacities C_2 and C_3 of the unit are also varied by this, but not in the same proportion as C_1. To secure a perfectly even distribution of voltage it would be necessary to have each unit different, entailing great complication and rendering manufacture very difficult. It was, therefore, decided to make a compromise, and divide the string into two, three or more groups, each group having different characteristics from the others.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

Fig. 2 shows three different sizes of units designed for use in a three-group string. On account of the width of the metal rings it is necessary to increase the diameter of the porcelain so as to give the correct flash-over voltage. The metal rings are stamped or spun out of sheet metal. They are held in place by the cap, and by the cement around the stud. A string would be composed of a certain number of *A* units next to the line, followed by a number of *B* units, while the rest of the string to the tower end would consist of the plain *C* units.

Measurement of the Distribution of Voltage.—Before proceeding with the results obtained it is advisable to give a brief description of the method of investigation.

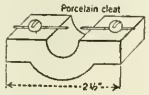

FIG. 3.

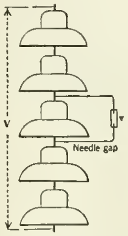

FIG. 4.

It is evident that a flash-over test is useless as an indication of the strains at normal voltage, due to the equalising effect of the corona preceding the spark. Some method must be used in which only the normal voltage is applied. Several very ingenious forms of potentiometers have been devised by Prof. Ryan for this purpose. Conditions, however, did not permit of using one of these, and the following method was, therefore, devised. While it cannot be considered an exact method due to several inherent sources of error, it is thought to be sufficiently accurate to give a satisfactory idea of the distribution. It has the advantage of being very simple and requiring very little apparatus.

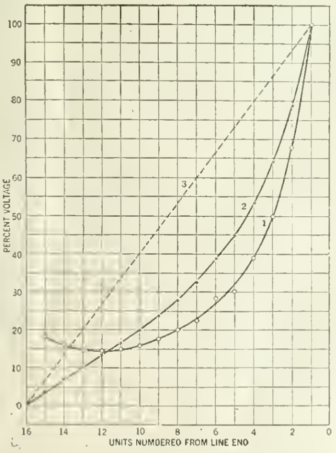

FIG. 5.

1—Voltage across each unit in per cent. of that across one nearest line.
2—Distribution of voltage to ground along string.
3—Ideal distribution of voltage to ground along string.

A small needle gap is provided having the minimum amount of metal in the parts in order to keep the capacity as low as possible (Fig. 3). This gap is placed across each unit in succession and the total voltage across the string which causes the gap to go over is noted. The gap setting is kept the same throughout the test (*see* Fig. 4.) The discharge across the gap is only the charging current of the insulators, and does not injure the needles, so that the same needles can be used throughout. In general, we wish to know what percentage of the total voltage is impressed on each insulator, and the percentage of the voltage across each unit in terms of that across some particular unit, as in all our work it showed the greatest voltage.

The errors in the method are due to the capacity of the gap and its leads, and the possible effect of surrounding objects on the spark voltage of the gap.

Results of Tests.—Experiments were made on strings of 15 units. The method used was to obtain the distribution on the ungraded units and then observe the change due to grading in various ways. For experimental purposes the effect of the metal rings was readily obtained by painting the porcelain with a conducting varnish. The string was placed outdoors to avoid the effect of the walls of the building. An iron pipe placed horizontally was used to represent the cross-arm, and the string of insulators was suspended vertically from this, the lower end being about 10 ft. (3m.) from the ground. A clamp was attached to the string and held a metal pipe to represent the line wire. The frequency used was 60 cycles.

Fig. 5 gives the results of tests on an ungraded string. Curve No. 1 shows the values of p, the percentage that the voltage on each unit is to that on the line unit. If the distribution of voltage were uniform a horizontal line at 100 per cent. would be obtained instead of the drooping curve, No. I. It will be seen that the lower portion of the curve is nearly horizontal and that the fourth unit from the grounded end has the lowest voltage across it. Curve No. 2 gives the distribution of voltage along the string in per cent. of the total voltage. Each successive ordinate is obtained by adding the value of P for that unit to the preceding ordinate. A uniform distribution would give the dotted straight line, No. 3.

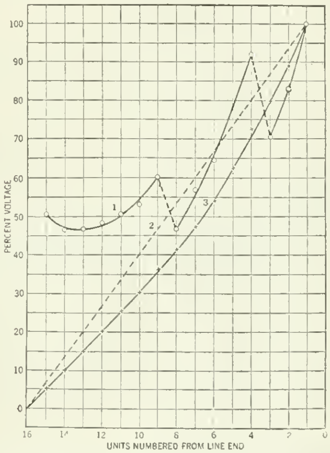

FIG. 6.

1—Voltage across each unit in per cent. of that across one nearest line.
2—Distribution of voltage to ground along string.
3—Ideal distribution of voltage to ground along string.

Fig. 6 gives the result of grading. In this case the three units next to the line had the largest conducting discs and a high internal capacity. The next five units had a somewhat smaller capacity. The last seven units had no coatings. Instead of uniform curves, the result is a broken line formed by joining the curves due to each group.

Conclusion.—The experiments described in this Paper are only preliminary, and much further investigation is desirable. It is felt, however, that the results obtained indicate the value of this method of grading where the voltage is such as to require the use of many units.

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MODERN WAGES IN MANUFACTURE.*

BY F. BAYLE.

At any other time one would have given a theoretical discussion of the question; to-day the author restricts himself to what appears to be indispensable to justify an application of the theory in munitions factories.

Modern tariffs, if the theory is not erroneous at its foundations, and which the author wishes to submit for your consideration, will rule a great part of the relations of capital and labour. The author says will, because from all sides the question is being studied, experiments are being made, formulæ have been devised, but the State goes on without doing anything; it seems then that the industrial world, so far as this subject is concerned, only awaits the crystallisation of the various efforts to rally at a single step, under the form of some simple idea.

The general formula $S = s_0 \varphi(m)$, of which the author will speak later, is called in to rule the question of the workman's wages. I would say that it rules it effectively already, and insures their interests, for the systems of payment already used are only particular cases of a more general rule, and although they are the most simple they are also the most defective.

It is this opinion, in view of the industrial resurrection of our country, that it will be good to popularise, not to-morrow, but immediately, in order to teach it to everyone, and especially to the sons of workmen, and those in the primary schools.

Men who have great influence with the working classes, heads of political parties, and philanthropic people, still propound the erroneous idea that increase of work is hurtful to workers. And it is only occasionally that a voice is raised to combat this enmity.

The words of Taylor are then quoted in this question, in which he states:

"And now we make practically nothing, and we leave the field free to agitators of whom the greater number are ignorant of the question, or sentimental persons who know nothing of the conditions of modern industry."

On all sides a theory of wages which would obtain the assent of thinking men would exercise a notable influence on the next economic "renaissance" of our country; it may be considered as equally true that a good war tariff applied in munitions manufacture would have more immediate importance to one's country.

On reflection, controlled by direct experiment, the author has acquired the conviction, which only a few experiments contradict for very obvious reasons, that the modern wage, in order to satisfy both employer and employed, should possess the properties of a fixed salary *by the day*, and a portion of the variable wages mobile as piecework, or *à la façon*, both being deprived of their faults, the first being intolerable to an active and zealous workman, and the second inadmissible to the employer who wishes to keep his contracts.

In studying time payments as suggested by Halsey, but neglecting the application he makes of them, for it is not, the author believes, the best possible, it was found the characteristics above referred to as necessary are combined by what one may call "prime" wages. The modern wage has another fundamental base of which the prime is only the consequence.

According to the conditions set forth, the fixed portion of the modern wage is the sum necessary to insure a living wage to the workman and his family in the place where they live; it is the normal [illegible]. The determination of this quantity depends on various economic conditions.

All kinds of combinations are possible—one is able to adopt as base, the [illegible] piece time wage or mean actual wage; the question has no great importance, the essential thing is to deliver the workmen from the [illegible] of the piece work wage, which immobilise and limit their production by a "task," which they are forbidden to exceed.

The supplementary portion or mobile prime, possesses for the workman a special character; it is obtained at the price of a special effort which varies according to the individual, his aptitude, and his strength; that represents for him the superfluous, pleasure, relative [illegible]. It is this part which supplies the [illegible] which one fails to obtain with a fixed salary.

Such "prime" wages are controlled by an algebraical formula, simple or complicated according to each case, which regulates the payment for fixed work as a function of a variable which depends on the work accomplished, that is to say, on the production, each formula constituting a tariff. [illegible] then a wage tariff as a unique law of some special type which establishes a known relation between the amount of payment and production, these are the properties, and the mathematical relations thus established constitute the advantages or defects of the system.

Any desired variation of wages may be obtained by adding a group of little independent rules; but as this is a process applicable only to the cases for which such rules have been devised, we shall omit all discussion of that at present.

From what has preceded, it has always been in the author's mind before the war to have a definite aim, viz., the application of Taylor's system to an important French factory employing 3,000 or 4,000 workmen.

In all questions of work introducing the time element, it is necessary to introduce a much more accurate system than that known as "estimating."

Taylor's system requires precision of measurement as well as investigation of all processes capable of augmenting the speed of production, making it difficult of application. Workpeople object to minute time measurements, which they regard as tyrannical.

Extreme prudence and a complete knowledge of modern wages is the one essential point absolutely necessary to vanquish this resistance. In proving its use, and living daily with it, the workman comes to know it by experience, and sees it according to its real nature; he finds it quite inoffensive; the opposition then ceases, and soon after he will appreciate its advantages.

One may class the systems known as modern wages by "bonus" and "time" systems; it is a purely formal distinction, for, in reality, one can express a modern system algebraically, either by means of "bonus" or "time." In spite of this identity at the foundation there is a great advantage in substituting "time" for "price."

Price is not a pure technical element; it is at the same time technical and commercial; it fluctuates owing to exterior influences impossible to prevent, and which do not interest the workman.

The real element to settle is the time necessary with the stock of tools available in order to execute a given task, the time the foreman is able to insist on from the workman.

With a bonus system complete technical information is practically impossible, which is abundantly demonstrated in practice. Whereas with time as basis, nothing hinders one from developing professional skill, and one is able to arrive rapidly at estimates, so that the method acquires scientific accuracy by frequent repetition.

The author then refers to Taylor's system, and it is stated that a "free" task is substituted for a "fixed" one, besides the recognition of a minimum wage.

Taylor undoubtedly was the first engineer who wished to systematise and generalise the measurement of work. He was also the first who introduced the idea of speed into the calculation of wages, always indissolubly linked with the idea of time.

The definition outlined above includes the case of reduction of wages by reduction of output; it is important that such questions as expense of tools, economy of materials, and so on be considered.

It remains to translate the tariff algebraically. If π_0 is the price per piece, V the value per unit of time, S the real payment per hour, then $S = \pi_0 V$. Under this formula it is simply piecework.

This expression is important as giving a value to the product between zero and some value determined in advance, say, V_0. For a value $V' > V_0$ the piece price changes abruptly, and becomes $\pi_0' > \pi_0$, the wages then become $S = \pi_0' V'$.

It is seen that S varies in a discontinuous manner as output is varied. This seems to be Taylor's differential tariff expressed by means of the notion of speed. This idea can be expressed in various ways: we may write for instance $S = \pi_0 V_0 + \pi_0'(V - V_0)$. For a value $V < V_0$ one has simply $S = \pi_0 V$, the second term being negative is taken as equal to nothing. For $V > V_0$ the second term is added to the first, so that in this way we have a discontinuous tariff without retro active effect as regards price.

Similarly several terms may be added, and written,

$$S = \pi_0 V_0 + \pi_0'(V_1 - V_0) + \pi_0''(V_2 - V_1) + \pi_0'''(V_3 - V_2) + \ldots$$

This species of tariff has had several applications; generally π_0 diminishes from term to term; sometimes in exceptional circumstances it increases; in such a case the tariff is then in formal contradiction of economic and commercial laws, and it is necessary to have exceptional reasons to justify it.

The price π_0 may be constant, and then we have the piecework tariff $S = \pi_0 V$. Finally the price varies arbitrarily as some function of the speed, increasing at first, diminishing later.

The bonus system of Gantt, an improvement of the differential tariff of Taylor, is more simple. In this case one has $S = s_0$ for $V < V_0$, and $S = s_0'$ for $V \geq V_0$ with $s_0' > s_0$.

These two tariffs are of difficult application, except in factories which have adopted Taylor's system.

If Taylor had introduced into the question of wages explicitly the question of price, and implicitly the notion of speed, Halsey was the first who had the idea of replacing the basis *price* by *time* in wages contracts. This allows one to write the modern conception as a function with a time base $S=\pi_0 V$, salary proportional to a task completed in a unit of time. Let us now endeavour to introduce into this formula the basis time and time of execution of the piece of work. It is necessary in the first place to convince the workman of his right to a minimum normal salary, or daily wage, or wage per hour; call this s_0. In these circumstances the basic time allowed to complete the work is

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* Abstract of a Paper read before the Société Internationale des Electriciens.

$$\pi_0 / s_0=T \text{ whence } \pi_0=s_0T.$$

Substituting for π_0 we have $S=s_0T \times V$. But the time of execution is $1/V=t$, from which finally $S=s_0\frac{T}{t}$, and putting $T/t=m=$activity, and generalising, we have $S=s_0\varphi(m)$ as the formula representing modern wages.

We will discuss now prime wages. Putting $S=\pi_0 V=s_0\frac{T}{t}$ one is able to write $S=s_0+s_0\frac{T-t}{t}$. Consequently the real salary is composed of two portions, a fixed portion s_0 and a variable portion. Thus we may write $S=s_0+s_0\varphi(m)$. Further, we may then write $S=a+\frac{b}{V}+V$, where the term a is a fixed sum, b/V is the cost per piece varying inversely with the speed.

Writing $S=a+\frac{b}{V}V=a+b=s_0=$constant, we have the prime salary, and we see that all wages without exception are prime, which will perhaps surprise the defenders of the usual tariffs. Only, the prime tariffs are in two categories, the good and the bad.

It was in truth Rowan who made Taylor's idea regarding variation of price as a function of the speed the first really happy application in making hypo-proportional wages, and limited prime salary. For instance piece work tariff $S=s_0\frac{T}{t}$ or $S=s_0+\frac{T-t}{t}=s_0+s_0(m-1)$.

The prime $s_0(m-1)$ is a direct proportional by reason of the excess of production $(m-1)$.

Writing $S=s_0+as_0(m-1)$ according as a is > or < unity, we have a wage with constant proportionality, in which the variations are hyper, or hyper-proportional in relation to the preceding.

The idea of Halsey was insufficiently understood even in the country of its origin, America, and was perhaps the reason why it failed to gain admittance there. In Europe, and specially in France, it has been little studied. His views, though less lofty and beautiful than those of Taylor, were a happy and incomplete vision. "All new ideas, said William James, pass through three stages. The first is that of repulse, and they are proclaimed absurd. Then they are admittedly true, but of insignificant result, useless. Finally their importance is recognised, and each one claims the honour of having invented it."

The author points out that before anything can be done workmen, and their employers, must be convinced of the fairness of Taylor's system, and the work of M. H. Le Chatelier is referred to in this connection. Further explanations of piecework are then given, and it is shown that, as a rule, when a workman increases his output, say three times, besides arousing the jealousy of his shop mates, the employer, urged by cupidity, takes steps to cut down the price till the original sum in the same time is earned. Then the process begins over again. In this way disputes and trouble arise. Consequently the workman voluntarily limits his output, without which his existence would be a miserable affair. Therefore he is content with his wages, knowing that he only provokes by his zeal a new lowering of price. Reduction of output merely augments the general misery, and civilisation is arrested or goes back. That is a "tableau" of what happens when a piecework tariff is used; if human beings were an industrial product, piecework tariffs would have annihilated the world.

Comparing this with the free task without minimum of wages explicitly recognised, and where the wages earned are a function agreed upon of the speeds of working, one is able to modify and confer many commercial qualities which the present system lacks.

Modern Contracts: or Contract of the Imposed Task.—Piecework and work done do not really differ from one another; it is the same contract named in different ways. On the contrary, Taylor considers there is a difference between the two systems.

After a discussion of other modes of fixing modern tariffs of which

$$\int\frac{dS}{dm}dm+C=s,$$

for $m=$unity, it is pointed out that the ratio m corresponds to the conventional production in unit time. This ratio has diverse expressions, and one of these is

$$m=\frac{\text{wage for piecework}}{\text{wage for the day}}.$$

It remains now to simplify the idea of modern wages, so that it can be immediately applied to a munitions factory. If P is the payment to the workman over the time T,

$$dP/dT=s_0f(m).$$

This is the *instantaneous wage*, as m is a time function that is known, and between the limits t_1 and t_2

$$\text{wage}=P=\int_{t_1}^{t_2}s_0f(m)dT.$$

This is called the instantaneous rule, only applicable on rare occasions.

For any given period we have then

$$P=s_0f(m_{g1})(T_2-T_1)+s_0f(m_{g2})(T_2-T_1)+\ldots$$

where $$m_{g1}=\int_{t_1}^{t_2}\frac{mdT}{T},$$

and m_{g2} a similar expression.

Finally, the total wage is

$$P=s_0f(m_g)(t_g-t_1)$$

where $$m_g=\frac{\int_{t_1}^{t_g}mdT}{t_g-t_1}.$$

For munition works the formula proposed is

$$S=\frac{s_0 3m^2-4m-2}{m^2};$$

if we put $\theta'=m-1/m$ we obtain

$$S=s_0-2s_0\theta'^2.$$

Finally, to make calculation easy, it suffices to remark that

$$\theta'=\frac{\text{payment for 15 pieces}-\text{payment for a day}}{\text{piecework pay}}.$$

In conclusion the author considers that the commercial struggle after the war will be more ardent than ever. In the interest of all, but more particularly in the interests of the working people, there is an urgent need of men who foresee now the crisis which will follow the actual struggle and prepare means to remedy it.

The Germans are doing this now. If we do not modify now our ideas, methods, and our technical teaching, the Germans will recover naturally their mercantile supremacy.

The time is particularly opportune for France to introduce modern methods of work, and wage payments to workmen. These methods will be the source of general richness.

The Germans in peace time know, and utilise already to a great extent, the properties of the modern wage; it is then reasonable to suppose that they will apply any improvements immediately to their industries.

The directors of industry in Germany possess this superiority, which it is impossible to deny, owing to their technical training, of being able to discern useful ideas from the mass of mostly useless ones, and to act at once on them, whereas we are only able to appreciate new ideas too late, and discourage inventions or force them to go to foreign countries.

The necessity of counting, taking time observations, and continually comparing the new results with the old ones, and verifying the time taken over various jobs is pointed out. It is an auxiliary element, it is true, but necessary to attain satisfactory results. When one speaks of Taylor's method, one forgets very often the effect of the system, with the decomposition of operations which follow it, and their systematic study, with the absolute necessity of reuniting a great number of experimental and numerical results, and above all of classifying them and putting them under a useful form which requires a special organisation.

If these ideas are not more applied at home, it seems this must be attributed to the fact that our engineers, and works managers, have neither sufficient data before them or, above all, the time necessary to go into the matter. Taylor's system ought, however, to be considered as a detail, very important, it is true, in the good organisation of any industrial enterprise.

In the discussion which followed, the chairman remarked that in using an electric motor to drive a machine, the meter told one at once the cost of energy used, and consequently if W_0 was the energy allowed the workman to complete a task, and if in reality a quantity of energy, W_1, was used, then in terms of the workman's wages the economy of energy would become a function of W_0-W_1/W_0. If $W_1 < W_0$ the wage will increase. If $W_1 > W_0$ the wage will diminish relatively. The number of turns of the shaft of a machine doing certain work might be introduced into the formula for wages, so that it could be written N_0-N_1/N_0. This permits the control of losses, and determination of loss as "dead" turns.

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2000th
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OF
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The wish has been expressed in several quarters that the Special Articles in the Souvenir 2000th number of THE ELECTRICIAN should be reprinted in book form, so as to be available for convenient reference.

On account of the high price and limited supplies of paper, the Publishers can only comply with this request *if they are assured of a considerable Subscription Order for the reprint.* The Book will be Demy 8vo. (5 in. by 8 in.) in size, and will contain approximately 320 pp. It will be printed on good paper, at a maximum price of 2s. 6d. per copy, paper covers; cloth covers 3s. (Orders for 12 copies less 10 per cent., 50 copies less 15 per cent., 100 copies and over less 25 per cent.) The subjects and contributors are as follows:—

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GAS FUEL EXPERIMENTS IN ELECTRICITY WORKS.

It is generally admitted that our present methods of using coal are wasteful, and that in the national interests steps will have to be taken to make better use of, and to conserve our fuel resources. In the final Report of the Fuel Economy Committee of the British Association it is likely that the use of coal in its raw state as fuel will be condemned, and that co-operation between electricity supply undertakings and carbonisation works will play an important part in the developments and economies to be made. By its sponsors it is claimed that the adoption of the low-temperature carbonising process enables a very high calorific value to be obtained from the coal in the form of "Coalite," a smokeless fuel suitable for domestic use, whilst the gas may be used for the firing of boilers, and all the valuable distillates may be usefully employed in fostering important chemical industries at home.

During the last decade little knowledge of low-temperature carbonisation has been gained, but the desire to secure economy and to have an abundant and cheap supply of power, to say nothing of placing home chemical industries on a firm foundation, enhances the value of the process. We are concerned with an abundant and cheap supply of power, and, failing the construction of relatively few electric power stations of large size for supplying the industrial areas of the country, it is profitable to determine how far the low-temperature carbonising process can be relied upon to reduce the cost of energy for industrial and other purposes.

To this end large scale experiments are being made and others are contemplated. In connection with the development of the Yorkshire Electric Power Company's undertaking, which supplies an area of 1,800 square miles, including the Yorkshire coalfield, Mr. W. B. WOODHOUSE, after a careful study of the various processes of low-temperature carbonisation, advised his company to enter into an agreement with a company, the Barnsley Smokeless Fuel Co. (Ltd.), working the Coalite process, to take all the surplus gas to burn under the boilers in place of coal. It is significant to note that the Government has taken a substantial financial interest in what we have referred to as a large scale experiment, and has entered into a contract for the purchase of the entire output of certain of the by-products. A long-term contract with a well-known colliery ensures a supply of suitable coal, and an agreement has been signed with a chemical company for the complete distillation of all the by-products.

A similar scheme for the supply of gas fuel to the Southwick electricity works of the Corporation of Brighton is under consideration at the present time, and extracts from the report of the electrical engineer, Mr. J. CHRISTIE, on the proposed agreement are given on another page. In our opinion many engineers would be glad to avail themselves of such an opportunity. On the face of it the scheme seems a sound one, and so far as the Corporation are concerned they stand to lose little by its adoption. It appears that in the event of failure Brighton only stands to lose the cost of the pipes and fitting of burners in lieu of the present coal-fired grates, a matter of £1,200, and as a set-off against this, the other party to the agreement will first have to spend upwards of £50,000 on engineering works of a permanent character. If the experiment is successful the Corporation should save at least £5,000 a year in their fuel bill. It is seldom that an investment of little over £1,000 stands to yield such an amount, and bearing in mind the fact that a similar experiment is being tried by one of our foremost power companies—a company famous for its sound engineering—we consider the scheme is one which the Brighton Corporation should adopt, as it affords an excellent opportunity at a very small cost or risk of thoroughly testing the merits of this method of firing under everyday working conditions. It is experience such as this of which we stand in urgent need if any progress is to be made, and the present seems to afford an opportunity which, as we have said, should not be missed.

The figures given are of a striking character. A ton of coal contains some 27-million heat units, and 90,000 cubic ft. of gas will have the same calorific value. Therefore, at the price quoted, the Corporation will obtain for 11s. 3d. the same quantity of heat as is contained in a ton of coal costing 20s., and in a form in which the heat can be used to the best advantage. It is estimated that the surplus gas will produce at least 7·5-million Board of Trade units per annum, and assuming that 110 cubic ft. of gas are required per kilowatt-hour, as against 3 pounds of coal, the cost for fuel, with coal at 20s. per ton, will work out at 0·165d. per unit for gas, as against 0·321d. for coal, equivalent to a saving of 0·156d. per unit. In addition to this, further saving due to reduced labour in trimming and ash-removal, and to a reduction of radiation and stand-by losses will be effected. The possibility of obtaining a plentiful supply of fuel for domestic purposes at a reasonable cost is another side of the question which makes the scheme an attractive one. Prior to the war the price of good coal in Brighton was prohibitive, and was always on the up grade. In these days coal of inferior quality is selling at 40s. to 45s. per ton. If the claims made for "Coalite" are substantiated, the use of this fuel should go a long way towards promoting cleanliness.

On several occasions in the past we have sounded a warning note against the depletion of reserve funds and against the appropriation of "profits" in relief of rates. Few electricity supply undertakings have been harder hit by the war than the Brighton undertaking has been, and this largely as the result of acting contrary to the advice of their electrical engineer. We hope that now there appears to be a reasonable chance of a return to the old prosperous conditions the Corporation will be guided by those competent to form an opinion on the subject, and that after building-up a reserve fund commensurate with the capital invested in the undertaking, the consumer, and the consumer alone, will be given the benefit of the decreased cost of production. In conclusion, we would add that such a scheme as the one proposed is much to be preferred to one which demands of the engineer in charge of the undertaking expert knowledge on highly technical subjects outside the range of his experience. We believe that when the question of power supply is taken seriously in this country, the time of our electrical engineers will be fully occupied in coping with the demand without being worried with the solution of problems in gas manufacture and industrial chemistry, to say nothing of finding markets for by-products.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Electrical Engineering: First Course. By E. J. BERG and W. L. UPSON. (London: Hill Publishing Co.) Pp. xii.+416. 17s. net.

The authors of this book are Professor and Associate Professor respectively of electrical engineering at one of the leading engineering colleges in the United States, namely, Union College, Schenectady. Like many successful teachers, they object to the use of a prescribed text book on the grounds that it tends to take the life out of the class room, and tends to take life out of the study by relieving the student of the responsibility of continued effort.

In the present volume, which is based on lectures first delivered eight years ago, an attempt has been made to maintain a harmonious inter-relationship between the book and the class room. There are 15 chapters in the book, and notwithstanding the fact that it is called a "first course" the standard reached in most of these chapters is about on a level with that required to obtain a pass degree at our universities.

Less than one-third of the book is devoted to a consideration of certain of the problems connected with direct currents, and in our opinion the importance of the subject warrants fuller and broader treatment. This does not apply to the chapters on alternating currents. Probably in no elementary book is so much ground covered, and the student who is not afraid of mathematics will be able to prepare the way for a study of the larger works on alternating-current engineering. Not that the mathematics are difficult, but it is well to mention that the authors rightly use vector representation of alternating-current waves as well as the symbolic method, devised by Kennelly and Steinmetz, of representing electrical relations. In addition, where calculus methods can be usefully applied they are so applied.

A correct understanding of the theory underlying design is indispensable to the successful designer, and although no attempt is made to deal with design, in many of the chapters not only is the theory given but the influence of it on design is emphasised. This is a valuable feature of the book, and one on which the authors are to be complimented. Another welcome feature is a good set of problems, and the solution of many of these problems will demand reasoning power on the part of the reader, as well as a close study of the text.

We like the book, and we recommend it to students who are preparing for higher examinations in the subject, or who are qualifying for a serious course on electrical engineering, and who are prepared to work and think for themselves. Such students could go a long way without discovering better masters than the Union College professors.

The Heat Treatment of Tool Steel. By H. BREARLEY. (London: Longmans, Green & Co.) Second Edition. Pp. xv.+223. 10s. 6d. net.

The exigencies of the past two years have brought into prominence the influence of the tool-room on production, and the lessons that have been learned are not likely to be forgotten. One of the most important processes carried out in the tool-room is the heat treatment of tool-steel. On correct heat treatment of the tools depends the output of the works. Notwithstanding the recent progress there are still many who stick to what they are pleased to call old-fashioned methods, and when anything goes wrong they blame anything and everything but themselves. As often as not when an expensive cutter is broken in hardening or in use, the fracture is attributed to bad steel, whereas the true explanation is faulty heat treatment or improper use of the material.

That this is so is evident from a study of this most useful book, which is now in its second edition. The scope of the book is indicated by the sub-title "An Illustrated Description of the Physical Changes and Properties Induced in Tool-steel by Heating and Cooling." Both as regards method and matter, the book is likely to make a strong appeal to the tool maker as well as to the steel maker.

In this edition alloy steels generally and high speed steels in particular, are more fully dealt with than in the last edition, and the chapter on Case Hardening has been omitted because it has been made the subject of a separate book. We should like to see the scope of the book further extended so as to cover the heat treatment of all commercial steels, and Heat-treatment Tables, such as those published some time ago by the American Society of Automobile Engineers, would be welcomed by many who have not the time to prepare such Tables for themselves.

Arithmetic for Engineers. By C. B. Clapham. (London: Chapman & Hall, Ltd.) Pp. xi.—436. 5s. 6d. net.

This is one of the "Directly Useful" technical series of books edited by Prof. W. J. Lineham. It includes simple algebra, mensuration, logarithms, graphs and the slide rule. The author has taken care not to make the subject too difficult either for the beginner or for the man of little education who needs these subjects in his every-day work. The exercises are happily chosen; the diagrams, of which there are many, are well drawn, and the examples which serve to illustrate the text add materially to the value of the book. In our opinion a better title could have been selected. A somewhat lower price would have been advantageous, because we take it that most of those who buy the book will be engineering apprentices in receipt of small wages.

SCHEME FOR GAS FIRING OF BOILERS AT BRIGHTON.

An interesting proposition for the gas firing of boilers came before the Brighton Council at their last meeting. After careful consideration the Lighting Committee had recommended the adoption of the scheme, but the bulk of the members of the Council had only received the report a few days before the Council meeting and many of them had not an opportunity of studying the question, and it was decided that the matter should be deferred until the next meeting of the Council. Extracts from the report of the electrical engineer (Mr. J. Christie) on the proposed agreement are given below.

Put as concisely as possible, the scheme is as follows:—

That the Corporation should lease to the company a portion (6 acres) of their vacant land at Southwick, and on this site the company would erect a wharf, coal handling plant and coal storage accommodation, together with retorts and plant for carbonising coal on the low temperature process.

It is claimed by the company that the adoption of the low temperature carbonisation process enables the maximum heat value to be obtained from the coal in the shape of "coalite," a smokeless fuel excellently adapted for domestic use, whilst the gas and all the other valuable distillates in the shape of tar, sulphate of ammonia, benzol, toluol, and light and heavy oils, are recovered to be usefully used in the manufacture of aniline dyes, fertilisers, rich motor spirit, high explosives, &c., for which this country has hitherto very largely depended on imports from Germany and abroad. The company contend that by the establishment of works of this description the coal of the country and coal supplies will be conserved for the benefit of the nation and thus enable many of these important chemical industries to be fostered at home.

As a by-product to the process, there would be a large volume of surplus gas available, and it is proposed that the Corporation should purchase this from the company at a low figure in comparison with the corresponding cost of coal, and by adapting a portion of their existing boiler plant at a comparatively small outlay, for firing by means of gas instead of coal, by this way utilise the waste heat contained in the gas for steam raising, and thus substantially reduce our fuel cost and minimise the labour, dirt and dust incidental to the present method of working with coal.

Should the scheme be approved it will be necessary for the Corporation to enter into an agreement with the British Coalite Company, and the following are the chief headings [illegible] for careful consideration.

1. For the Corporation to grant to the company a lease for a term of 25 years [illegible] of land [illegible] the cost [illegible] to the cost of the [illegible] equivalent to the interest and sinking fund charges on the capital outlay, which amounted to [illegible] per annum, with the option of renewal for a further period to be mutually agreed on.

2. For the company, at their own expense, to construct a wharf, [illegible] coal handling plant, bunker [illegible] together with retorts and plant capable of [illegible] per day.

3. It is estimated that the first installation of plant will yield, in addition to the "coalite" and other by-products, approximately [illegible] cubic ft. of gas per day. This would be delivered to the Corporation [illegible] at [illegible] pressure and of a standard thermal value of 300 B.T.U.s per cubic foot, subject to a margin of 5 per cent. up or down.

4. The Corporation would undertake, so far as their load permits, to utilise this gas to its fullest extent in preference to solid fuel, and would pay for same by meter at the rate of 1·5d. per 1,000 cubic ft., with coal at 20s. per ton as a base, subject to an increase or decrease at the rate of 5 per cent. for each 1s. per ton that the cost of coal varies above or below this figure. With regard to the basis price of coal, it is understood that the coal to be purchased is of a suitable class for the special purpose for which it is intended, and that the price is the then current price for coal, including freights, dues and cost of placing same in the bunkers, and on demand evidence is to be given showing the actual price paid.

5. The Corporation to supply the company with the necessary energy for operating their machinery, approximately a demand of (say) 100 kw. direct current or alternating current, whichever may be decided as the most convenient, at the rate of 0·6d. per unit with coal at 20s. per ton delivered to our bunkers, subject to an increase or decrease at the rate of 5 per cent. for each 1s. per ton that the cost of coal varies above or below this figure. With regard to the basis price of coal, it is understood that the coal to be purchased is of a suitable class for the special purpose for which it is intended, and that the price is the the current price for coal, including freights, dues and cost of placing same in the bunkers, and, on demand, evidence is to be given showing the actual price paid.

6. The Corporation to adapt three of the present nine boilers for burning gas instead of coal. This can be done by removing the present grates and substituting burners at an estimated outlay of some £750, plus the cost of the necessary piping. Two out of these three boilers would be used almost continuously with the full output of the gas available for the steady 24-hour load, and steam would only be raised by coal on such of the remaining boilers as were required to meet the varying peak load throughout the day and year.

7. It is estimated that the surplus gas will produce at least 7,500,000 units of electricity per annum, and assuming that 110 cubic ft. of gas is required per kilowatt-hour as against 3 lb. of coal, the cost for fuel with coal at 20s. per ton will work out at 0·165d. per unit for gas, as against 0·3213d. for coal, equivalent to a saving of 0·1563d. per unit, representing in round figures (say) £5,000 per annum on this output. Further saving due to reduced labour in trimming coal, removal of ashes, general cleanliness of the boiler house and station, radiation and stand-by losses, will also be effected, and, of course, if the available gas is sufficient to generate a larger output, then the saving will be proportionately greater.

The company are at present putting down their first plant in this country at Barugh, near Barnsley, and the Yorkshire Electric Power Co. at one of their power stations are under contract to take the residual gas for firing their boilers in the same way as is proposed in the scheme above set out. The coalite plant is almost similar to that which the company propose to install on the Brighton site, and there can be no question but that they are making a very sound engineering job of it.

If this scheme be carried out, the increased tonnage which will necessarily come to the harbour will, of course, very materially benefit the trustees by the increased dues which they would receive.

THE SCOPE OF ILLUMINATING ENGINEERING.*

BY C. P. STEINMETZ.

Summary. This Paper defines the term "illuminating engineering." The phenomena and effects of light in producing effective illumination are outlined from the viewpoint of the illuminating engineer, the physiologist, the psychologist and the ophthalmologist. Brief mention is made and examples given of the effect on the eye due to directed, diffused and coloured light.

Ten years ago the Illuminating Engineering Society was founded. Five years ago illuminating engineering was established as a recognised branch of engineering, through a course of lectures, given by the Illuminating Engineering Society jointly with the Johns Hopkins University. In the fall of the present year another lecture course will be given by the Illuminating Engineering Society jointly with the University of Pennsylvania, covering and bringing up to date the entire field of illuminating engineering.

While illuminating engineering probably is the youngest recognised branch of engineering, it is not engineering merely in the narrow sense of electrical and mechanical engineering—the application of the laws of Nature to the service of man—but its scope is far broader. It represents a problem in the application of physics, that is, engineering, to the design and construction of a lighting installation. But the product of the installation is light, and light is the physiological effect of radiation on the human eye, and the efficiency of the illumination thus comes into the realm of physiology as well as engineering. The psychological effect of the physiological phenomenon of light is what very largely determines the satisfaction of an illumination, and thus the psychologist becomes interested. The success of an illumination depends not merely on the location and size of the light sources, but equally on the architectural structure of the building, on the decoration of the walls and ceilings, &c., and hence the architect's and the decorator's work is of importance in the success of illumination. The abuse of light, the defects of illumination, become of interest to the ophthalmologist. Light, especially certain forms of it, exerts a powerful effect on living tissue, and thereby becomes of value in sanitation, in medicine and therapeutics.

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* An address presented before the Illuminating Engineering Society, New York.

It is seen, therefore, that illuminating engineering embraces the sciences of physics, physiology and psychology, architecture, decoration, ophthalmology, hygiene, bacteriology, and therapeutics, and our society is of importance to the physicist and engineer, the physiologist and the psychologist, to the architect and the decorator, to the ophthalmologist, the sanitarian and the physician. The design of a successful illumination begins with the plans of the architect, and ends with the consideration of the occupation and the temperament of the user of the light.

It is a problem of engineering to determine the amount of light required for the different purposes of a business street or a suburban street, a theatre or a school room, an office or a private dwelling house. But this does not yet make the success of the illumination; one may use a few large units of light, and in some places get insufficient light, in others excessive light traversed by black shadows. Such unsatisfactory results are seen in many street illuminations. Or he may go to the other extreme, and by the use of numerous small lamps, or by hiding the lamps and using their reflected light, get high uniformity, and yet the illumination becomes dull and the seeing poor because of lack of contrast. Good seeing thus requires the avoidance of excessive contrasts, but also the avoidance of absolute uniformity. It requires a certain amount of properly directed light, to give the contrast of shadows and background, but also diffused light, that is, light coming in all directions, like the daylight on a cloudy day, not to have the shadows too dense.

The eye is not a physical instrument, its scale is the logarithmic scale, and not the algebraic scale of most physical instruments; it is affected by higher illumination of surrounding objects—as glare—by the duration of its use, manifested in fatigue, &c. Hence, there arises the problem of avoiding glare to limit the location and character of the illuminants, by relegating them out of the field of vision, or restricting their intrinsic brilliancy—by diffusion globes, &c. The study of the problem of reducing fatigue becomes an extensive one; fatigue to a large extent depends on the use of illumination. An illumination which is least fatiguing for one purpose may become most fatiguing for another. This also involves the colour of light. Thus a colour of light which accentuates slight differences in certain colour shades, would reduce fatigue where the distinction of these differences is of importance, and yet would increase the fatigue where these distinctions are immaterial. This effect is marked, for instance, between the yellow incandescent and the green mercury light.

Custom and association exert dominating psychological influences. Thus, the corpse-like appearance under the mercury light condemns its use in the ballroom, while the higher acuity of vision recommends it for other uses. The harsh appearance under white light gives a preference to yellow light where the appearance of human faces is of interest. The "warm yellow light" may be preferable to the "cold white light" for the dweller in the northern temperature zone, while the "cool white light" may appear preferable to the "hot yellow light" for the desert dweller.

The further the design of a satisfactory illumination leads us from applied physics into physiology and psychology, the more naturally the human element dominates and the more the success of the illumination depends not alone on light flux and its distribution, but largely on the condition of the human being using the illumination.

It is only in our generation that light production has reached an efficiency making artificial illumination universally available for industrial and other work, and thereby extending the hours of daylight. With the extension of the day by artificial illumination, the art and science of illuminating engineering becomes of fundamental importance to the human race. It is true that through ages lighting equipments have been installed without illuminating engineering, and that even to-day most illuminating installations are not properly designed, but have just "happened." But it is also true that working under artificial illumination is recognised as putting a far more severe strain on the eyes than daylight work, and that the number and gravity of eye troubles is increasing. Only to a limited extent is this due to the abuse of the eye made possible by artificial illumination by using the eye for too long a period during the day. Mainly it is the result of the unsatisfactory character of many artificial illuminations. There is no reason why a good and properly designed artificial illumination should pace any greater strain on the eyes than an equally good daylight illumination. Here then is a field in which the ophthalmologist is interested.

Direct sunlight, and especially ultra-violet light, is one of the most powerful germ killers, and it is becoming recognised as of increasing importance as a disinfectant and sterilising agent. However, it destroys not only micro-organisms, but also the living tissue of animals and of man. Ultra-violet light, especially that futher away from the visible violet, is very harmful to the eye, and may even produce blindness. Fortunately, it is absent from the light of common illuminants, and glass is opaque to it—it does not let it pass, but absorbs it. Human tissue is more resistant to ultra-violet light than germs are, and germ diseases of the skin (tuberculosis) can be and are frequently cured by ultra-violet light, while deeper-seated ills are reached by that extreme ultra-violet light, the X-ray, which penetrates opaque bodies. The therapeutic value of the ultra-violet light and X-ray residess in the difference between the higher resistance of the normal human tissue and the lesser resistance of the germs or the diseased tissue which gives the curative effect, and, therefore, this subject, which is of great interest and importance to the physician, is an unsafe one for the layman to handle.

RADIO-TELEGRAPHY OVER GREAT DISTANCES.*

BY W. DUDDELL, F.R.S.

It is pointed out that although it may be possible to receive messages at 1,000 km. from a wireless set on board ship of only 2 kw. output, these must only be regarded as the result of particularly favourable conditions. One of the great difficulties is the variation of signalling intensity from day to day and from hour to hour, perhaps occurring 50 or more times during the day.

Reference is made to the researches of Austin. If I_R is the receiver intensity, then

$$I_R = 4{\cdot}25 I_s h_1 h_2 / \lambda d \epsilon^{-0{\cdot}0015 d/\lambda},$$

where I_s is the transmitter intensity, $h_1 h_2$ the antennæ heights, λ the wave length, and d the distance; ϵ is the base of the Napierian logarithms. When the distance is doubled four times the power is required, and the increase is due to the presence of the factor $\epsilon^{0{\cdot}0015 d/\lambda}$ in the above expression. The presence of λ in the denominator indicates that it is necessary to employ long wave lengths, and so we obtain 6,000 or 7,000 metres. There is a certain relation between the length of wave and the dimensions of the antenna. For wave lengths of 6,000 to 7,000 metres we require antennæ of 1 km. to 2 km. in length, of which the supports are 100 to 150 metres high.

There are three principal ways of producing oscillations. By sparks, by arcs and by means of an alternator. There are also three different values of the coupling according to the nature of the primary oscillations. The primary currents may be little damped, and the coupling is loose. The currents may be much damped and have only a single oscillation; the coupling is tight. When the primary currents are damped and have two or three oscillations, the coupling has a mean value. The first method is used by Marconi, the second by Mr. Galletti, and the third by the Telefunken Company.

The apparatus for sparking gives good results for short distances, but when the power is increased the arc tends to extinguish itself. In order to overcome this difficulty various devices are used. Marconi uses a disc turning between dischargers; in this way a cold surface is introduced which draws a current of cold air. Tesla allows a strong current of air to play on the sparks. At the Eiffel Tower a tube and plate is used. The spark passes between the plate and the edge of the tube by which a current of air passes and cools the spark. The Telefunken Company use discs close to one another, by which the cooling surface is increased.

Marconi has employed a new arrangement in Carnarvon. The antennæ are supported by eight towers each 110 metres in height, so situated that the most strongly-energised rays are directed towards the sea. The curve of ray intensity has an oval form, and one of the advantages of this arrangement is that one can use a sort of duplex arrangement.

If T, in Fig. 1, is a transmitting station, R its corresponding receiving station, the antennæ being directed toward TR, T_1 is a transmitting station, and R_1 a receiving station, placed as indicated in the diagram, the distance from R_1 to T being about 30 km., then the wave transmitted by T has only a feeble effect on R_1. In reality, the signals proceeding from T_1 received at R are intense enough. With a 25 per cent. difference in the wave length it is possible to separate them by means of a compensating circuit branched on to a third antenna. The station T_1 serves a unique function in the scheme of transmission: the apparatus in this station are controlled from a distance from the station R by means of ordinary aerial lines. The same observations apply to the station T.

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* Abstract of an article in the "Annales des Postes, Télégraphes et Téléphones."

The Nauen station is equipped with apparatus by the Telefunken Company. The generator has an output of 200 kw., and the discharger consists of a number of discs in series. By this means signalling between Nauen and Sayville, a distance of 6,400 km., has been accomplished.

At Nauen a new antenna 2 km. long is supported on a tower 350 metres high and five others of 120 metres. The power used will be 100 kw. in the antenna.

At the Eiffel Tower station two systems are used, one a musical note emission, the other by intermittent sparks. The alternator used for the musical signals is driven by a motor connected to the mains, for spark transmission: the supply current is used.

For great distances relays are used instead of the ordinary instruments. Col. Ferrié has used with great success a mercury interrupter for this purpose.

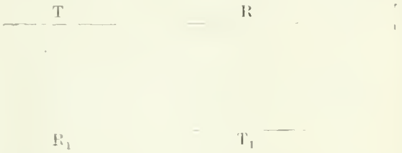

FIG. 1.

Regarding the tube-plate discharger already described the capacity of the oscillating circuit is about 1 mfd. In order to obtain resonance, self-induction coils are used. Mr. Abraham has succeeded in registering at Arlington, in the United States, the Eiffel Tower signals. The Galletti system is still in the experimental stage. The antenna is fixed to a hill about 550 metres high, so that the station possesses an antenna of great height, but small horizontal development.

As shown in Fig. 2, a source of continuous current charges a condenser of capacity C through a resistance R. The time necessary to charge the condenser depends on its capacity, resistance and P.D. used. When the condenser is sufficiently charged a spark passes at T, and the discharge is oscillating. As the continuous current passes always through R the condenser begins to charge again; it will again discharge after its potential rises sufficiently. In this way we obtain sparks which follow one another regularly.

By raising the potential and using 50,000 or 100,000 volts and by diminishing the resistance, sparks pass more and more rapidly. Mr. Galletti has used the arrangement shown in Fig. 3.

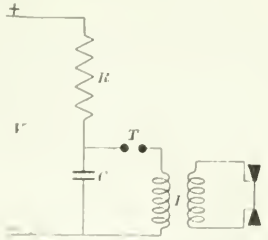

FIG. 2.—PRINCIPLE OF GALLETTI SYSTEM.

The condensers C_1 and C charge and discharge themselves in series through the inductance L, as we shall see. The condenser C_2 also in series with C charges itself and discharges through L, then C charges and discharges in its turn. A spark is thus discharged successively at the points t_1, t_2, t_3 and that with perfect regularity. One is able in this way to work several oscillatory circuits on the same antenna, which permits one to obtain great power; the difficulty that is then encountered is in cooling the condensers.

The second method used to produce oscillations is the arc method. The arc works in gas, and is subjected to the action of an intense magnetic field. In parallel with the arc there is a self-induction and capacity. When the arc is in action oscillations are produced in the circuit which one can make almost quite regular. The self-induction serves also as the primary of the transformer which excites the antenna.

The apparatus gives the best results for short distances; actually experiments using 30 kw. between San Francisco and Arlington gave good results. The signals from San Francisco cross the American continent, but, in spite of that, one hears them quite distinctly all day.

There will be installed shortly in Ireland a station which will allow of communication with Canada. It is hoped that the arc employed will allow of the use of 200 kw. The central tower will be 150 metres high, and will be surrounded by six masts each 100 metres high.

The third system is that in which an alternator is used. Although it is easy to build an alternator for low frequencies, it is very difficult to construct a machine giving high frequency currents, because one is not able to exceed a linear velocity of 300 metres per second. Various arrangements are adopted to overcome this difficulty.

Alexanderson's alternator enables a frequency of 100,000 to 200,000 to be reached. It consists of a disc turning between inductive bobbins, next which are placed the inducing coils. The disc is of steel, and revolves with a speed as great as possible, and is pierced with holes which serve to vary the iron circuit, and consequently the magnetic flux. The disc turning very rapidly tends to collapse under the stress of centrifugal force, and so it is made of steel as tough as possible. Another difficulty is the friction of the air on the surface of the disc; at the speeds employed this is very considerable. In order to reduce this, the openings are bushed with brass and the whole neighbouring surface is highly polished, so as to make it as glossy as possible. Toothed gearing enables one to turn the disc at a speed of 20,000 revs. per min., which is equivalent to a frequency of 100,000 cycles per second. The linear velocity is then 300 metres per second.

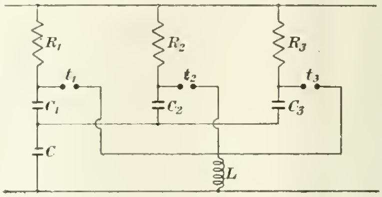

FIG. 3.—THE GALLETTI SYSTEM.

The principle of Goldschmidt's alternator is entirely different. If we take a three-phase machine excited by continuous current this machine giving a current of frequency N, then the current produced in the rotor of a second machine similar to the first will produce a current of frequency $2N$. One is able to add a third machine, in which there will be current of $3N$. Goldschmidt's idea was to combine these machines in one, and put the different portions in resonance for each of the periods dealt with.

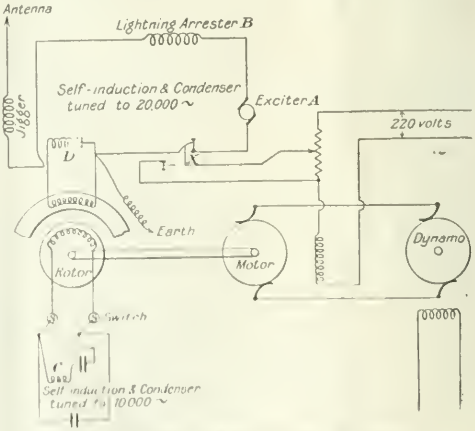
Antenna
Lightning Arrester B
Jigger
Self-induction & Condenser tuned to 20,000 ~
Exciter A
220 volts
D
Earth
Rotor
Motor
Dynamo
Switch
C
Self induction & Condenser tuned to 10000 ~

FIG. 4.—GOLDSCHMIDT'S ARRANGEMENT AT NAUEN.

To obtain the same result one may use a single-phase alternator. The stator is energised by continuous current, and it produces in the other a current of frequency N, which is led into a circuit comprised in the rotor tuned to this frequency. The field produced reacting on the stator gives a current of frequency $2N$. This current reacts on the rotor, and gives a current of frequency $3N$, which reacts again on the stator, and gives another current of frequency f.N; this serves to excite the antenna.

Small machines of this type have given good results; as an experiment an alternator of 150 kw. has been built, but it is still on trial. The wave-length will be 7,500 metres. The station of Eilvese, which uses this machine, has antennæ supported on a tower 250 metres high.

We shall now consider the receiving apparatus. There is not a great difference between the methods employed for receiving messages at great and small distances. In the case with which we are interested, however, the intensity of the signals are very feeble, and atmospheric disturbances are more troublesome. The antenna is connected to the detector by an intermediate circuit of a transformer. There are two kinds of detector. The first type respond to a difference of potential, the other to quantity. Matters are so arranged that by means of an inductance and capacity the difference of potential at the poles of the detector are as great as possible. This difference of potential is greater if the resistance of the detector is not infinite. If there is a current circulating in the circuit, there is energy dissipated in the circuit, and the presence of the detector augments the damping. There is a limit to the augmentation of the voltage at the terminals of the detector. To diminish this one may employ two condensers in any convenient proportion. To increase the sharpness of resonance one may introduce a third circuit. This intermittent circuit excited by the antenna reacts on the circuit of the detector. One is able by this means to reduce the atmospheric perturbations and augment the syntony of the arrangement. In the Marconi system the third circuit comprises two inductances and a condenser joined between them. This arrangement allows one to eliminate easily other signals of stations of which the wave-length is close to those which one wishes to receive.

In order to increase the power of the signals received various arrangements are adopted. One of these consists of relays of the type invented by Mr. S. G. Brown. These are used to replace the telephone generally employed. They comprise coils as a telephonic receiver, the diaphragm being replaced by a small strip of steel exceedingly rigid. The contact is a polished carbon point to which is applied a small point of an extremely hard metal, generally an alloy of iridium and osmium. These relays are connected to the terminals of the detector as an ordinary telephone. Across the point passes a current which acts upon the telephone. One is able thus to increase considerably the intensity of the received signals. At the contact a microphonic effect is produced which is a cause of trouble. In order to avoid this it is necessary to shield the apparatus from external vibrations. Recently relays based upon the properties of vacuum tubes have been invented. One of these is the Lieben relay. The bulb is filled with a rarefied gas containing a filament which is raised to the incandescent point. This is done to increase the number of electrons emitted, the filament being impregnated with calcium oxide. In the upper part of the figure one notices a plate and in the lower part a battery. Between the plate and the filament there is a difference of potential of about 220 volts. A current of feeble intensity traverses the bulb. Between the plate and the filament there is a grid of aluminium which hinders the passage of electrons. The transformer allows one to pass the current coming from the detector through the grid. An amplified current is then received between the filament and the plate, and this current produces a sound in the telephone.

Generally speaking, in practice, there are two of these relays used, thus producing an amplification of about 50 times. This arrangement has not the inconveniences of the ordinary relays composed of mechanical parts, but it does not remain constant with time, as at the moment constructed these relays constitute one of the greatest points in the progress realised in wireless telegraphy. If we wish to work in conjunction with cables it is not necessary to transmit very rapidly. At present one receives 20 words per minute, but this speed is not sufficient, and it is necessary to find a means of registering the signals. The currents received have a strength of $\frac{1}{10}$ micro-ampere. The relays which have been tried so far, based on various principles, have not yet succeeded in registering currents of such feeble strength.

The Orling relay comprises a mobile arrangement similar to a syphon recorder placed in an intense magnetic field. This body moves when a current passes through it. The movement is too small to be capable of writing. A fine jet of acidulated water descends on the plate conductor and touches a thin pointer supported by the body. The angular displacement of the jet of water is much greater than that of the pointer, about 10 or 20 times. In the position of rest of the moving body the pointer is just in contact with the external surface of the jet of water. In this way one is able to receive signals and to print them with an ordinary apparatus; for example, the Wheatstone automatic. Good results have been obtained with currents of the order of a micro-ampere, but we hope to arrive at good working with feebler currents.

Another relay comprises a mobile body placed between two very fine wires which form two of the arms of a Wheatstone bridge. When the body is displaced one wire rises and the other descends. A current of air strikes the two wires; when the body displaces itself one wire enters the current of air and the other one moves out of it. The two wires are heated by current from a battery of accumulators, and the one that enters the current of cold air has its resistance varied. The equilibrium of the bridge is then destroyed. The galvanometer is replaced by a sensitive relay similar to those which are employed in submarine telegraphy. The self-induction coils mounted on the bridge arms hinders too rapid variations of current and increases the rapidity of the relay.

In conclusion, it may be said that the power installed is generally about 500 H.P. to 1,000 H.P. The station is, therefore, of considerable size, and should be placed near water and coal. It is absolutely necessary that the station should be placed near the sea, and at a slight altitude, so that it cannot be masked by hills capable of obstructing communications. Generally the antennæ are of the length of about 1 km., covering a considerable area of ground, and further the earth plates hinder cultivation in the neighbourhood. Finally, these stations ought to be out of range of naval guns and able to communicate easily with the telegraphic network reaching into the interior of the country.

THE INFLUENCE OF HEAT TREATMENT ON THE THERMO-ELECTRIC PROPERTIES AND SPECIFIC RESISTANCE OF CARBON STEELS.*

BY EDWARD D. CAMPBELL.

The object of this Paper is the study of the correlation between thermo-electric properties and specific resistances of carbon steels which have been subjected to varying heat treatments, thus undergoing progressive changes in the chemical constitution.

Although investigations on the thermo-electric properties of steel and the influence of heat treatment on these properties have been carried on for more than 60 years, the experimental technique employed by most of the investigators has not been one based on the solution theory of steel as generally held at the present time.

The most exhaustive research which has yet appeared on this subject is that of Dupuy and Portevin,† who examined 88 different steels in the form of rolled bars. In these experiments the bars were connected to copper leads, and two series of thermo E.M.F. measurements made.

Now the thermo-electromotive potential of carbides in solid solution is of opposite sign to that of pure iron when these are both opposed to copper. This renders it difficult to interpret the results obtained from heat-treated steels when the thermo-electromotive potential of the steel as a whole over a given temperature gradient is opposed to that of copper, and the results of these measurements again compared with that obtained by opposing the thermo-electromotive potential of pure lead against copper with the same temperature gradient.

Thermo-electromotive potential, like specific resistance, appears to be an inherent property of steel and dependent upon the chemical constitution; therefore, if strictly accurate results are to be obtained, there must be no change in chemical constitution of the steel between the two points over which the temperature gradient exists. It has been shown that the total specific resistance of steel must be considered as made up of two components. First, that due to the pure iron solvent; and, second, that due to the carbides or other solutes. The specific resistance due to solutes depends upon whether or not these latter are in solid solution. The carbides which are in solid solution are by far the most active energy transformers, and by transformation of electrical energy into heat cause that portion of the total specific resistance not due to the solvent iron. It is the solutes which are in solution that most profoundly modify the properties of the solvent. A method has now been devised to determine directly the thermo E.M.F. of such solutes, involving the substitution of pure iron for the copper leads. In this way the thermo-electromotive potential of pure iron and steel are opposed, so that the thermo E.M.F. measured is that due to the solutes alone.

Experiments were carried out on a series of nine samples of iron and steel containing progressively increasing percentages of carbon, manganese, phosphorus and silicon. The bars on which both specific resistance and thermo E.M.F. measurements were made were about 6 mm. square by 15 cm. in length. Bars which had been previously carefully annealed were suspended in an electrically-heated furnace for one hour, the furnace being so designed that the temperature could be accurately measured and oxidation of the bars completely prevented. When the bars had attained the temperature of the furnace they were quickly removed and quenched in ice water. After making specific resistance and thermo E.M.F. measurements on the quenched bars, these were placed for 18 hours in a drying oven maintained at a temperature between 97 C. and 102 C. After again measuring the specific resistance and thermo E.M.F. the bars were carefully packed in a steel tube, which was then placed in an electrically heated furnace and the temperature raised to 205 deg., at which it was maintained between one and two hours, after which the furnace was allowed to cool over night. The subsequent heat treatments were carried on in substantially the same manner. After each re-heating followed by slow cooling, measurements of both specific resistance and thermo E.M.F. were made.

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* Abstract of Paper read at the autumn meeting of the Iron and Steel Institute, September 21-22, 1916.

† "Journal" of the Iron and Steel Institute, 1915, No. I., p. 206.

Specific resistance was determined by measuring the fall in potential between knife-edges clamped to the bar 10 cm. apart, while a current of constant density was flowing through the bar, which was immersed in an oil bath at a temperature of 25 C.

The thermo E.M.F. developed by the temperature gradient between the melting point of ice and the boiling point of water was determined by the following method: Two bars, which had been subjected to the same heat treatment, and which, therefore, could be assumed to be chemically homogeneous throughout their length,

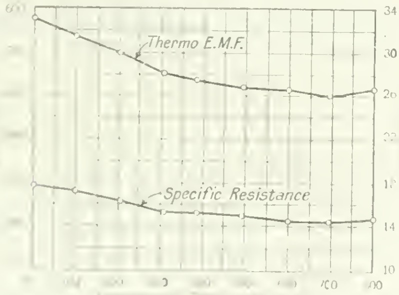

Fig. 1.

[illegible]

were lapped about 1 cm. and held by a small clamp, thus giving a double bar about 24 cm. in length, but of uniform molecular composition throughout. By means of small clamps machined out of carefully annealed ingot iron pure iron wire leads were attached to the ends of the compound steel bar. To furnish the upper temperature of the gradient used in this work a deep cast iron [illegible] was employed, while for the lower temperature of the gradient a deep crucible filled with crushed ice was used.

The ends of the pure iron lead not connected to the compound bar were attached by means of small connectors to the copper conductors leading to the galvanometer. The connectors joining the iron leads and copper conductors were placed in a small bottle containing petroleum, [illegible] to ensure both connectors being at the same temperature, so that the total temperature difference between the pure iron leads should be exactly the same as that across the compound steel bar to which they were connected. The galvanometer deflections were converted into microvolts by comparing [illegible] to a standard electric cell through a known resistance [illegible] six microvolts produced [illegible] on the galvanometer scale, on which [illegible] could be estimated. Duplicate measurements could be kept inside of [illegible] than the reading obtained is not more than [illegible]

The thermocouple composed of [illegible] pure iron [illegible] cell, the [illegible] corresponds to the positive pole of the cell. [illegible] temperature gradient from 0 C. to 100 C. [illegible] pure copper [illegible] that of steel the E.M.F. would be found [illegible] 1.70 [illegible] while with [illegible] of pure lead it will [illegible] 1.42 microvolts.

[illegible] the relation between the [illegible] and (b) thermo E.M.F. and (a) specific resistance [illegible] of the results obtained.

Both (*a*) and (*b*) increase progressively as the percentage of carbon and the other ingredient rises.

The following points deserve notice:—

First, the parallelism between the thermo E.M.F. and the specific resistance of the different steels, as influenced by chemical composition and heat treatment, would prove almost conclusively that the total thermo-electromotive potential of steel, like the total specific resistance, must be considered as being made up of two components: that due to the solvent iron and that due to the solutes, the proportion of the total due to these latter depending upon the extent to which they are in solution. The parallelism is strong confirmatory evidence of the essential unity of mechanism of the nature of metallic and of aqueous solutions, for it is well known that in the latter it is the molecules in solution that are the most active energy transformers. In the present case we have transformation of electrical energy into heat, resulting in specific resistance, and transformation of thermal energy into electrical energy, resulting in thermo E.M.F., both phenomena apparently being due to the same molecular condition.

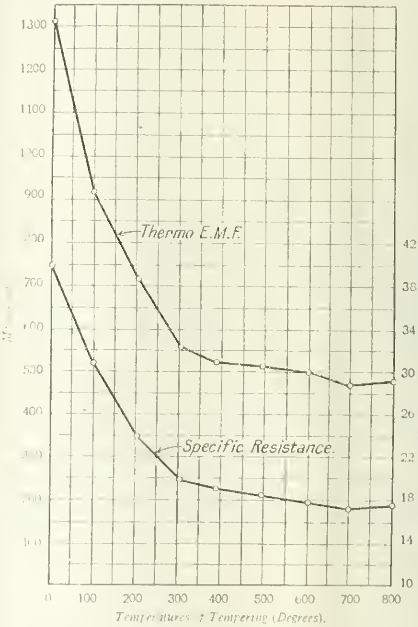

Fig. 2.

Steel C7 [illegible]: Carbon, 1·05 %; manganese, 0·190 %; phosphorus, 0·013 %; sulphur, 0·020 %; silicon, 0·167 %.

Second, the transformation of the allotropic into the alpha form of iron by re-heating is nearly completed after re-heating to 300 deg. This is shown by the rapid drop of both specific resistance and thermo E.M.F. up to this point; but complete equilibrium, indicated by minimum specific resistance and thermo E.M.F. is not attained except after long heating to about 700 deg. The fact that the minima in all the present steels is for those which have been re-heated to 696 deg. would indicate that if the re-heating temperatures exceeded the lower critical points, so that carbides re-dissolved, the re-precipitation would not be quite as complete as was effected by a series of long re-heatings, none of which, however, quite reached the critical range.

Third, neither the specific resistance nor the thermo E.M.F. due to carbon in solution as carbides is directly proportional to the atomic concentration of the carbon. These data show that equiatomic concentrations of carbon, as hypoeutectoid carbides, produce only about one half the effect on the specific resistance and thermo E.M.F. as is produced by equal atomic concentrations of carbon existing in the form of the carbides of eutectoid or hypereutectoid steels.

The molecular concentration of solutes in steel may be readily calculated from the formula $\frac{10da}{n\ \text{at. wt.}}$, in which *d* is the density of the steel, *a* the element in question expressed in per cent., *n* the number of atoms in the molecule, and the atomic weight that of the element under question. If the assumption is made that equimolecular concentrations of carbides in solution exert equal influence on the specific resistance, we would have an experimental method by means of which the relative molecular weights of the different carbides might be determined.

The conception in regard to thermo-electromotive potential outlined above would suggest at least two applications of the principles involved: (1) If constancy of thermo E.M.F. in couples is to be expected, the molecular concentration in those members not consisting of strictly pure metals must remain constant over the temperature range within which the couples are used. (2) The thermo E.M.F. is independent of the size and shape of the cross-section between the points of contact, but is wholly dependent on the molecular composition and the temperature gradient between these points. Hence it should not be difficult to develop a method, based on the observation of thermo E.M.F., for testing molecular changes induced in a given piece of steel by the heat treatment to which it has been subjected.

CORRESPONDENCE.

ELECTRICITY SUPPLY.

TO THE EDITORS OF THE ELECTRICIAN.

In the discussion which is proceeding on the proposals for the reform of the electricity supply of Great Britain, the issues, which were originally fairly clear, are becoming involved, due to misconception and misunderstanding. Partisanship, that barrier to reform, if tending to grow, must be checked. It is very unfortunate that the word *nationalisation* has been mentioned, for in the Paper I had the honour to read before the I.E.E. on this subject there is no proposal for the nationalisation of our electricity supply, to which I am opposed.

We are practically unanimous that reform is needed and the proposals advanced by me were that we should attain that reform by (*a*) co-operation, and (*b*) co-ordination of control

We must co-operate where centralisation would produce the best results, as, for example, in many instances in the generation and bulk distribution of electricity but should remain independent where no advantage would accrue from centralisation, viz., in the distribution and application of electricity.

We *already have* Government control of electricity supply in a not very satisfactory form, viz., the Home Office, Local Government Board, Board of Trade, and Parliament itself. There is no co-ordination of control, no live connection between the supply undertakers and the Government, and no scientific plan for the electricity supply of the country as a whole.

The proposal in the Paper was to take this existing Government control, and vest it in a professional public Board, which would watch over the industry as a whole, both of the interests of the public and the legitimate interests of the supply undertakers.

In so far as the powers of this Board would be contained in a Parliamentary Bill, it would really be what might be termed a quasi-Government Board, which is very different to a Government Department. The Board would have Government authority through its Bill without many of the restrictions of Government Departments. The Port of London Authority is a somewhat similar organisation, and the remarkable success of its administration is its justification. Again, the Public Trustee Office is run on less restricted lines than an ordinary Government Department, and is self-supporting, and its success is shown in the rapid rise of this office.

Under this Board enterprise would be extended and it was to be part of the Board's duties to *encourage private enterprise to the maximum extent*. The Board would operate in conjunction with existing undertakers when this was to the interests of all, and would operate in such districts as were unprovided for, and for which no private or municipal enterprise sought powers.

Shareholders of companies should realise that if reform can be effected in which their interests are protected and in which their further enterprise is encouraged, then they have everything to gain by it. Those companies in particular whose powers are not in perpetuity would be given a new lease of life under the scheme.

Another point made in the Paper was that drastic alterations and the immediate sweeping away of existing generating stations was not proposed. The proposed Board would lay out plans for the supply of this country to meet its requirements, say, 15 years hence, and then see that all new plant, new stations, new interconnecting mains, &c., &c., were devised to form part of the final scheme. The necessity for and value of a transition period was insisted on both for economic and administrative reasons.

To sum up—reform by co-operation and co-ordination was to take place on the basis of protecting and advancing the interests of existing undertakings and those who had invested their money in them, whether shareholders or Corporations. It is possible to do this and at the same time benefit the country as a whole, because the electricity supply industry is rapidly growing. The saving in coal alone under the scheme would amount to several millions sterling per annum. The owners of the undertakings as well as the general public, would participate in this beneficial result.

Moreover, it must not be lost sight of that if the supply industry is not reformed from within it will be taken that the industry is not capable of effecting such much-needed reform. This leaves it open to attack from without, when probably more drastic and less equitable action would result. Apart from this it is the duty of all to look at the problem from the standpoint of the national need and seek to attain the desired end.

It is useless to expect to achieve this result by taking a short and narrow view. Any particular series of proposals if looked at from the standpoint of the immediate results might not be considered advantageous, but studied with a view to the ultimate result, for which all undertakings would be working on a preconceived and scientific plan, would certainly be carried out. In this connection, the establishment of the Public Electricity Board would inspire confidence and justify the broader view being accepted by individual undertakings.

There is no reason to fear that because powers are vested in a Public Board sympathetic to electricity supply, personal interests will suffer we may reasonably expect the opposite. So long as these interests are adequately protected in the Bill, and we can be assured those responsible will see to this, then the shareholders should work for the reform as being in *their* interests and the interests of the whole country.

Finally, let us not make the foolish mistake of mistrusting those who represent the industry in positions of influence. The recommendation (2) of the Council of the I.E.E. to the Board of Trade, means, I take it, neither more nor less than it states, and the Council of the I.E.E. deserves the thanks and encouragement of the industry for all the trouble it has taken in this matter.

When we read the names of those who constitute the Committees dealing with this reform in electricity supply, we can be assured by their past and present achievements that they will only take such steps as they are satisfied will be steps of true progress, which includes the interests of the industry itself as well as those of the greater public.

I hope the time may not be far distant when the Council, with the support of the whole industry and shareholders, may be able to boldly approach the Government and ask for the Parliamentary authorisation of a complete scheme somewhat as outlined in the Paper discussed by the Institution.

London, Oct. 3. ERNEST T. WILLIAMS.

THE AUDION FLEMING VALVE LITIGATION.

TO THE EDITORS OF THE ELECTRICIAN.

In the summer of 1914 attorneys for the American Marconi Company approached officials of the De Forest Radio Telephone & Telegraph Company, and proposed that this company give to the Marconi Company an unlimited licence under the

De Forest audion patents in exchange for a licence under the Fleming valve patent.

Although at that time the audion had been very generally used since 1907, thousands having been sold, no threat of suit had ever been made by the owners of the Fleming valve patent, whereas so far as is known not a dozen genuine Fleming valves had been used in the U.S.

Shortly after the above-mentioned conference a suit was brought by the Marconi Company. The De Forest Company found with little difficulty that the three-electrode audion—containing filament, plate and grid, was being extensively but secretly used at various important Marconi stations, the super-sensitive receivers there required being simply inoperative without the audion. Whereupon it promptly brought counter-suit under several of the De Forest audion patents. "Caught thus with the goods," the Marconi attorneys early in the litigation admitted validity and confessed judgment under the "three-electrode" audion patents, but continued nevertheless to manufacture and use them.

Judge Mayer, of the U.S. District Court, has just handed down his decision in this suit. It is in effect that Prof. Fleming, having been the first to describe the application of the well-known Edison rectifying action in an incandescent lamp to receive high frequency oscillations, was entitled to broad patent protection on any form of detector comprising an incandescent filament in an evacuated vessel. He holds that the addition to the simple Fleming rectifier of a "B Battery" by De Forest (even though it was shown in the trial that this addition made of the lamp a true *relay* device, where the local energy and not the received energy produced the audible signal) did not constitute a patentable improvement. Nevertheless, it is an incontestable fact that this "obvious employment" of a second battery with its immense addition to the sensitiveness of the so-called valve was not appreciated by Fleming until incorporated in his 1908 patent—two years after De Forest had disclosed the idea!

The judge admits that the introduction of the grid electrode by De Forest was a most important advance in the art—a truth emphasised by the fact that since its first disclosure tens of thousands of grid audions have been employed the world over, as against a few hundred two-electrode lamps and almost no genuine rectifiers as disclosed in the original Fleming patent.

During the course of the trial the De Forest Company's experts demonstrated very conclusively that electrical rectification between the hot and cold elements of an audion played no essential part whatever in the operation. Bulbs were tested having one, two and finally, three incandescent electrodes—*i.e.*, filament, grid and anode all incandescent, heated from separate batteries. The actions and sensitiveness of these audions was unchanged as grid and then anode were brought from cold to the same temperature as the filament. In this sense either electrode could be made to play the part of "filament," "grid" or "anode" indifferently; proving beyond all cavil that the rectification principle, on which the Fleming valve avowedly does and must operate, plays no part whatever in the audion.

Under these considerations—fundamental divergence in operation, and values of utility simply not to be compared—it seems that the Court has erred.

Pending a reversal by appeal, the radio art in America at least faces this peculiar situation: The Marconi Company alone can use the Fleming valve or any form of incandescent lamp detector. But neither they, nor anyone else wants to employ it without the grid electrode, and by their confessed judgment they are effectually stopped from using that—the modern audion!

The audion amplifier and the oscillion generator of undamped oscillations for transmitting purposes are unaffected by the recent litigation. These devices now constitute the largest part of the De Forest Company's business.

DE FOREST RADIO TELEPHONE & TELEGRAPH CO.

New York, Sept. 22.

[We have taken the liberty of slightly abbreviating our correspondents' letter.—EDS. *E.*]

TECHNICAL RESEARCH.

TO THE EDITORS OF THE ELECTRICIAN.

I have read with great interest the article of Mr. J. Swinburne on "Technical Research." His argument is that official interference is not wanted nor even desirable to favour the development of technical research.

1. Because the money spent by the Government would produce a flourishing of science which would be at the *expense* of England, "while the benefit would be spread among humanity."

2. Because a cable maker who would like to discover a new and better dielectric will spend £10,000 and will know very well who are the right men to find out for him what he requires, better than an official school teacher.

The first argument is indeed unshakable, but it has been the same position for all countries who have once been the pioneers in science. France invented and created the metric system to her benefit, but also to the great benefit of the Germans, who adopted it. You may only consider that if the expense is bearing on the country for the cultivation of science, the honour and glory resulting are also some part (and by no means the most negligible one) of the portion only of the nation.

The second argument falls flat in most cases, because the cable maker *very seldom* says to himself "I will spend £10,000 for a research." He says more often: "My trade is all right, I am making the best cable in the world and I do not want costly and useless improvements." This second argument fails also because even if the cable maker is so munificent as to spend £10,000 he spends it amongst men who, certainly, know their line, and know all that has been made in the dielectric department, &c., but all the same those men are not always the qualified men for invention, and often are quite the reverse. You cannot have an invention made to order.

If a telegraph company had settled to make some new device for transatlantic telegraph, and decided to spend millions for the salary of consulting experts, &c., would they have brought out wireless? No! The invention and research generation has its roots lying deeply in the cultivation of pure science, which can only be the lot of a special body of men whose minds are only profoundly devoted to science and science alone. These men must be kept up by the Governments of civilised nations. They must remain scientists and purely scientists, but must be kept in contact with the *desiderata* of industry; so that it must not be the technical engineer or expert who come to science and look throughout if they can find something useful for their purpose. But, inversely, it must be the scientific corporation which must be aware of the needs of industry so as to be able to direct their researches to a given orientation, although they must keep true to the motto: "Science for Science."

Then whatever you can do there will always be this inventive genius, which cannot be given to experts or scientists. The alphabet by dots and darts, the Morse alphabet, is certainly an invention of immense importance, and Morse was an *American painter!*

All the same, the inventors, as a rule, and now more than ever, in the state of highly advanced science, can only work from the facts discovered by the scientist, and the State must see that the scientists are *numerous*, well *instructed*, well *equipped* and well paid.

London, Sept. 27. B. J. X. IGNATUS.

Magnetic Gear-Shift on Motor Cars. The magnetic gear-shift, says the "Motor," is being adopted on a number of American cars, though its use at present can only be regarded as an experiment. The device brings one within measurable distance of automatic gear-changing, but its operation is dependent on the accumulators, which is again dependent upon the dynamo, and there are many connections and contacts to be taken into consideration. While, therefore, the method has attractive possibilities, its advantages must be accompanied by a sacrifice of simplicity. It will be interesting to watch how this novelty develops.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

The Metropolitan Electric Supply Co. A report of the proceedings at the recent extraordinary general meeting of this company appears in another column, and we are pleased to see that the compromise suggested by the shareholders' committee has been adopted. The company's business is developing in a satisfactory manner, its area of supply is an extensive and important one, and with the return of peace good progress should be made. The prospects of this important supply company are bright, and we think the shareholders were wise to avoid internal friction in these times of difficulty for all electric supply and gas undertakings.

* * * *

Prohibited Exports. It is announced that no further licences will be issued in the United Kingdom or in British possessions overseas for the exportation of vaseline to Denmark, rubber and balata manufactures to Holland and talc (powdered) to Sweden.

Privy Council licences will similarly not be accepted by the Customs as authority for shipment without special authority from the War Trade Department. Holders of unexhausted licences should at once communicate with the War Trade Department, stating the reasons for which they desire to receive such special authorisation.

* * * *

Excess Profit Duty Decisions. The Procedure Committee of the Board of Referees constituted by the Finance (No. 2) Act, 1915, have decided that decisions of the Board under sec. 42 (1) of the Act, fixing an increase of the statutory percentage as respects a class of trade or business, shall be published in the "London Gazette," but not decisions of the Board under secs. 40 (3) and 42 (2) which affect particular traders only.

* * * *

Federation of British Industries. The Executive Council of the Federation of British Industries, an organisation whose aims and objects were recently set out in THE ELECTRICIAN, has issued a circular (signed by the president, Mr. F. Dudley Docker) inviting manufacturers, engineering firms, &c., to become members.

It is stated that the Federation is intended to occupy itself mainly with the broader questions which affect the trade and industry of the country, and to represent British producers and manufacturers in much the same manner that the General Federation of Trade Unions represents organised labour.

The Federation will not interfere with the normal functions of existing trade associations, but will support and strengthen them by every means in its power in order that they may deal effectively with the particular problems confronting each individual trade. Its objects may be summed up briefly as the organisation and development of industry now and after the war, in co-operation with labour and in conjunction with the Government and Government Departments.

Among the immediate objects of the Federation will be reconstruction of British trade after the war, development of sources of supply of raw materials and consideration of questions arising out of the transition from war to peace, such as demobilisation, the future of temporary war workers, measures to mitigate possible unemployment during the transition period, and economic problems in general. At the same time there will be no delay in dealing with such important question as the efficient representation of British manufacturers abroad, the improvement of the existing commercial intelligence system, the extension of financial facilities for industry and foreign trade, and the better co-ordination and regulation of freight and transport. A condition of membership is an annual subscription of £100 a year, with an obligation to continue such subscription until June 30, 1919. Applications for membership should be sent to Mr. R. T. Nugent, 57, Lincoln's Inn-fields, London, W.C. The Executive Council includes Messrs. F. Dudley Docker, C.B. (president), Wilfrid Stokes (Ransomes & Rapier), F. R. Davenport (Willans & Robinson), A. W. Tait (British Aluminium), Hy. Howard (Stewarts & Lloyds), Godfrey C. Isaacs and E. Manville, Sir Vincent Caillard (Vickers Limited), Sir Algernon F. Firth, Bart., M.P., Sir Robert A. Hadfield, F.R.S., Sir J. S. Harmood-Banner, M.P., Sir Geo. H. Murray, G.C.B. (Sir W. G. Armstrong, Whitworth & Co.).

* * * *

After-War Problems. At a recent gathering of the members of the Wolverhampton Chamber of Commerce, Sir Algernon Firth, President of the Association of Chambers of Commerce, said that in some Continental countries Chambers of Commerce had official status and virtually were under Government control.

In this country, he said, we did not want official status, or official interference with our work, but in order to increase the efficiency of Chambers of Commerce he advocated, where possible, the appointment of a whole-time secretary and staff, the establishment of a separate office, the levying of an adequate subscription, and keen competition for the election of officers. The war had shown one thing—that no one of alien origin should be allowed membership of a Chamber of Commerce. Some Chambers had cleared out those members; the great thing was to see that no more got in. They wanted the British Consular Service for the British, and there should be closer co-operation between Government departments and Chambers of Commerce.

After referring to the aims of the Russo-British Chamber of Commerce and the British-Italian League, he urged the business community to recognise the importance of the Russian and the Italian markets. In 1913 the import trade of Russia was represented by £140,000,000, of which 47 per cent. was done by Germany and Austria. There was a strong feeling in Russia about that, and if we would help them they would wipe it clean off the slate. But we had to find the means to do it, and it was our duty as well as to our interest to do so. In Italy the Germans had exploited the markets most unscrupulously, and now that Italy had cut her connection with Germany they asked how their enterprises were going to be financed except by the British. To secure the continuity of goodwill shown by the Italians it was our duty, even if we did not get an immediate return from our efforts, to do business with them.

* * * *

Contraband of War. Proclamations published in the "London Gazette" of the 3rd inst. add to the list of articles to be treated as contraband of war, and also to the list of goods the importation of which is prohibited.

The additional articles to be treated as absolute contraband are insulating materials (raw and manufactured), fatty acids, cadmium, cadmium alloys and cadmium ore, and waxes of all kinds. (Paraffin wax was already declared contraband.)

* * * *

Import of Goods. The importation into the United Kingdom is now prohibited of aluminium powder, manufactures of bone, horn, ivory and celluloid. The prohibition will not apply to such goods as are imported under licence of the Board of Trade.

* * * *

Control of Supplies. An Order in Council dated Oct. 3 makes additions to the Defence of the Realm Regulations empowering the Admiralty or Army Council or the Minister of Munitions by order to regulate, restrict, or prohibit the manufacture, purchase, sale, delivery of, or payment for, or other dealing in any war material, food, or stores of any description, or any article required for or in connection with production thereof.

Any person who refuses to sell any article, the sale whereof is regulated by any such order, he may be required by the Admiralty or Army Council or the Minister of Munitions to sell it on the terms and subject to the conditions on and subject to which the sale thereof is authorised by order. Failure to comply with any provision of any such order or any requirements made thereunder, and aiding or abetting any other person in doing anything which would be a contravention of any such order, are made offences against the Regulations.

It is further provided that the Admiralty or Army Council or the Minister of Munitions may by order require any person engaged in the production, manufacture, purchase, sale, distribution, transport, storage, or shipment of any war material, food, forage, or stores of any description or of any article required for or in connection with the production thereof, to give such particulars as to his business as may be specified in the order, and may require any such particulars to be verified as they may direct. Failure to comply with the Order, or the unauthorised disclosure or use of any information given under this regulation is made an offence.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Sept. [illegible]3, 1916, *to* Sept. 29, 1916.

IMPORTS.

Folkestone.—[illegible] 16 [illegible], unenumerated [illegible].

Grimsby.—*France*: Unenumerated, 4 c[illegible].

Liverpool.—*U.S.A.*: Electrodes 154 [illegible]; insulated copper wire, £1[illegible]; [illegible] carbons 60 pkgs.; graphite electrodes [illegible]; unenumerated, 102 pkgs. [illegible] Elec. carbons 34 pkgs.

London.—*U.S.A.*: Carbon candles, £783; wire and cable, £711; telephone material, £1,071; elec. motors 42 [illegible]; elec. wire 323 [illegible]; elec. machinery, £260; unenumerated £6,11[illegible]. *Holland*: Elec. lamps, 1,216 pkgs.; elec. glow lamps, £2,[illegible]52; unenumerated, £2,194. *Japan*: Electric [illegible] 22,389 [illegible]; unenumerated, £1,526. [illegible] *Switzerland*: Elec. machinery, £5,321; unenumerated, £82. *Sweden*: unenumerated £265. *Italy*: Unenumerated £1[illegible]1. *France*: Carbon candles £[illegible]03; telegraph material 13 pkgs.; unenumerated, £160.

Manchester.—*France*: Electrodes, 29 [illegible].

Southampton.—*France*: Unenumerated, 41 pkgs.

EXPORTS.

To Australasia.—*Au*[illegible]: Wire and cable £610; unenumerated, £190. *Melbourne*: Wire and [illegible] £[illegible]; elec. machinery, £3,597; elec. meters, £265; unenumerated £1,047. *Sydney*: Elec. machinery £658; wire and cable, £1,665; elec. lamps, [illegible]; unenumerated, £1,446. *Wellington*: Wire and cable, £753; elec. machinery, £25; unenumerated, [illegible]1,041. *Lyttelton*: Wire and cable, £974; elec. machinery, £208; unenumerated, £27[illegible]. *Dunedin*: Elec. machinery, £10; unenumerated, £635. *Adelaide*: Unenumerated [illegible]. *Christchurch*: Wire and cable £54; unenumerated, [illegible]. [illegible] Wire [illegible] £[illegible]0; unenumerated, £537. *Newcastle*: Elec. machinery, [illegible]. [illegible]: Elec. machinery, £[illegible]. *Timaru*: Unenumerated, £23. *Wanganui*: Unenumerated, £17. *H*[illegible]: Unenumerated, £340. *Invercargill*: Unenumerated, £1[illegible].

Africa.—*Durban*: Elec. machinery £13[illegible]; wire and cable, £10; unenumerated, £[illegible]. *Cape Town*: Wire [illegible] £64; unenumerated, £1,818. *Port Elizabeth*: Wire and cable £4[illegible]; unenumerated, £1[illegible]. *[illegible]*: Unenumerated, £42.

M[illegible].—*Co*[illegible]: Unenumerated, £14. [illegible]: Unenumerated, £25.

E[illegible].—[illegible]: [illegible], £265. *Port Said*: Elec. [illegible] lamps, [illegible] unenumerated, £176. *Suez*: Unenumerated, £16.

M[illegible] W[illegible] £193 [illegible] material £37; unenumerated £56.

India, [illegible] Straits Settlements.—*Bombay*: Wire and cable, £1[illegible]. [illegible] Elec. [illegible] lamps [illegible],000 [illegible]; [illegible] £[illegible]; unenumerated, £1,14[illegible]. *Madras*: Wire and cable, £[illegible]1 [illegible] £1[illegible]6 [illegible] material, £1[illegible]; unenumerated, £415. [illegible] Elec. [illegible].

[illegible] Elec. [illegible] lamps [illegible].

[illegible] A[illegible] Wire [illegible] cable, £109; unenumerated, [illegible]. [illegible] £143. [illegible] unenumerated, £3[illegible].

[illegible]

[illegible] Elec. [illegible] £16[illegible]; wire and cable [illegible]; unenumerated, [illegible].

[illegible]

[illegible] Elec. [illegible] unenumerated [illegible]. [illegible] Unenumerated [illegible]. [illegible] Elec. [illegible] £[illegible]21. [illegible] Unenumerated, £67. [illegible] Elec. [illegible].

[illegible]

[illegible] £1[illegible] [illegible].

FOREIGN GOODS (duty paid and free).

[illegible] Unenumerated £[illegible]. [illegible] Unenumerated [illegible] £1[illegible]. [illegible] Unenumerated, £[illegible].

IN TRANSIT.

[illegible]

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL.

Armstrong College (University of Durham), Newcastle-on-Tyne.—The new session commenced on Sept. 25. Full particulars relating to the departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce may be obtained from the secretary, Mr. F. H. Pruen, M.A.

University of Bristol.—We have received a copy of the Calendar of the Merchant Venturers' Technical College, which provides and maintains the faculty of engineering in the University. The courses include schemes of study for persons intending to engage in civil, mechanical, or electrical engineering. The department of automobile engineering is closed for the duration of the war, the professor of this department being engaged on important work in connection with munitions.

School of Photo Engraving and Lithography.—The 1916-17 session began on Sept. 18. Particulars of classes, fees, &c., may be obtained from the Principal (Mr. A. J. Bull), Bolt-court, Fleet-street, E.C.

BUSINESS NOTICES.

The partnership between W. C. Gilbert, F. Rogers and E. J. Field (trading as Gilbert, Field & Co.), motor and electrical engineers, 79 and 80, Station-street, Burton-on-Trent, has been dissolved.

Sale by Tender.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the Controller of the Electrical Company (Ltd.) (Mr. Maurice Jenks, F.C.A.) to offer for sale by public tender, as detailed in the lots of the catalogue, the entire stock of electrical supplies, equipment and accessories at the offices and showrooms, 122-4, Charing Cross-road, London, W.C. The stock includes generating and testing plant, motors, arc and incandescent lamps, fans, cable, insulators, carbons, meters, switches, electrical accessories, &c., and will be on view for two weeks commencing Monday, Oct. 2, from 10 a.m. to 5 p.m. daily. Catalogues from the selling agents, Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and at Manchester and Newcastle-on-Tyne. Tenders must be sent in to the firm at 46, Watling-street, E.C., by noon Oct. 17.

The Controller, Mr. Maurice Jenks, is prepared to receive offers for the trade and business connections as lately carried on by the Company. The Controller also invites applications for copies of the Company's bound catalogue, price 5s. post free in U.K.

Further particulars are given in advertisements.

Patent Development.—The proprietors of patent No. 27,477/1913, for "Improvements in controlling devices for variable speed dynamos and their circuits," desire to enter into arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Dundee.—The Electricity Committee has reported that after the war an extension of the existing buildings and the installation of additional generating plant, &c., will be required. The approximate cost of the extensions is put at £90,000.

Hebden Bridge.—Application has been made for sanction to a loan of £450 for laying an additional cable to Bankfoot Bridge.

Heston-Isleworth.—The Council have informed the Samuelson Film Co. that, provided they are willing to pay the Council £350, an additional set of cables will be laid to the company's studios for affording an increased supply of current thereto.

The actual initial cost over £360 will be borne by the Council, and as soon as the latter are in a position to obtain sanction from the L.G. Board to a loan for main extensions, they will repay to the company the actual cost (estimated at £220) of laying such portion of the cable as may lie along the public highway.

Ilford.—A special committee of the Council reports that the electrical engineer (Mr. A. H. Shaw) has submitted preliminary tenders for the provision of main and sub-station plant, cables and conduits required in connection with the scheme for the utilisation of the steam at the refuse destructor, and indirectly augmenting the supply of current to the eastern side of the district. The Committee recommends that application be made to the L.G. Board for sanction to borrow £10,000 for the scheme.

Sunderland.—The Electricity and Lighting Committee recommend the Corporation to carry out extensions of the Hylton road electricity works at an estimated cost of £15,246.

In a report by the engineer and manager (Mr. A. S. Blackman) it is stated that the necessity for an immediate extension is clearly shown by the fact that when the largest turbine broke down last year the works cost increased by £3,500, and the works were then running without any standby. The demand for electrical energy has grown during the past 12 months to the extent of 830 kw. and the new consumers would soon make a further demand of 2,500 kw. The present plant was altogether inadequate to deal with that demand in addition to the present load. The estimated cost of the extension was £15,246, and it was thought that the new plant working at the minimum of cost would provide for any obsolescence of plant that might have to be set aside and also for interest, sinking fund and income tax and still leave a margin of profit to deal with the general demand of the undertaking.

The Committee decided to recommend the scheme to the Council, but the second part of the engineer's report, dealing with prospective requirements, was not discussed.

GENERAL.

Accrington.—A sub-committee of the Electricity Committee recommends that the rate of pay of the following classes of employés be increased by 1d. per hour.

Charge hands, under hands, sulphate house and blow house men, tar skimmers, firemen, coal trimmers, fitters' labourers, day men and general labourers. All overtime is to be paid at rate of time and a half, but no overtime will be paid in any week to any man until he has worked 56 ordinary hours during the preceding seven days.

Barnes.—The Council have decided to accede to the application of the Barnes Mechanical Works for a further supply of 100 H.P. It will be necessary to lay a special cable from the electricity works to the premises at a cost of about £1,000. The consumers must, however, provide the capital.

Barnsley.—The Electricity Committee propose to apply for an order to supply electric current to Mount Vernon-road.

Chester.—The Council have discontinued the minimum charge for electric current during the winter.

At a recent meeting of the Electricity Committee replies were received from 19 towns as to minimum charges. In eight a minimum charge is made to consumers (one for power only); in three towns there has been an increase of the minimum charge. Eleven towns have no authority or do not make a minimum charge.

Eastbourne.—In future the Electricity Committee will charge consumers through slot meters a meter rent of 6s. per year, or 1s. 6d. per quarter.

Kendal.—The Electricity Committee has decided to grant the Manager an increment of £25 per annum from Oct. 1.

Kingston-on-Thames.—At the last meeting of the Council the chairman of the Lighting Committee (Councillor Kerrison) said he felt bound to draw the attention of the Council as to what might happen in the future. They would not be able to utilise the Diesel engine until February or March, and as the new crank would cost £1,000 he felt the future of the electric supply department was not quite so bright. The broken crank was not covered by insurance, but that this matter had now received attention.

Salford.—The Electricity Committee proposes to enter into an agreement with F. Smith & Co. for the supply of current to their premises on the following terms :—

The company will guarantee a minimum payment of £600 per annum ; all current to be paid for by the company at the usual sliding scale for power ; the maximum demand made by the company not to exceed 400 kw., unless by special arrangement with the committee ; the Corporation will lay the necessary h.t. cable from Blackfriars sub-station to the company's premises and provide the requisite switch cubicle at the sub-station, and also the high-tension feeder cubicles ; the company will purchase the necessary transformer and h.t. and l.t. switchgear and provide a sub-station at their premises, but will not consume electric current between 4 p.m. and 6 p.m. in November, December, January and February. The agreement will be for 10 years from Dec. 1 next.

Twickenham.—The Twickenham & Teddington Electric Supply Co. recently intimated that the charges for electricity supply for all purposes would be advanced by a further 10 per cent., making 20 per cent. in all.

The Clerk of the Council pointed out that a clause of the Council's agreement with the company provided that the charge for electric current for public lighting must not in any circumstances exceed 2½d. a unit, and the company was so informed. At a subsequent meeting a letter was read from the company alleging that the term "public lighting purposes" referred to street lighting only, and that that reading of the clause seemed confirmed by the reference therein to clause 34 of the Electric Lighting (Clauses) Act, 1899. As, however, a court might feel itself bound by the definition of "public purposes" in the Electric Lighting Act of 1882, it did not propose to press the point further, but it would be only reasonable for the Council to meet it in the matter on account of the low price for current and the war conditions.

The Clerk has been instructed to reply that the Council is not prepared to make any payment in excess of 2½d. a unit.

The Council's surveyor has been in correspondence with the company's engineer regarding the overhead line across the Mereway allotments, which was erected under licence granted by the Council in March, 1911. The surveyor reported that the line was recently entirely renewed without previous notice having been given to the Council, and that additional wires had been erected for giving a supply to some engineering works, in respect of which the consent of the Council had not been obtained. The Highways Committee recommends the Council to give six months' notice to the company to terminate the licence, and that the company be required to take down and remove the wires at the expiration of the notice.

Walthamstow.—The Lighting Committee has fixed the salary of G. F. Bridgman and H. J. Halliday (who have been trained as switchboard attendants) at 25s. per week each, rising by half yearly increments of 2s. 6d. per week to 35s. Mr. R. E. Mason, a switchboard attendant, is to be promoted to the position of junior charge engineer, with an increase of 2s. 6d. per week, and his maximum salary increased to 45s. a week.

Wimbledon.—The borough electrical engineer (Mr. H. Tomlinson Lee) has been authorised to obtain a new governor for the 10,000 kw. Curtis turbo-alternator at a cost of £80.

LIGHTING & POWER NOTES.

Electricity in Collieries.—It is reported that the Banknock Coal Co. (Bonnybridge) has decided to put down electric generating plant in order to supply their own electric power.

Hospital Lighting.—Luton Council has sanctioned the wiring of the blocks of Spittlesea Hospital, not at present lighted electrically, and to have electric radiators installed if the House Sub-committee consider them desirable. The Borough Engineer is to report upon the question of installing private telephones between the various blocks.

Hull.—The Corporation have recently erected an electric derrick on the Victoria Pier for the purpose of lifting heavy motor and other vehicles from the landing stage on to the Great Central Railway Co.'s ferry steamers which cross the Humber between Hull and New Holland.

Mansfield.—The Council recently ordered a 2-ton electric tipping wagon from the General Vehicle Co., at £1,070, delivery to be within eight weeks.

It was explained that when they had the vehicle they would be customers of their own electricity works to the extent of £40 or £50 a year. It would take the place of four horses and save some amount of labour. The decision to purchase had been come to in the interests of the efficient working of the sanitary department of the borough.

St. Austell.—The police have sanctioned the lighting of 28 public lamps until 10 p.m. The Council has given the local electric supply company notice to discontinue for 12 months the lighting of 95 of the public lamps.

Water-power in Ireland.—At the annual conference of the Association of Municipal Authorities of Ireland last week Mr. P. J. M'Andrew, B.E., read a Paper on the "Development of Water-power in Ireland."

In the Paper Mr. M'Andrew pointed out that in the United Kingdom steam costs ½d. to ¾d. per unit to produce, and really costs the manufacturer who uses it £15 to £20 per horse-power-year. Foreign nations, such as America, and practically all Continental countries, by the use of water-power were getting power for not more than £6 per horse-power year. In January, 1915, the author prepared a report on the water power available in the rivers Shannon and Erne, giving the approximate cost of harnessing the powers in those rivers as well as the approximate revenue to be derived from the supply of industrial and lighting power. The survey was made by a large staff of engineers under the direction of Mr. Theodore Stevens and the author as consulting engineers. The company which had made the survey was negotiating for the sale of the power to manufacturers and others. There were 50,000 H.P. available in each of the rivers Shannon and Erne for eight months of the year, and from 20,000 H.P. to 40,000 H.P. during the remaining four months. Unfortunately, the Board of Trade had prohibited private Bills being promoted during the war; but if the Government wanted to improve the economic conditions of the nation it ought to encourage the development of the natural resources of the country and particularly of its water-power. As regards arguments which had been put forward against the practicability of transmission of power, say, from the Erne to Belfast and from Doonas to Dublin, he pointed out that in Mexico a company transmitted their power 160 miles, the Ontario Power Co. 160 miles, the Great Western Power Co. 154 miles, the Southern Power Co. 161 miles, the Great Falls Co. 130 miles, and the Mississippi Hydro-Electric Co. 144 miles, while the Niagara & Victoria Falls Companies also transmitted their power for long distances. The distance from the Erne to Belfast and from Doonas to Dublin was in each case about 120 miles. It was the intention of the Irish Hydro-Electric Co. to transmit the power by high-tension cables on steel towers, which would not be subject to the same climatic changes as in other countries where such work had been carried out, notably Norway and Sweden. No difficulty would arise in transmitting the power over the distances between the respective sources of power and consuming centres like Belfast and Dublin. In most of the countries of the world Governments had substantially aided developments of that kind, and if the Government of the United Kingdom was sincere about placing the country in a position to compete with the foreigner it ought to allow those prepared to put their money into undertakings of that kind to be in a position to put their goods in the market as soon as possible, and therefore ought to review immediately the conditions imposed by the Committee appointed on the issues of fresh capital. The author pointed out the various purposes (including agriculture) for which electrical power could be utilised. Results of experiments on electro-culture had been most remarkable, while the use of electricity for incubators, &c., had had a decided success. The author asked the members of the conference to impress upon their respective boards the absolute necessity for a determined effort to bring about the execution of the scheme.

TRACTION NOTES.

Croydon.—The fare on the Thornton Heath High-street and the "Greyhound" (Croydon) route, which was formerly 1d., but recently increased to 2d., has now been reduced to 1½d.

Edgware and Hampstead Railway.—The Board of Trade has granted an extension of a year for completing certain specified works and for the exercise of powers of purchase in connection with this undertaking as set out in the Acts of 1902, 1909 and 1912.

Edinburgh.—Mr. J. B. Hamilton (Leeds), Mr. J. A. Brodie (Liverpool) and Mr. A. H. Campbell (Burgh Surveyor, Edinburgh) have sent in their report to Edinburgh Corporation on the method of traction to be adopted on the tramways after the expiration of the tramway company's lease.

The report (which consists of over 80 pages) has not yet been published, and the Town Clerk has been asked to present a summary of it to the Tramways Committee.

Hanwell.—At the meeting of the Council last week it was reported that the London United Tramways (Ltd.) proposed to take up the rails in Lower Boston road for repairing purposes elsewhere, and had asked that that action should not be considered as an abandonment of the line, which is at present unused.

This action is due to the difficulty in obtaining new metals, and the company promised to reinstate the disturbed line within two years of the termination of the war.

It was decided to assent to the proposal.

Ilford.—The tramways manager (Mr. L. E. Harvey) reports that the police authorities have now definitely decided to press tramways to carry out the new lights on vehicles order to the fullest extent, and two white lights in front of the car (at the extreme corners), and one red light at the extreme off-side corner at the rear, have now to be shown.

In order to comply with the order, Mr. Harvey is fixing a considerable number of carriage lanterns purchased some time ago. In addition, he has found it necessary to buy about half a mile of twin wire and 15 dozen special lamps and lamp holders. The work will cost at least £50, and considerable alteration will have to be made to the wiring of the cars.

Leyton.—The Tramways Manager has been authorised to alter the lights on the tramcars to conform to new lighting regulations. The cost is estimated at £55.

The Great Eastern Railway Co. has informed the Council that they propose to strengthen the approaches to the bridge carrying Lea Bridge-road over their railway, and that their principal engineer was of opinion that the proposed work was rendered necessary owing to the cars on the tramway over the bridge approaches being moved by electric power, and inquiring whether the Council would admit liability for payment of the expense to which the company will be put.

The Legal and Parliamentary Committee is to report on the matter.

Newcastle-on-Tyne.—The Tramways Committee is appealing against the assessment of the tramways undertaking.

Newport, Mon.—An unusual tramcar accident occurred on Stow Hill on Saturday evening, but the precise cause is not yet known, as one of the drivers is too ill to be interrogated.

It would appear that one of the cars got into the loop on the down journey with the points against him, and as the result of a collision one of the cars was knocked slightly off the line. The driver of this car promptly applied his brakes and prevented it from moving further outwards. The driver of the other car (Palmer, who is ill and who is alleged to be in fault) quitted his car to ascertain the extent of the damage and in his absence the car commenced to move, and, gaining speed with the gradient, it collided with the other car for the second time. On this occasion the latter car was knocked crosswise across the track. Palmer attempted to [illegible] the way, but was pinned between the car and the [illegible]. The [illegible] about 4 ft. to 5 ft. [illegible] of the top of the [illegible] down on top of [illegible]. This fact probably [illegible]. Both cars were [illegible], but all the passengers were got out safely.

[illegible] was on the spot [illegible] the work of removing the [illegible]. An [illegible].

Mr. [illegible] on the part of Palmer [illegible] but was probably excited [illegible] the cause of the car [illegible] in the loop [illegible] properly on.

He found that the slipper brake was off and that was probably done when Palmer backed the car up the hill, and he must have omitted to put it on again when the car came to a standstill.

North London Railway.—The Richmond and Kew electric train service was inaugurated on Sunday last.

FOREIGN NOTES.

Hydro-Electric Power in France.—A recent issue of the "Echo des Mines" gave particulars of hydro-electric developments in France.

The war and the dearness of coal have given a marked impetus to enterprises of this character. Lists of stations in operation and in progress or projected are given. The electrical energy is used for power and lighting, but especially for electro-metallurgical and electro-chemical purposes. The following lists are not, however, complete:—

COMPLETED INSTALLATIONS.	Horse-power.
St.-Georges-de-Commiers Station (Grenoble)	25,000
St.-Gervais-sur-Isere Station (Grenoble)	20,000
Saut-du-Moine Station (Pont-de-Claix Works)	15,000
Drac inferieur (Grenoble Works)	15,000
Veneon Station	10,000
Basse-Isere Station	10,000
Verces Station (Livet Works)	3,000
BUILDING AND PROJECTED.	
L'Eau d'Olle Station (River d'Allemont Works)	15,000
D'Arvillard Works	13,000
Largue Works (Durance)	10,000
Sept Laux Station (Fond de France) Works	8,000
Curtillard Works	4,400
Balme Works	4,000
Tarentaise—Aigue blanche Fall (Meyret Bouchayer)	20,000 to 40,000
Sainte-Fay Fall (Schneider)	20,000
Maurienne—Arc Fall (French Nitrate)	12,000 to 16,000
Neuvache Fall (Delamarche)	15,000
Durance—Carbans Fall	17,000 to 60,000
Serre Poncon	15,000 to 60,000
Basse-Durance Fall	20,000 to 50,000
Manoske Fall	35,000
Poet Fall	25,000
Chateau Arnoux Fall	16,000
Presles Fall	15,000
Savines Fall	15,000

Norway.—It is reported that extensive deposits of molybdenum have been discovered on farms near Mandal, and have been taken over by a company. The production is at the rate of about 3 tons weekly.

The prohibition of July 17, 1915, of the export of copper, &c., has been revised and extended, and since Sept. 5 it has been prohibited to export copper, unwrought, copper ore; pyrites of sulphur containing copper; alloys of copper with common metals, unwrought; scrap of copper and of copper alloys (bars, &c.), copper and alloys of copper with common metals, wrought, plates and ribbons; rods, rolled wire; drawn wire; cup-shaped materials for the manufacture of cartridges; bolts, rivets, nails, tubes, cloth; shaped pieces; wire twisted into ropes, or cables without insulation, fitted with mantle, armoured or unarmoured, also cables covered with insulating materials of all kinds; castings.

Russia.—"Lloyd's List & Shipping Gazette" states that in European Russia, including Finland, and in the Ural and the Caucasus, the utilisable hydraulic power is estimated at about 10,000,000 kw., while the amount utilised is only between 180,000 kw. and 220,000 kw.

According to an Italian report, the Germans neglected to develop Russia's water wealth in order to preserve a market for their own manufactures, and the French and British have abstained from assisting to develop Russian industries.

The Russian imports of German electrical goods represented in 1909 £700,000, and in 1913 £1,700,000. The war has forced Russia to seek other suppliers, but England has not been able or willing to take any particular interest in the market. The Germans exported to Russia in 1913 12·6 per cent. of their whole exports of electrical machines, while England sent only 2·7 per cent. of hers. Germany sold to Russia 6½ times more than England. The English will not consider the market, probably because of the reputation for commercial punctuality of Russians not being good. This belief, however, is erroneous.

American agents have already taken orders for considerable quantities of telegraph and telephone apparatus and copper wire. There is a strong demand for small motors of from 1 h.p. to 5 h.p., for dental and electric appliances, for X-ray apparatus, and every kind of electric material. A month ago it was impossible to purchase a battery cell in Petrograd, and the Russian market can absorb huge supplies in the future. Three fifths of Russian capital has indeed been offered to American firms if they will contribute two fifths, in order to establish manufactures in Russia.

Swedish Exports.—The Swedish Government has prohibited the export of all copper and nickel ore, sealing wax, &c.

MISCELLANEOUS NOTES.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding up of 224 businesses controlled by alien enemies.

The latest list includes Selas Co. (Ltd.), 5, Newcastle-street, Hulme, Manchester, manufacturers of installations for lighting and heating (Controller: J. P. Garnett, 61, Brown-street, Manchester); Feld Bros. & Co. (Ltd.), 432-433, Mansion House-chambers, Queen Victoria-street, London E.C., manufacturers of electric wires (Controller: J. E. Percival, 6, Old Jewry, E.C.).

Inquest.—At Peak Dale, Derbyshire, on the 29th ult., an inquest was held on Tom Bennett, a wagoner, employed by the Buxton Lime Firms Co., who was found dead in a tunnel on Sept. 13.

The inquiry was attended by Mr. G. Scott Ram, H.M. Electrical Inspector of Factories, and by Mr. C. D. Mottram and Mr. W. J. Charlton, Inspectors of Mines.

A witness who saw Bennett going through the tunnel with empty wagons, said the tunnel was about 75 yds. long.

Mr. Thomas Guy Griffiths, electrical engineer of the company, said that the particular line of wiring was there before his time and it was to provide light for the tunnel. It was taken from a line they had feeding the motor. The current was 500 volts. The lighting was discontinued in April last, owing to a conversation witness had with Mr. Ram. Witness went round and told each man not to touch the switches or lampholders until the system of lighting was revised or altered in some way. He took the further precaution of having the wire cut, and the fuses in some cases removed. In some cases he took the lighting wire away altogether. The length where the wire passed through the pipe was overlooked in cutting away the current. Notice was posted up in the shop. Having made this error, and not cut away that line, he was led to understand there was no light in the tunnel, because complaint had been made to him about the absence of lights as recently as a fortnight before the accident. It had been decided to get transformers to bring the voltage down from 500 to 50. The transformers had been ordered. He was upset to find the man had been killed at a place he thought was "dead." He found that circuit was put on a motor circuit. He had stopped the shop lights, he cut the wires, and he thought he had cut off the current. The wire had a "kink" in it, and in the course of time the voltage would break down the insulation, and cause it to get on the pipe. That would be enough to make it alive.

The verdict was: "Killed accidentally by an electrical discharge."

Light and Coal Economies.—The National War Savings Committee, in co-operation with the Board of Trade, has issued appeals to all householders, and especially to the well-to-do, to exercise the greatest economy in the use of coal, gas and electric light.

It is pointed out that for the purposes of the war coal is an asset of supreme value. The requirements of the Navy, the munition works, and the factories engaged in the production of war material are constantly increasing; the needs of our Allies are as urgent as our own; and the maintenance of exports to neutral countries was never of greater importance. No substantial increase of output can be expected during the coming winter, and there is only one way in which the exigencies of the situation can be met; all householders must restrict their purchases to the lowest possible minimum. In particular, a considerable saving must be effected by those whose consumption is relatively large, and to whom one or two fires less would mean nothing more than the sacrifice of a little comfort and convenience.

Coal can be saved directly as fuel and indirectly as light. If the household consumption in both forms were reduced by even one-tenth the quantity available for national needs and for export would be increased by three or four million tons a year.

Trading With the Enemy.—The "London Gazette" of Sept. 29 contains lists of firms removed from the statutory list of firms, &c., in the Netherlands, Netherlands East Indies, Portuguese East Africa and Sweden with which trading by firms, &c., in the United Kingdom is prohibited; and alterations to names and addresses in the lists of firms, &c., in Bolivia, Brazil, Denmark, Netherlands East Indies, Norway and Sweden with which trading is prohibited.

Tribunal Cases.—At Accrington last week, the Borough Electrical Engineer applied for five employés at the electricity works.

Capt. Harwood told the Tribunal that the cases came before the Advisory Committee, but on account of there being three young men under 30 years of age among them they declined to have anything to do with them. They felt strongly that the management of the electricity works ought to get older men.

The Engineer said there were good grounds for making all the applications. The first one (aged 25) had been in the Territorials, was sent out to Egypt, and was there until last April, when he became time expired. Older men had been tried, but it was found they were physically unfit.

Capt. Harwood: What will happen if, as an M.P. is proposing, all young men up to 25 or 30, whatever they are doing, shall be called up?

The Town Clerk: They will have to do without light and power in Accrington, that's all.

Conditional exemption was granted to all the men.

Tribunal's Exemption Conditions.—At the House of Commons Committee of the Appeal Tribunal last week it was held that they had power to order a man to whom they granted exemption on the ground that he was in a certified occupation to join a volunteer training corps.

The Chairman said we think it is in the national interest that we should have that power, and we shall go on exercising it until we are stopped.

The point was raised by Mr. R. C. Hawkin, who appeared for a mechanical and electrical engineer named Ryan, and contested the condition imposed by the local tribunal in granting him temporary exemption if he joined the volunteers. Counsel argued that the tribunal illegally imposed the condition, as Mr. Ryan was in a certified occupation, and the fact that he was reserved was sufficient in itself to obtain for him exemption.

The Chairman said: "It is quite clear that if a tribunal is satisfied by evidence that a man's principal and usual occupation is one of the certified occupations, then, unless due notice has been given by the military representative and the regulations have been complied with, the tribunal has no option but to grant exemption. They were quite satisfied that they had power to order a reserved man to join the Volunteers.

The tribunal gave Mr. Ryan two months' freedom from the Volunteers as well as exemption, and told him that at the end of that period he must join a V.T.C.

War Relief Funds.—The war relief funds of the employés of the India Rubber, Gutta Percha & Telegraph Works Co. now amount to £1,500, and regular donations have been made to the Prince of Wales' Fund, British Red Cross Society, Belgian and Serbian Relief Funds and the Anglo-Russian Hospital at Petrograd.

TENDERS INVITED.

Telephone and Telegraph Material, &c.

Tenders are invited up to Dec. 22 for the supply to the Australian Commonwealth Postmaster-General's Dept., State of Western Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492. Specification, &c., from the Commonwealth Offices, London. *See also an advertisement.*

Tenders are invited (up to Nov. 15) by the Postmaster General's Dept., State of South Australia, for the supply and erection at the telephone exchanges of Glenelg and Brighton, of Automatic Switchboards and all associated apparatus (as per schedule No. 426). Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are also required by 3 p.m. Nov. 8 for the supply of Accumulator Parts (100 positive and 24 negative plates) to the Australian Commonwealth Postmaster General's Dept., Perth (W.A.). (Schedule No. 527, W.A.) Specification, &c., from the Deputy Postmaster-General, Perth, Western Australia

Turbine-driven Pump.

Manchester Corporation require tenders by 10 a.m. Oct. 9 for the supply and erection at Bloom street station of One Steam Turbine-driven Boiler Feed Pump. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Coal Transporter Plant.

Tenders are invited for the supply, delivery and erection in Melbourne, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Pty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders by noon Dec. 11.

Tramway Material.

Johannesburg (Transvaal) Municipality require tenders by noon Nov. 6 for supply of 18 Grooved 12 ft. Points and 24 Grooved 9 ft. Points and six Ordinary Crossings (contract No. 171). Specifications, &c., from the Municipal Offices (Room 53), Johannesburg

Electric Lighting.

BALLYMENA Guardians require tenders by noon Oct. 7 for the Electric Lighting of two new annexes at their fever hospital. Forms of tender from the Clerk.

Electric Time-releasing Mechanisms.

The Victorian Railway Commissioners, Spencer-street, MELBOURNE, invite tenders (by 11 a.m. Oct. 18) for the supply and delivery of Electric Time-releasing Mechanisms (100 with two normal and two reverse contacts, and 50 with four normal and four reverse contacts) for automatic signalling. Specifications from the Commissioners, Spencer-street, Melbourne.

Steam Tubes and Fittings.

The COMMISSIONERS OF H.M. WORKS, &c., require tenders by 11 a.m. Oct. 12 for the supply of Steam Tubes and Fittings. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W.

Converter Plant, Batteries, Booster Plant and Switchboards.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Jan. 22 for (A) Converter Plant (three-phase to c.c.), (B) Two Storage Batteries, with switches and accessories, (C) Booster Plant, (D) l.t. c.c. Switchboards. Specification, &c., from the General Manager of the Electric Lighting Department.

Electrical Sundries.

The MERSEY RAILWAY Co. require tenders by noon Oct. 12 for supply of Electrical Sundries, &c. Form of tender (No. 12) from the Manager and Secretary, Central Station, Birkenhead.

Carbon Brushes.

Johannesburg Municipal Council require tenders by noon Nov. 27 for the supply of 12 gross of Carbon Brushes for Electric Motors. (Contract No. 178.) Specifications, &c., from the Controller of Stores, Municipal Offices, Johannesburg.

TENDERS RECEIVED AND ACCEPTED.

BARKING.—The following tenders have been accepted by the Urban Council:—

[illegible] Bros. & Co., e.h.t. cable, £1,913. 11s. 9d.; General Electric Company, [illegible] sub-station switchgear, £888; Brush Co., transformers, £611; Babcock & Wilcox, chain grate stoker, £602.

SALFORD.—The Tramways Committee have accepted the tender of Isaac Bentley & Co. for six months' supply of oils and paints, at about £600.

The Electricity Committee has accepted the tender of the British Westinghouse Co. (at £275) for equipping a blank cubicle with h.t. switchgear, together with the necessary control panel, in connection with a 1,000 kw. rotary converter recently supplied by the firm.

ST. ASAPH.—The Guardians recently accepted the tender of the Premier Accumulator Co. for the supply of new accumulators at £229. Last week the Clerk reported that the company had written to say that they had made an error in their estimate, and that the price should have been £257, with £16. 5s. per annum for maintenance. The Special Committee had considered all the tenders afresh, and recommended the acceptance of the tender of the D.P. Battery Co. at £256, including free maintenance for the first year, and £17. 12s. per annum for subsequent maintenance, and this was agreed to.

GLASGOW.—The Tramways Committee has accepted the tenders of Pirelli (Ltd.), for v.i.r. cable, and of Miller & Co., for chilled iron brake blocks.

AYLESBURY.—The Council has accepted the tender of the Chloride Electrical Storage Co. for the maintenance of the battery at the electricity works.

SUNDERLAND.—The Corporation have placed an order for the supply of 50 steel boiler tubes with Messrs. Babcock & Wilcox.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Dept., Sydney.—Gibson, Battle & Co., additional plates, &c., for existing battery at Petersham Telephone Exchange, £147; Western Elec. Co., supply (for Petersham Exchange) of 120 relays in strips of 10 10s. 6d. each, 12 strips multiple jacks 20 per strip, 14s. 9d. each, 12 strips local jacks 9s. each, 12 strips lamp jacks 10 per strip 9s. each, 480 ft. cable 5s. 6d. per yard, 43 ft. ditto 9s. per yard, 400 yds. twin jumper wire 5d. per yard, 200 yds. triple jumper wire 7d. per yard.

Public Works Dept., N.S.W.—Globe Elec. Co. (Albury), electric lighting at Albury Hospital, £895; A. Leplastrier & Co., supply, testing, &c. of pumping machinery, with electric motor, for Wagga Wagga water supply, £6,997.

Victorian Railway Commissioners.—W. T. Henley's Telegraph Works Co., car lighting material for electrified rolling stock, at rates; British Insulated & Helsby Cables h.d. copper wire £67. 5s. 10d. per mile.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Metropolitan Electric Supply Co. (Ltd.)

A [illegible] general meeting was held on Sept. 28 to consider the report [illegible] appointed at the ordinary general meeting held on March 22 last. Mr. W. [illegible] presided.

The SECRETARY (Mr. [illegible] Owen) having read the notice convening the meeting,

The CHAIRMAN [illegible] made a feeling reference to the death of [illegible] almost since the formation of the company [illegible]. The object of this meeting is to confirm [illegible] satisfy nobody, and it [illegible] I am entirely satisfied with the arrangement come to between [illegible] committee and the board. I should have liked all the [illegible] between the board and those responsible for the appointment [illegible] to have been thoroughly threshed out, and in [illegible] have been placed in a position [illegible]. The public [illegible] to the time [illegible] satisfied myself that an [illegible] of the [illegible] which will be a [illegible]

I regret that the committee in their report did not further explain the statement as to the fall in dividend since 1905, implying that it was the result of bad management on the part of the board, and suggesting that this was the cause of the retirement of certain directors. It was this statement that so thoroughly alarmed the shareholders when asked for their proxies. The earnings of the company have not fallen; they have increased. The actual gross receipts in 1906, the year after the sale of nearly half your property to Marylebone, were £175,000. Last July they had risen to £253,000, a rise of over 44 per cent.; and you have already received with your interim dividend the report of the progress during the first half of this year. You will remember that 1906 was the first year after the loss of Marylebone, and it is, therefore, the first year for ascertaining either increase or decrease of receipts.

I fully explained in March that the initial fall in dividend in 1906 was fully and amply compensated for out of the excellent award of £1,212,000. Included in this sum was compensation for lost future dividends, assessed by the arbitrator at no less than £660,000. At a special meeting held in this room at the time it was unanimously decided to return this sum, representing the lost future dividends, to the shareholders, who received approximately a bonus of £6. 10s. for each £10 share held. Further, a cordial vote of thanks to the board as to the success of the arbitration was unanimously carried. I am sorry the shareholders could not have seen Mr. [illegible]'s report on this vital matter, which entirely supports the explanation given by me at the last meeting. I also see that the committee suggest that Mr. Highfield's services as engineer should be retained. I fear they cannot have followed accurately the facts. The board, fully confident of the value of Mr. Highfield as an engineer, had already retained his services for a period of five years from the commencement of the year. The arrangement come to has—and it is the inevitable fate of all such arrangements—been the subject of diverse criticism. There are two criticisms put forward by my own supporters on which I desire to say a few words.

How, I have been asked, have you brought yourself to abandon this or that particular line of policy or this or that commercial principle on which you have till now insisted as essential to the well-being of the company? My answer is that neither I nor you would have abandoned any line of policy or any commercial principle to which we have heretofore attached importance. This compromise which has been come to decides nothing as to policy or principle. It effects merely a change of *personnel* in the directorate. The reconstituted board will consider all these questions and determine them to the best of their ability and in accordance with the best advice that can be obtained. I have no doubt that every member will act *bona fide* in the interest of the company. As on all boards, there may be differences of opinion, and a certain amount of give and take; but obviously questions of the sort are better decided by an authorised board of directors than by an *ad hoc* committee. The second criticism to which I have referred is this: Why, I have been asked, with so many able business men already shareholders in the company, have you thought it necessary to find a new chairman and new directors from outside? In my opinion this criticism is well founded, and I am afraid that I am not altogether free from responsibility. The new chairman and new directors were selected by your committee, but I made it a condition of my resignation that they should be gentlemen not hitherto connected with the company. This may have been taken to exclude existing shareholders, though it was meant only to exclude those who had already taken part in the management of the company. The matter is not however, now of any great importance. The new chairman and directors, whether taken from inside or outside, may be assured of the cordial co-operation of their colleagues. Mr. George Verity is known to us all as having always taken a great interest in the company, and his brother, the late Mr. John Verity, was long a valued member of your board. But I have not the advantage of knowing the other two gentlemen nominated, who, however, seem to have a wide experience of company matters. With close attention to detail and goodwill on the part of all concerned, I see no reason why the prospects of the company should not be assured. Ladies and gentlemen, I would say, in conclusion, that for my part I shall in the future, as in the past, do everything in my power to advance the interests of the company, in whose future I most firmly believe.

Mr. ROGER GREGORY (chairman of the Shareholders' Committee) said he would first like to say that he thought that those who were on that (the shareholders') side of the table much appreciated the genial terms in which the chairman had expressed himself on that occasion, and had carried out a task which he was sure must have been a painful one personally. The task of the committee had been an arduous and difficult one. They had had to peruse an enormous mass of statements and reports, some of the latter being of a highly technical and difficult nature, and they had formed their conclusions to the best of their ability upon them. It had seemed to him and his colleagues as they had proceeded with their work that a change on the board of the company was desirable. He and the two gentlemen associated with him had endeavoured to select, and he believed they had succeeded in selecting, three gentlemen as directors who would commend themselves to the whole of the shareholders. The committee did not think there was any cause for anxiety as to the prospects of the company. They believed that if it was properly and carefully managed the shareholders might look forward to considerable prosperity, and they might safely realise that in their class of property they had a very valuable one indeed. The chairman had made very kind remarks about Mr. Highfield's services to the company, to which reference had been made in the Committee's report. That gentleman's services had been of the greatest possible value to the company. He concluded by proposing

"That the report dated Aug. 16, 1916, of the committee appointed by the general meeting held on March 22 last, and issued to the shareholders with the notice convening this meeting, be, and the same is hereby, approved and adopted, and that the arrangements thereby recommended be carried into effect."

Mr. J. CARR SAUNDERS seconded the motion.

Mr. TOY critised the management of the company, and said he would like to hear from Mr. Gregory or Mr. Tuckett whether the sum of £337,000 was adequate in their judgment for depreciation with a capital of £2,258,000. He proposed the following amendment:

"That the report dated Aug. 16, 1916, be referred back to the committee to enable them to amplify the same and report to the shareholders in accordance with the terms of their appointment, and, further, that the extraordinary and adjourned ordinary general meetings of the company be adjourned until Nov. 9, 1916, at which the further report of the committee shall be submitted."

Mr. GREGORY said that he believed the report presented was by far and away the best and most in the interests of the shareholders. The whole of the information the committee had obtained would go before the new board, who would meet the shareholders at the annual general meeting in March, and the shareholders would then be able to ask what the directors had done on the recommendations of the committee, and what they had done in regard to other questions. The question of depreciation had been dealt with very fully by the committee.

Mr. R. MELVILL BEACHCROFT (a member of the committee) stated that the matters which came before the committee were of the most technical character, and they had felt that they could only be advised by technical experts. Four experts of the highest position were employed, and had made their report, but they did not agree, and he very rarely found two experts who ever agreed on any technical matter. He maintained that the committee had taken a very wise course, and they thought the shareholders ought to extend their hearty thanks to the chairman in having been ready to sacrifice himself in order to bring about the proposed arrangement.

Mr. F. BAILEY stated that he was an original shareholder of the company, his knowledge of which went back, therefore, for 27 years. The committee had devoted a great deal of time and attention to the company's affairs, but the shareholders had a right to expect something more conclusive than the very abbreviated report which had been submitted to them. He referred in warm terms to the services which had been rendered to the company by Mr. Tuckett, Lord Avebury and Sir James Pender, and in conclusion supported the amendment.

The CHAIRMAN put the amendment, which he declared lost, and afterwards put the resolution, which he declared carried.

On Mr. GREGORY'S motion, Mr. Andrew Wilson Tait, Mr. Geo. Balfour and Mr. Geo. Verity, who were recommended by the committee and by the board for election, were unanimously elected directors.

It was also resolved to direct the committee to place at the disposal of the board the reports of the experts employed by them, together with all such information as the board may consider to be of service to the company.

The adjourned ordinary general meeting was then held.

The CHAIRMAN proposed the re-election as directors of Mr. Geoffrey Blackwell and the Right Hon. F. Leverton Harris, M.P., and the motion was seconded and carried.

Mr. SAMUEL proposed a resolution expressing appreciation of the services which had been rendered to the company for the past 17 years by the chairman. He referred to the amount which they received some years ago for the Marylebone part of their undertaking and to the sum which was distributed among the shareholders on that occasion. One speaker had spoken of the progress made by the company in the past 10 years as slow, but in the interval they had increased their actual gross profits from £175,000 to £253,000, a fact which he regarded as sufficient reply to such a contention.

Mr. BEACHCROFT seconded the resolution, which was unanimously carried. A vote of thanks to the committee was unanimously agreed to and the proceedings then terminated.

ASSOCIATED FIRE ALARMS (LTD.) For the year ended June 30 the profit was £40, against a loss of £614 in the previous 12 months. With balance brought in there is a credit of £290 to be carried forward. The preference capital has been increased by the issue of 6,500 shares of £1 each, and the ordinary capital by the issue of 20,000 shares of 5s. each, fully paid, in order to pay for the assets of Aero Fire Alarm (Ltd.).

BANK FUR ELEKTRISCHE UNTERNEHMUNGEN (ZURICH).—The report for the year ended June 30 states that business has been unfavourably affected by the war, a loss in exchange having been incurred on the dividends on some of the foreign holdings. The net profit was 6,461,757 frs. (£258,000), and a dividend of 8 per cent. has been declared.

S. SMITH & SONS (MOTOR ACCESSORIES) (LTD.)—Mr. S. Smith, who presided at the meeting on Monday, said that the profit for the past year had been £42,169, after providing a substantial amount in respect of the levy under the Munitions Act and duty which the company might be called upon to pay. The year's turnover amounted to £396,412, and in the current year this would be increased. They were paying a final dividend of 1s. 7d. net, which, with the interim, was equal to a dividend of 10 per cent. (tax free) for the year. During the year the company introduced upon the market a successful paraffin carburetter. It had been demonstrated that with the assistance of the carburetter vehicles could be run quite satisfactorily upon 80 per cent. of paraffin and 20 per cent. of petrol without any disadvantages hitherto associated with the use of paraffin. The carburetter was purely automatic, and could be fitted to any motor, and was without complications. To be able to cope with the growing demand for the company's specialities all over the world important additions were about to be made to their factory.

The report was adopted, and after the ordinary meeting it was resolved to increase the capital by 100,000 £1 shares.

NEW COMPANIES, MORTGAGES & CHARGES.

◆

NEW COMPANIES.

ALFRED H. MOULD & SONS (LTD.) (144,947.) Reg. Sept. 28, capital £10,000 in £1 shares (2,000 6 per cent. cumulative preference), to take over the business of a malleable and general ironfounder carried on by A. H. Mould as Joseph Bullows & Co., and to carry on the same and the business of brass, nickel, steel and aluminium founders, manufacturers of electrical conduits and fittings, galvanisers, &c. Private company. First directors are A. H. Mould and H. V. Mould (both permanent).

WILFRED ROGERS & CO. (LTD.) (144,957.) Reg. Sept. 28, capital £20,000 in £1 shares (5,000 6 per cent. preference), to take over the business of metal merchants and mechanical and electrical engineers and manufacturers carried on as Wilfred Rogers & Co., and to carry on same and the business of founders, shipbuilders and millwrights, dealers in mechanical products and electrical accessories, &c. Private company. First directors are A. W. Rogers and G. H. Rogers (both permanent). Reg. office: Audrey House, Ely-place, E.C.

MORTGAGES AND CHARGES.

ELECTRIC IGNITION CO. (1913) (LTD.)—Memorandum of satisfaction in full on Sept. 1, 1916, of debentures dated May 24, 1913, securing £2,500 has been filed.

MAGNETIC WAVES (LTD. (1,52[illegible] F.)—Particulars filed Sept. 28, 1916. Capital £25,000 in £1 shares. Reg. in Jersey, Channel Islands, in August, 1916, to carry on the business of electromagnetic wave treatment, &c. British address, 133 and 135, Oxford-street, W. Sir Ernest W. Robinson, Bart., Craismore, Queen's road, Jersey; H. G. Barrett, Mill Land, Clayton, Sussex; R. A. Pitcairn, 10, Hanover square, W. [illegible] and T. W. Norman, Spring-hill, Wellingborough, are authorised to accept service. Directors, Sir Ernest W. Robinson, Bart., H. G. Barrett, T. W. Norman and R. A. Pitcairn.

RECEIVERSHIP.

WALTON & CLOUGH (LTD.)—Notice of appointment of G. Walker, Tyrrell-street, Bradford, as receiver on Sept. 8, 1916, under powers contained in debenture dated Aug. 23, 1912, has been filed.

CITY NOTES.

MEMORANDA Oct. 4.—**Bank rate 6 per cent. (since July 13, 1916). Consols** 5[illegible]. Consols Pay Day, Nov. 2. **Stocks and Shares Ticket Days,** Oct. 12 and 26. **Pay Days,** Oct. 13 and 27. **Price of silver,** 32 9/16.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared an interim dividend on the ordinary shares at the rate of 7 per cent. per annum for the half-year ended June 30 last, such dividend to be payable on Nov. 15 next.

CLAUD HAMILTON (LTD.)—A dividend of 7½ per cent. has been declared on the ordinary shares.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—An interim dividend has been declared for the six months ended June 30 last at rate of 5 per cent. per annum (tax free) on the ordinary shares.

MONTREAL LIGHT, HEAT & POWER CO.—A quarterly dividend of 2 per cent. has been declared for the quarter ended Oct. 31.

NEW AMERICAN WAR COMPANIES.—The "New York Journal of Commerce" states that the war demands upon America caused the formation of new companies with an authorised capital of £160,845,400 in the past 26 months.

TORONTO RAILWAY CO.—A dividend for the quarter ended Sept. 30 at the rate of 8 per cent. per annum has been declared.

METAL PRICES.

Messrs. J. B. G[illegible] & Sons, 132 Upper Thames-street, London, E.C., quote under date [illegible] the following as the present prices of

New Metals.	[illegible]		Per ton
Solid Drawn Brass Tubes	[illegible]	English Lead	£31 5 0
Solid Drawn Copper Tubes	[illegible]	Antimony	Nominal.
Brazed Copper Tubes	[illegible]	Old Metals.	Per ton.
Brazed Brass Tubes	[illegible]	Clean Copper Scrap	£104 0 0
Brass Wire	[illegible]	Clean Brass Scrap	62 0 0
Copper Wire	[illegible]	Braziery Copper Scrap	90 0 0
Rolled Brass	[illegible]	Old Lead	[illegible]7 0 0
Brass Sheets	[illegible]	Old Zinc	3[illegible] 0 [illegible]
	Per ton.	Hollow Pewter	120 0 0
[illegible]	£1[illegible]7 0 0	Black Pewter	[illegible] 0 0
[illegible]	[illegible] 0 0	Gun Metal	82 0 0

M[illegible] A. J[illegible] E[illegible] London-road, Southwark, London, S.E., quotes under date [illegible] approximate prices of Scrap Metals:—

	Per ton.		Per ton.
A[illegible]	£11[illegible]	Old Lead	£3 15. under English lead price
[illegible] Brass	64 [illegible]	Old Zinc	38 0 0
[illegible]	1[illegible]	Hollow Pewter	130 0 0
[illegible]	[illegible]	Sheared Black Pewter	90 0 0
[illegible]	[illegible]4 [illegible]		

M[illegible] price per ton: Plumber's Solder [illegible] bar [illegible] Tinman's Solder, £97, Blowpipe Solder, £107.

ELECTRICAL COMPANIES' SHARE LIST.

We [illegible] below the latest prices at which actual transactions took place on or before Tuesday, Oct. 3.

[illegible]	[illegible]	NAME.	Price, Tues., Oct. 3	R[illegible]	Dividend Due.
		Electricity Supply.		£ [illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Oct. 3	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6⅜	6 5 6	Feb, Aug
5	7%	Do. do. Pref.	5 13/16	6 0 5	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72¼	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1⅛	6 14 8	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6 5/16	5 10 11	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4⅛	5 4 1	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Deb.	83	6 4 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	80¼	7 9 6	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	72	5 11 1	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82¼	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	76	5 5 3	Jan, July
St.	4%	City & S. London Deb.	74¼	5 7 0	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1¼%	London Electric Ry. Ord.	2 3/16	5 15 4	Jan, July
St.	4%	Do. 4% Pref.	65	6 3 1	Mar, Sept
St.	4%	Do. 4% Debs.	76	5 5 3	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23¼	4 4 0	Feb, Aug
St.	3½%	Do. 3½% Pref.	62	5 12 11	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	58	6 0 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	67½	5 3 8	Jan, July
St.	3½%	Do. 3½% Debs.	68	5 2 11	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	17⅝	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	75¼	5 6 4	May, Nov
St.	4½%	Do. 4½ First Pref.	70	6 8 7	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	70⅛	5 14 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	3 1/32	4 19 0	Apl, Oct
1	6%	Do. 6% Pref.	1 1/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1 [illegible]	4 18 0	Mar
100	5%	Do. Prior Lien Debs.	93½	5 6 11	Jan, July
1	6%	Do. 6% Pref.	15/16	6 8 0	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12⅜	7 1 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 3/16	5 15 8	Jan, July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 7 5	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2 [illegible]	5 3 7	April
100	6%	Do. 6% Prior Lien Debs.	102¾	5 16 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 16 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12⅝	7 18 5	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	[illegible]	6 12 5	Sept.
5	..	Edison & Swan U. Elec. Lt. A. £3 pd.	½	..	Feb, Aug
St.	4%	Do. 4% Deb.	61¼	6 10 7	Jun, Dec
1	7½%	Elec. Construction Ord.	[illegible]	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1 [illegible]	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 [illegible]	7 4 9	July
10	6%	Do. 6% Pref.	10	6 0 0	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16 3/16	5 19 0	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4	5 12 6	..
St.	4½%	Do. 4½% Db.	88½	5 1 8	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	12 1/16	8 5 10	Feb, Aug
10	5%	Do. Pref.	7½	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38¾	6 3 10	Mar, July
100	4%	Do. 4% Debs.	95¼	4 4 1	Jan, July
1	7½%	Vickers Ord.	1 [illegible]	3 18 8	May, Aug
1	6d.	Do. 5% Pref.	[illegible]	5 10 4	May, Aug
St.	4%	Do. 1st Deb.	75	[illegible] 6 8	June, Dec
100	4½%	Do. 4½% 2nd Deb.	99¼	4 10 8	June, Dec
St.	4½%	Willans & Robinson B. Cm. Pref.	41½	9 18 10	..
St.	4%	Do. 1st Mt. Deb. St	56¾	7 1 0	..
		Telegraphs.			
St.	30/0	Anglo Amer[illegible] 6% Pref. Ord.	100¼	5 19 1	Fb,My,Aug,N
St.	11%	Do. Def. [illegible]	23⅞	6 18 8	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70½	5 14 2	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	8 [illegible]	6 0 9	May, Nov
10	10%	Do. 10% Pref.	13¼	6 11 2	..
5	5 0	Direct Spanish 10% Pref.	[illegible]	6 13 4	..
10	4%	Direct United States	[illegible]	5 18 6	Ja,Ap,Jly,O
St.	8%	Eastern Tel. Co. Ord.	144	5 11 1	Ja,My,Jly,O
St.	3½%	Do. 3½% Pref.	66	5 6 1	Ja,My,Jly,O
St.	4%	Do. 4% Deb.	79	5 1 3	May, Nov
St.	4%	Eastern Extension Tel. Co. 4% Deb.	7[illegible]	5 3 3	Feb, Aug
10	8%	Do. Ord.	14[illegible]	5 9 [illegible]	Ja,Ap,Jly,O
10	[illegible]	Gt. Northern Tel. Co. With C[illegible] 11	4[illegible]	5 4 8	Ja, My, Jly
[illegible]	13%	Indo-European [illegible]	4[illegible]	6 14 0	May, Nov
1	10%	Marconi's Wireless Tel. Co.	3	3 6 8	April
1	7%	Do. 7% Pref.	[illegible]	2 16 0	July
10	1%	West India & Panama Ord.	1 1/16	8 14 11	May, Nov
10	6%	Do. 1st Pref.	7[illegible]	7 16 9	May, Nov
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† Ex dividend or interest.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

Interlinking.

DURING the last few years there has been a great deal of talk about the advantages of interlinking electricity supply undertakings. The advantages were so obvious that they required no labouring. On the other hand, there has always been a tendency, particularly on the part of municipal undertakings, towards isolation. One effect of the war, however, has been to render undertakings more dependent upon each other. Restrictions have been placed on capital expenditure, fuel has become more costly, and the demand for electric power has become very much greater. These new conditions have acted as levers to force the various undertakings into closer connection, and consequently there is a greater readiness to consider co-operative working. On May 25 last the Board of Trade issued a circular letter to all electrical supply authorities calling their attention to the importance of interlinking. Earlier in the year discussions on the subject had taken place before the Institution of Electrical Engineers, and a Committee was subsequently formed to deal with the position in Lancashire and Cheshire. As an outcome of this movement an interim Report has now been published by this Committee, and will be found in abstract on another page. From this it will be seen that six groups of undertakings have been considered and the conclusion is reached that if the undertakings in four of these groups are interconnected the average coal consumption per unit generated, which is at present 3·24 lb., can be reduced by not less than 0·5 lb. With coal at 17s. 6d. per ton this reduction would represent a saving of about £82,000. A considerable amount of statistical information is given in the report, and it is remarkable that one of the undertakings considered, namely, Eccles Corporation, should withhold the information desired to bring it into line with the others. We can only suppose that this is an example of the spirit which has produced such regrettable results in the past.

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THE next step proposed by the Committee is to call a general conference of all the statutory supply authorities concerned, and that such conference should be presided over by a Government official. An application would then be made to the Board of Trade to set up a general committee, or board, with powers to enable agreements to be entered into with the power companies, whose inclusion in the scheme is regarded as essential. Pending the appointment of such a committee it is suggested that the various undertakings should enter into voluntary arrangements for joint working. We feel that this report marks an important step in the co-ordination of electricity supply in this country, and we congratulate the members upon the progress so far made to a very desirable end. Although the report shows what is being done energetically in one locality, this effort is really only part of a much larger scheme dealing with the country as a whole. Municipal and company undertakings have now come together through the medium of the Incorporated Municipal Electrical Association on the one hand, and the Incorporated Association of Electric Power Companies, on the other, and have appointed a Joint Committee. This Committee has issued a memorandum, which we give in abstract elsewhere, and from this it will be seen that the whole country has been divided up into districts. Each district is to consider its own requirements, and to report to the main committee. The scheme appears to be eminently practical, and we trust that a supply worthy of the country will be the result.

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The Future of Industry.

IT is not very generally known that an institution exists—namely, the Garton Foundation—for the study of economic problems, such as the relations of capital and labour, which will certainly become a most serious matter for this country in the near future. The trustees of the Foundation are the Right. Hon. A. J. BALFOUR, Viscount ESHER and Sir RICHARD GARTON. At the instance of the Foundation, the industrial situation after the war has been studied by a group of men whose names, however, are not mentioned, and the result is a memorandum which has now been issued. This is of considerable length, and deals with all the aspects of capital and labour, industrial unrest, the dislocation of labour by the war and the effects that must follow the freeing of so much labour by the disbandment of military forces when peace comes. In perusing the memorandum we have been struck by the impartial way in which the whole question has been approached. From the brief abstract which we give on another page it is seen that stress is laid upon the dangers of being unprepared for peace conditions, or the idea that because there is a truce between capital and labour at the present moment any such good feeling will necessarily follow at a later date. The difficulties are fairly stated, as felt by the employer on the one hand and the employé on the other; but the view is taken that capital and labour are not necessarily antagonistic. In a sense they are antagonistic in their attitudes towards the distribution of the wealth created; but there should not be antagonism on any other ground. In the future, co-operation will be far more necessary than in the past. A suggestion is made that Works Committees should be established, consisting of representatives of both management and employés, and that there should be joint boards of representatives of the employers, trade associations and trade unions. Finally, representatives of these boards should form a supreme board of control dealing with industry as a whole, forming, as it were, a National Industrial Parliament. The memorandum is a thoughtful document, and we commend its careful perusal to every employer. The problems with which it deals should be faced without delay, for it is useless for any employer to shut his eyes to the facts of the case.

A Press Visit to Leeds and Sheffield Universities.

It will be recalled that a visit of members of the scientific and technical Press to the Imperial College of Science took place some months ago, and arrangements have since been made for some visits to provincial centres of education. The object of these visits is to keep scientific and technical journalists informed of the work going on at our chief universities, so that they in turn may bring this information before the manufacturers of the country. Technical journals are in a unique position to act as a channel for the dissemination of such information, and their combined influence may do much to bring about that fuller appreciation of the benefits of applied science which is a necessary preliminary to future progress. In particular, the work already done by our leading universities deserves to be more widely known. The enterprising step taken by the Universities of Leeds and Sheffield, in inviting a party of journalists from London to inspect their arrangements, should bear good fruit.

An account of this visit appears in another column. It is evident that at Leeds and Sheffield close relations between the universities and the local manufacturers have already been established, and it will perhaps be a revelation to many to find how much has been done in this direction. No doubt, in course of time, the admirable lead given by the Universities of Leeds and Sheffield will be followed by other provincial educational centres. We hope, too, the coming visit will mark the initiation of much closer relations between the universities and the scientific and technical Press, not only in this country but throughout the Empire.

Long Distance Telephony. A course of six lectures on this subject will be delivered at University College, London, by Prof. J. A. Fleming, D.Sc., F.R.S., on Friday afternoons at 5 p.m., beginning October 20th. A public lecture (for which tickets are not necessary) on "Long Distance Telegraph and Telephony" will be delivered by Prof. Fleming at University College on Wednesday, October 18th, at 5.30 p.m.

Juvenile Employment. Memorandum No. [illegible] of the Health of Munition Workers' Committee has recently been issued by the Ministry of Munitions. The Memorandum is divided into three sections, of which the first is [illegible], the second deals with hours of labour, and the third with supervision of health and welfare. Like most of the Memoranda prepared by the Committee, this contains much matter of interest to those who employ such labour in their works.

The Gilbert Club.—A general meeting of the Gilbert Club will be held in the rooms of the Royal Society of Arts, John-street, Adelphi, W.C., on Wednesday, the 18th inst., at 3.30, for the purpose of winding up the Club, the object of its formation having been attained, which was the translation and issuing to the members of William Gilbert's "De Magnete." Proposals will be made as to the disposal of the property of the Club, consisting of the remaining copies of the book, as well as of such funds as remain in the hands of the hon. treasurer.

The "Central."—The current issue of the journal of the old students of this college is devoted entirely to chemical matters. It was originally intended to issue a special number, but the outbreak of war put the undertaking in abeyance. It was judged desirable to avoid further delay, and the articles form a sort of double number instead of an extra issue, as originally contemplated. The list of careers of past students that is given in the volume negatives the view that technical chemists cannot be trained at home. An excellent portrait of Prof. Armstrong is included.

Pocket Wireless Outfits.—Since the outbreak of war there have been many reports of pocket wireless outfits, and their presumed illicit use by unauthorised persons. In this connection the "Electrical World" remarks that it is true that sensitive and selective wireless receivers, which are portable enough to be easily carried about, have done good service on the field of battle. But the production of vigorous waves from low antennæ wires and the design of powerful transmitting apparatus small and light enough to be carried about by a single person, are vastly different matters. The daily Press would do well to scrutinise the claims of new inventions in this field, "without losing sight of the conservation of energy."

The I.M.E.A. and Trade after the War. The council of the Incorporated Municipal Association has issued a letter stating that it has appointed representatives to give evidence before the Electrical Trades' Committee appointed by the Board of Trade to consider the question of British trade after the war.

It is stated that it is proposed to draw the attention of the committee to several matters of special importance in the trading interests of municipal electricity undertakings, and to emphasise the fact that such undertakings are especially concerned in the development in British trade after the war. In many towns large capital outlay has been incurred in order to meet the demand for power required for the manufacture of munitions, and unless after the war there is a great development of British trade to absorb the power so provided, there will be a large amount of capital not bringing in an adequate return. Such being the case, it is desirable that the representatives of the I.M.E.A. should be able to give the Board of Trade Committee some idea of the amount of capital which has been expended for war purposes, and the Association is asking local authorities who own electricity works to let it have approximate figures for such expenditure, under the usual headings of land, buildings, machinery, mains, &c., the figures to include all work in hand or about to be put into execution, as well as that already carried out.

Woolwich Borough Council has authorised the Electrical Engineer to furnish the Association with the desired information, and to bring to its notice the importance of maintaining for general manufacturing purposes the various munition factories established in the country during the war.

OBITUARY.

Percy Webberley.—We regret to record the death of Mr. Percy Webberley, at his home at Longton, Staffordshire, on the 6th inst., at the early age of 37. He was the assistant electrician in the Board of Trade Electrical Standards Laboratory from August, 1908, until June, 1915, when he retired through failing health.

Mr. Webberley was educated at Mason University College, Birmingham (1896–1899), where he took the electrical engineering diploma. He was an improver at Messrs. Belliss & Morcom, and acted for some time as assistant in the electrical engineering department of the Northampton Institute, Clerkenwell. After this he was employed in the Westminster Electric Supply Corporation for four years in testing and maintaining instruments in the generating stations under Mr. C. O. Grimshaw, during which he took first place in laboratory work in the electrotechnics examination and second in the theoretical work at Finsbury Technical College. He matriculated at the London University in 1902. He was selected from a considerable number of candidates for the post in the Board of Trade, on account of his knowledge of electric meters and of electrical measurement and testing. He was a careful and accurate worker, and a genial and attractive colleague.

KILLED IN ACTION.—The following deaths in action or of wounds are recorded :—

Capt. Keith Lucas, Sc.D., F.R.S. (R.F.C.), has died of injuries received in a collision of aeroplanes on Oct. 5. He was a Fellow of Trinity College, Cambridge, and a director of the Cambridge Scientific Instrument Co. He was the inventor of the R.A.F. Mark II. compass, which is now being made in large quantities for aeroplanes.

Capt W. A. Douglas (Royal Scots), who has been killed in action, was 26 years of age, and a member of the firm of James Gray & Son, electrical engineers, &c., of Edinburgh.

Lieut. Frank A. Eve (Canadian Infantry), who died of wounds on Sept. 15, gained distinction in mathematics at Whitgift Grammar School, Croydon, and was subsequently engaged upon telephone construction work in Canada.

Second-Lieut. Kenneth Restall, who has been killed in action, was a student at the City and Guilds Technical Institute, Finsbury, and the Royal School of Mines, S. Kensington, when the war commenced.

Second-Lieut. C. H. Marshall King (R.F.C.), who was killed on Sept. 30, was educated at Birmingham University, where he studied engineering, and gained a research scholarship in his B.Sc. Exam.

Private H. Greenwood (Lancs. Fusiliers), 21 years of age, who has died of wounds, was formerly employed in the Bolton electricity works.

PERSONAL.

We regret to learn that Mr. S. H. Bill, R.N.V.R. (formerly engineer and manager of Ilkley Council's electricity dept.), has been wounded. His left arm is broken, and a piece of shrapnel has been removed from the roof of his mouth.

Mr. Lloyd George, Secretary of State for War, has created the following new appointments :—

Sir Eric Geddes, with the title of Director-General of Military Railways, will act as Deputy to the Quartermaster-General in matters affecting transport services, and will also direct and organise such services in France under the General Officer Commanding-in-Chief.

Mr. H. J. Creedy will take charge of a new department in the War Office for the preparation of statistical information.

Baron Den has been appointed Minister of Communications in the new Japanese Cabinet.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

Tyne Electrical Engineers.—Second-Lieut. (temp. Capt.) G. L. L. Russell and Second-Lieut. (temp. Capt.) F. D. Pyne to be Lieutenants (temp. Capts.) ; Sergt. S. W Newman to be Second-Lieutenant (on probation ; Second-Lieut. L. Horton (R. Warwickshire Regt.) to be Second Lieutenant.

APPOINTMENTS VACANT.

The Cable Makers' Association invites applications for the post of secretary. Applications to "Cable," c/o Messrs. Claremont, Haynes & Co., Vernon House, Sicilian-avenue, Bloomsbury, London, W.C.

A few first-class electricians and assistants are required to take charge of electrical installations in provincial variety theatres. Applications to "Engineer," Moss' Empires (Ltd.), Cranbourn-mansions, Cranbourn-street, London, W.C. *See Advertisement.*

Wigan Corporation invite applications for the position of borough electrical engineer and manager. Salary £400 per annum. Applications to the town clerk, Mr. Wm. Hy. Tyrer, Municipal Offices, King-street West, Wigan, by Oct. 19.

A switchboard attendant is wanted by Stoke-on Trent Corporation. Applications to the borough electrical engineer (Mr. C. H. Yeaman), St. Peter's-chambers, Glebe-street, Stoke-on-Trent. *See advertisement.*

Attendants are required for electric light installations in camp hutments. Applications, stating wages required, &c., to be sent to Commanding R.E., Curragh Camp.

INSTITUTIONS AND SOCIETIES.

Electric Vehicle Committee.—A meeting of the Electric Vehicle Committee was held in London on Sept. 29, 1916, Mr. R. A. Chattock presiding. Mr. E. S. Shrapnell-Smith, representing the Commercial Motor Users' Association, was unanimously elected vice chairman of the committee. Having in view the extent to which electric vehicles are now being employed in municipal sanitary service, it was resolved to issue an invitation to the Institute of Cleansing Superintendents to nominate a representative to sit upon the committee.

It was decided to send a circular letter to British automobile manufacturers, and another to British electrical manufacturers, suggesting that they should consider the question of taking up, after the war, the manufacture of electric vehicles in the case of the first mentioned, and electrical equipments for same in the case of the second mentioned class of manufacturers.

Upon the basis of a communication received from the Recorder of the Standards Committee, Society of Automobile Engineers of America, stating that breakages of charging plugs and receptacles made according to the present standard had indicated the necessity of increasing the length of the outer metal protective casing of the receptacle and that the American standard design had accordingly been altered by increasing the length of the said outer casing by $\frac{11}{16}$ in. (18 mm.), the committee decided to suggest to the British Engineering Standards Committee the desirability of altering the British standard in a similar manner. It may be mentioned that the said lengthening of the shell involves no alteration to the plug portion or to the contacts or moulded insulation of the receptacle.

A letter was considered which had been received from the City Electrical Engineer of Bradford relative to the period of the loan authorised by the Local Government Board for the purchase of electric vehicles. It appeared that the loan for the three Bradford vehicles has been granted for a period of only four years, although it seems that in September, 1914, the Corporation were only able to get a similar period granted for the purchase of a steam wagon. The question of better charging facilities on the route London to Birmingham was again under consideration. The secretary was directed to write to the managers of the electric supply undertakings at Coventry and Northampton in order to enlist their assistance in this matter.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 13th (to-day).

ELECTRO-HARMONIC SOCIETY.

8 p.m. At the Holborn Restaurant. Smoking Concert. Chairman, Capt. H. Riall Sankey.

SATURDAY, Oct. 14th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Swan Hotel, New-street, Birmingham. Discussion on "The Effects of the War on the Electrical Trade," opened by Mr. G. O. Donovan, M.I.E.E.

WEDNESDAY, Oct. 18th.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

5.30 p.m. Public Lecture on "Long Distance Telephony," by Prof. J. A. Fleming, F.R.S.

FRIDAY, Oct. 20th.

6 p.m. At the Institution of Civil Engineers. Paper on "Trials on a Diesel Engine, and Application of Energy Diagram to Obtain Heat Balance," by the late Lieut. Trevor Wilkins, M.Sc., to be presented by Prof. Burstall.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding : Lieut.-Col. C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week.—Platoon Commander A. Gerard.

Next for Duty.—Platoon Commander W. J. A. Watkins

Appointments.—Company Sergt.-Major H. de P. Birkett to be Platoon Commander. Section Commander J. W. Roger to be Company-Sergt.-Major. Section Corporal R. T. Morris to be Section Commander. Sapper E. C. Taylor to be Section Commander. Section Corporal E. G. D. Carter to be Section Commander (all dates Oct. 3rd). Sapper J. W. Stubbs to be Sergt. Instructor of Physical Exercises (dated Oct. 5th).

Monday, Oct. 16th.—Technical for Platoon No. 9 at Regency-street ; Squad and Platoon Drill, Platoon No. 10 ; Signalling Class ; Recruits Drill, 6.25-8.

Tuesday, Oct. 17th.—School of Arms, 6-7 ; Lecture 7.15 : "Duties in Camp and Quarters," Company Commander Hynam ; Range Practice.

Wednesday, Oct. 18th.—Instructional Class, 5.45 ; Platoon Drill, Platoon No. 2 ; Range Practice.

Thursday, Oct. 19th.—Platoon Drill, Platoon No. 5 and 6 ; Range Practice.

Friday, Oct. 20th.—Technical for Platoon No. 10, Regency street ; Squad and Platoon Drill, No. 9 ; Signalling Class ; Recruits Drill, 6.25 8.25.

Saturday, Oct. 21st.—N.C.O's Class, 2.30, Company Commander W. Hynam.

Sunday, Oct. 22nd.—Entrenching at Otford, Parade Victoria (S.E. & C. Railway) Booking Office, 6.15 a.m. Uniform, haversacks, water bottles. Mid-day ration to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice and Tables A and B at Headquarters.

NOTE.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

STANDARDISATION AND ITS ASSISTANCE TO THE ENGINEERING INDUSTRIES.*

BY C. LE MAISTRE.

General Views on Standardisation.—In regard to standardisation as applied to engineering practice, much has been written, and it has, in fact, become so necessary to progress and is, indeed, so familiar to most of you, that it will suffice on such an occasion as this to draw attention to a few of the more important aspects of the subject and at the same time place on record something of the success which has been achieved in this country of late through the effective co-ordination of individual effort.

It is scarcely necessary nowadays to insist on standardisation as being of paramount importance to economic production, but that was not so clearly seen 16 years ago, before the advent of the British Engineering Standards Committee. However, keen competition from outside, the legitimate demands of labour for a higher standard of living, coupled with the desire of capital for an adequate return, have compelled the whole industry to introduce modern order and system in all its methods of production, former individualistic methods giving way to co-ordination and collective effort. These improvements, which have already resulted in marked benefits, must not only be maintained, however, but continually added to if the full advantages are to be reaped.

The individual gain in private workshop standardisation is acknowledgedly great to the producer, for it tends towards interchangeability of component parts, facilitates quick delivery, and reduces maintenance charges and stores. In these ways it benefits also the consumer and the nation at large.

Crystallisation, however, which would tend to impede and to stultify progress, must be jealously guarded against if standardisation is to be of permanent value and the purchaser is not to be deprived of the benefit of competitive effort and inventive genius. Those responsible for the initiation of the standardisation movement in Great Britain realised from the first that in order to avoid undesirable stereotyping of practice it would be necessary from time to time to revise standards, and this has become recognised as an essential part of any standardisation work, which never can be regarded as final. In this way the community of interest of buyer and seller was, and is, realised through the acceptance by both of an agreed yet flexible standard.

Satisfactory results have been arrived at not by one section of the community imposing its opinions on the other, but rather as the result of co-operative action, mutual concession and ultimate agreement between all the interests concerned. The adoption of standards agreed on in this way undoubtedly promotes uniformity of practice, avoidance of waste, elimination of harsh and unnecessary conditions, reduction of manufacturing costs, and last, but by no means least, engenders a feeling of mutual confidence between user and producer such as could not be secured by isolated action on the part of either.

Experience, moreover, has shown clearly that such procedure does not lower the standard of quality, but tends rather to raise it, for standardisation carried out along these lines reflects, in effect, the concensus of opinion as to what constitutes best modern practice.

Successful standardisation can only be arrived at by common consent of all those who take full part in the initiation and working out of the actual details of the various specifications which are intended to be recommended ultimately for public use. The recognition of this guiding principle by the founders of the Engineering Standards Committee is probably one of the chief reasons for the wide adoption of the British Standard Specifications, which have no authority other than that of public opinion.

The Committee, Its Inception and Growth.—The movement, as represented by the Engineering Standards Committee, the greatest voluntary effort of its kind, in which public spirit has been so lavishly shown, was founded in 1901 through the initiative of Sir John Wolfe Barry, K.C.B., who had long been coming to the conclusion that some means were urgently required to systematise design and production of component parts.

In 1897 certain remarks made by the late Lord Salisbury on the desirability of securing physical standards and constants to an important scientific deputation which resulted shortly afterwards in the establishment of the National Physical Laboratory, confirmed Sir John Wolfe Barry in his opinion, and in January, 1901, he laid the matter as affecting the engineering trades of the country before the Council of the Institution of Civil Engineers, with the result that a committee was appointed to consider the question of standardising various kinds of iron and steel sections. The Committee reported favourably of the project and the Council of the Institution of Civil Engineers adopted the report, and the co-operation of the five leading engineering institutions of the kingdom—viz., Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Naval Architects, Iron and Steel Institute and Institution of Electrical Engineers—was subsequently secured. The original reference to the Committee was enlarged by resolution of all the Councils of the supporting institutions, and full power was conferred on the Committee as to publication and the best manner of giving effect to their findings.

Thus from a single committee, consisting originally of seven members, appointed to discuss the advisability of standardising rolled sections and rails, has grown the present far-reaching organisation, with its 64 committees and sub-committees, as well as numerous panels, including in all well over 500 members freely giving their time and experience, often at great personal inconvenience, and dealing with subjects embracing practically the whole of engineering practice. It is due to the memory of the late secretary, Mr. Leslie Robertson, to say that the success of the Committee has been largely owing to his energy, foresight and conspicuous ability. His intimate knowledge of men and affairs, combined with sympathetic consideration for the views of all, enabled him to cope successfully with problems which otherwise would have presented more serious difficulties.

The internal organisation of the Engineering Standards Committee need only be very briefly referred to, as it is fully set out in the Report on Work Accomplished, which is issued annually. The Main Committee, which is composed of 19 official representatives of the five leading engineering institutions, has charge of the administration of the whole of the work, the raising of the necessary funds, the controlling of the expenditure, the selection of subjects for standardisation, and the ratification of all reports and specifications presented by the various sectional committees for its approval prior to publication. The sectional committees are appointed by the Main Committee, who nominate the respective chairmen and arrange the mode in which the subjects are to be dealt with. The sectional and sub-committees contain representatives of the various Government departments, consulting engineers, manufacturers, contractors and users, as well as representatives from the technical societies and trade associations concerned.

The Main Committee only studies subjects at the request of the various sections of the industry concerned, and does not venture to make recommendations except on the initiative of the engineers or responsible representatives of the trade affected.

The utmost care is taken at the very outset to ensure that all who have or could have an interest in the proposed standardisation shall be adequately represented (through their recognised societies and trade associations if such exist) on the committee entrusted with the work. If necessary, evidence is taken, the advice of experts is sought, and in this way all parties are consulted and have a voice in the initial proposals, thus avoiding much subsequent friction which might otherwise occur.

In drawing up industrial standards, experimental investigations frequently become necessary in order to establish the facts underlying the principles involved, and in this connection the National Physical Laboratory has been and is conspicuously useful. It is in effect the Committee's official testing bureau, and its ultimate authority in matters concerning electrical and mechanical tests, acting in an advisory capacity in all the work in which unbiased experimental data are essential.

Each sectional committee is given an opportunity once a year of passing in review the specifications for which its has been responsible, for possible revision or addition if experience shows that such is desirable, and it is this system of keeping abreast of invention and progress which adds so greatly to the practical value of the work of the Committee.

The British standard specifications, which are confined to the main technical clauses necessary for the purchase of the product to which the specification relates, find an increasingly wide adoption. They are being increasingly adopted throughout the country, in home and export trade in general, and are also being largely substituted for the various and differing Government and municipal specifications formerly employed. They are proving of increasing value to the Crown Agents for the Colonies and the self-governing dominions, and are in large numbers being sent abroad for use in the supply of engineering material required.

Success of the Movement.—As already mentioned, one of the first objects in the formation of the Committee was to simplify the rolling of steel sections for engineering structures and rails as well as shipbuilding material so as to save unnecessary cutting of a variety of rolls for no good reason and also to facilitate the making to stock during slack times. That the work of the Committee in this direction has been amply rewarded is shown by the fact that the number of rolls in use by British manufacturers has been largely reduced. As an instance, whereas there were formerly 70 sections of tramway rails, there are now only five. The same is true of all ordinary merchant-le sections, such as angles, tees and channels and rolled joists. he percentage of British standard tramway rails to the total nnage rolled during the year ending March, 1915, was 75 per cent., hich is an indication that the number of standards recommended is lequate to meet all ordinary requirements. A considerable duction has similarly been effected in regard to railway rails, and e work of the Committee is evidently of material benefit to the ilway companies by the wide adoption of its findings and the bstantial manner in which they financially support the Committee's tivities.

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* Paper read before Section G of the British Association. Slightly abbreviated.

Turning to the case of Portland cement, the British standard is ow generally adopted by engineers and manufacturers throughout he whole country, and the large number of copies of the specification hich have been sold, 3,500 copies since the 1910 revision, goes to ow its general utility to the industry. For 1913 the output of ortland cement of the country was over 3,000,000 tons, 95 per cent. f which, it is estimated, was made to British standard.

The London County Council, in its General Powers Act, 1909 Part 4), amending the London Building Acts so as to provide for the onstruction of steel frame buildings, has required that all rolled teel used in the construction of skeleton frameworks of buildings hall comply with the British standard specification for structural eel for bridges and general building construction, and that all rickwork, concrete, stone and other similar materials used in connection with the metal frameworks shall be executed in cement onforming with the British standard specification for Portland ement.

It is estimated that 60 per cent. of the material used in the manucture of railway rolling stock in Great Britain is made to British andard. It would also appear from returns that for five of the rgest steel works during 1913-14 the British standard sections otalled 95 per cent. of their output. The sections recommended by e Committee for structural steel may be had from practically all e steel works in the country.

The Admiralty has adopted the British standard specification for eel for marine boilers, where steel of the tensile strength dealt with erein is required, the British standard specification for structural eel for shipbuilding, and subject to certain additional requirements ade necessary by the special character of naval work, the British andard specifications for steel castings and forgings for marine urposes. The Admiralty has also decided to adopt the British andard fine threads (Report No. 20) for all bolts, nuts and studs for arine work generally, and the War Office has specified them in many ases. The War Office has also adopted the British standard rim iameters for solid tyres (Report No. 71).

The Board of Trade rules for the survey of passenger steamships re in accordance with the British standard specifications for boiler eel ingot steel forgings and steel castings. Lloyd's Register has dopted the British standard sections, and the standard specifications for steel for shipbuilding and marine boilers and for steel stings and forgings for marine purposes, and has incorporated ese in its rules. The British Corporation for the Survey and egistry of Shipping, and the Bureau Veritas have likewise given ffect to the Committee's recommendations in their rules.

The Admiralty has, moreover, taken the keenest interest in the ectrical work, and in nearly all cases has adopted the electrical ecifications of the Committee, except where the exigencies of the rvice required departures owing to the special conditions which ave to be met at sea.

The Indian Government and Indian Government Railway Companies, besides adopting the specifications of the Committee for anufactured work, requested in 1903 that the standardisation of pes of locomotives be undertaken by the Committee, and in all six road-gauge and four metre-gauge engines have been standardised, nd at the further request of the Indian Government designs for ree more standard engines are in preparation. Since the issue of e first report in 1905 more than 1,600 standard broad-gauge and 0 standard metre-gauge engines, representing roughly about 7½-illion sterling, have been built for India. Criticisms have somemes been heard in regard to this policy of the Railway Board of dia, but over 10 years of practical experience has evidently emonstrated the wisdom and economy of this policy, which might, ith advantage, be followed by our home railways. Crystallisation f design and stagnation has clearly been avoided by the policy of a tanding Committee reviewing its recommendations at stated periods nd adopting modifications as and when deemed necessary. Evidently he requirements of the locomotive engineers of the Indian railways re being met satisfactorily by the comparatively small number of andard types recommended.

The Home Office, in a memorandum on chains and lifting devices, otes the increased use of the two higher grades of wrought iron commended by the Committee, and encourages their general adoption by chain makers. Also in a recent Order in Council the Home Office requires that the wattage of tungsten filament lamps used for automobiles shall be limited to the maxima given in the Committee's report dealing with that subject.

Much work has been carried out for the Road Board in regard to sizes of broken stone for roadmaking, and these recommendations having been adopted will doubtless be of increased assistance after the war.

Turning to the electrical side of the Committee's activities, it is interesting to note the large amount of preparatory work of importance which has been successfully carried through during the past two years. The most important electrical work completed is that of the standardisation rules for electrical machinery, in the preparation of which the Committee has received the cordial co-operation of the British manufacturers through their official organisation.

The conditions of the electrical industry in this country are very different from those existing either in Germany or America. In the United States two large corporations deal with practically the whole of the business, whereas here there are some 40 to 50 firms more or less in competition with one another. However, conferences held both in London and in New York with the Standards Committee of the American Institute of Electrical Engineers has resulted in the establishment of a thoroughly practical basis for the comparison of tenders for electrical machinery made in the United States of America or Great Britain, the rules of both countries being now in agreement on all essentials.

It is a pleasure to be able to place on record the Committee's appreciation of the courteous manner in which our American cousins have co-operated with their British confreres in this important matter and the generous way in which they have dealt with the British criticisms of their original proposals. The result of such work cannot fail to exercise a most beneficial effect in doing away with misunderstandings, and so promoting fair dealing in international contracts.

Much also has been accomplished in one of the most difficult of tasks, the standardisation of small electric fittings with due regard to liberty in design. This work, in which again the makers' association has been most helpful, has occupied a great deal of time, and the difficulties and prejudices to be overcome have been great. Ordinary household wall plugs and sockets have at last been standardised as regards interchangeability. A specification to secure interchangeability between any charging plug and any socket of the type recommended by the Electrical Vehicle Committee of the Incorporated Municipal Electrical Association, should be of material assistance in promoting the use of electric wagons and runabouts. A specification for electric supply meters has recently been evolved after much labour, and, although some modifications may still be required, it is hoped that it may eventually prove satisfactory to both producer and purchaser alike.

A system of British standard graphical symbols for use in electrical engineering plans is being drawn up, and in this work the Committee has the co-operation of the American and Canadian Electrotechnical Committees.

An appendix given by the author shows the number of different subjects being studied by the Electrical Committees and upon which reports and specifications useful to the industry will be forthcoming in due course.

The ramifications of the Committee, as will be seen from the cases cited, are extremely widespread, and the commerce of the world, due to the increasing ease of communication, being largely international, one might almost say in spite of the artificial barriers set up by different nations, it is natural that the Committee should be forced to envisage co-operating internationally. The Sectional Electrical Committee, with a different chairman, is, *ipso facto*, the British Committee of the International Electrotechnical Commission, which has branch committees in 15 to 20 different countries

The complex nature of electrical machinery calls for different treatment, from the point of view of standardisation, than in the case of other engineering materials. Indeed, the problem of the rating of electrical machinery is, possibly, more intricate than is the standardisation of any simple pieces of mechanism, electrical or otherwise. The conductivity of the copper, the permeability of the iron, the mechanical strength of the materials, can be estimated with sufficient accuracy from the results of definite and easily carried out tests on samples. When the question of the insulating materials, however, is considered, the problem is, of course, very different, and one can but acknowledge that, owing to their inherent properties, the insulating materials employed at present come into an entirely different category. They are governed by no well-defined laws, as in the case of the copper and iron, their properties are variable and alter largely for very small changes in the conditions of manufacture as well as those under which they are employed in the completed machine. One of the important problems, therefore, is the settling of the limits which it is considered necessary to impose in order to ensure that the principal causes of destruction of the insulating materials, the heating combined with the time element, shall be well kept within safe limits.

A clear distinction exists also between an "international standard of quality" and an "international rating." The international acceptance of the former has already been brought about by the adoption by the I.E.C. at its Berlin meeting in September, 1913, of certain limits of observable temperature applying to the materials in general use to-day; but these limits do not offer a means of comparing directly machines from various sources, since they would not necessarily have the same temperature rise. The fact, however, that American and British electrical engineers are at one on this point of immense commercial importance will doubtless have a great influence on the electrical industry of the world.

On all sides there are signs of strenuous preparations for meeting conditions after the war; science and industry are coming closer together, the commercial and technical sides inseparably linked together are being more efficiently organised, research work to assist manufacturers is being co-ordinated, finance is organising, combinations of commercial organisations are in the air; in fact, everything is being done with a view to strengthen British industry.

The German League of Economic Associations recently formed out of the six great associations of German engineers, architects, furnace men, chemists, electricians and marine engineers, numbering, so it is said, some 60,000 members, is an indication of what may be expected. Every effort must, therefore, be made to ensure that the British standard specifications are readily available to foreign purchasers as well as to those in the British Empire. A few of the specifications have already been translated into French, and it is hoped that satisfactory arrangements may be made to translate them all both into French as well as Spanish. In regard to Russian, the question is somewhat complicated, but in this case also the matter is being given the most careful consideration.

In conclusion, I cannot do better than refer to the views expressed by Sir John Wolfe Barry at Glasgow in 1908, for they are true to-day. In many markets, formerly exclusively British, he said, we no longer hold supremacy, because by quickness of despatch rather than through superiority of material or workmanship our rivals have been able to beat us; but the work which has been effected by the Committee should very materially assist in keeping the trade of our great colonial Empire in the hands of British manufacturers.

Sufficient evidence, you will agree, has been brought forward to show the great utility of the Committee's work to the engineering industry of the Empire. As regards the immediate future, so pregnant with vital issues to our trade, both home and export, the influential position of the Engineering Standards Committee as the central body, with its unique expert knowledge of standardisation, surely holds vast potentialities for good to the industry. The question of standardisation is, indeed, a national one, and should be regarded in the broadest way possible. Undoubtedly it is exercising a profound effect on the industry generally, and if supported at home and abroad, not only by the British Government but by all concerned, as it richly deserves to be, will in the future prove of incalculable value in furthering the legitimate aims of our British manufacturers, the products of whose workshops for solidity, for efficiency and continuity of service are second to none.

1,500-KW. GEARED TURBO-ALTERNATOR.*

Owing to the steadily increasing load at their power station the British Westinghouse Electric & Mfg. Co. (Ltd.) recently decided to replace an existing slow-speed engine-driven generator of American manufacture by a steam-turbine driven unit.

When planning the change three alternative schemes were carefully considered. The works periodicity was 25 cycles per second, and [illegible] [illegible] [illegible] [illegible]. The [illegible] at the [illegible] 1,500 revs. per min. [illegible] proved very unsatisfactory, and one alternative proposal was simply to duplicate this set. Another suggestion considered was to install a high-speed turbine direct-coupled to an alternator with a corresponding periodicity, from which a motor generator set would be driven. The third plan, which was then ultimately adopted, was to couple a high-speed turbine to a slow-speed alternator by means of gearing. This arrangement proved to be the lowest in ultimate cost, since although the initial outlay required was, owing to the gears, as high as that of the slow-speed turbo-alternator, the steam consumption would be 10 per cent. less owing to the more favourable ratio of blade speed to steam speed which became practicable with the higher revolutions of the turbine per minute.

The reduction gears were supplied by the Westinghouse Machine Co., of Pittsburg, U.S.A., and are said to be the first provided with a floating frame to be seen in this country. The turbine runs at 3,750 revs. per min., and is rated at 1,500 kw. The gearing transmits the load to a slow-speed alternator with salient poles, which runs at 750 revs. per min.

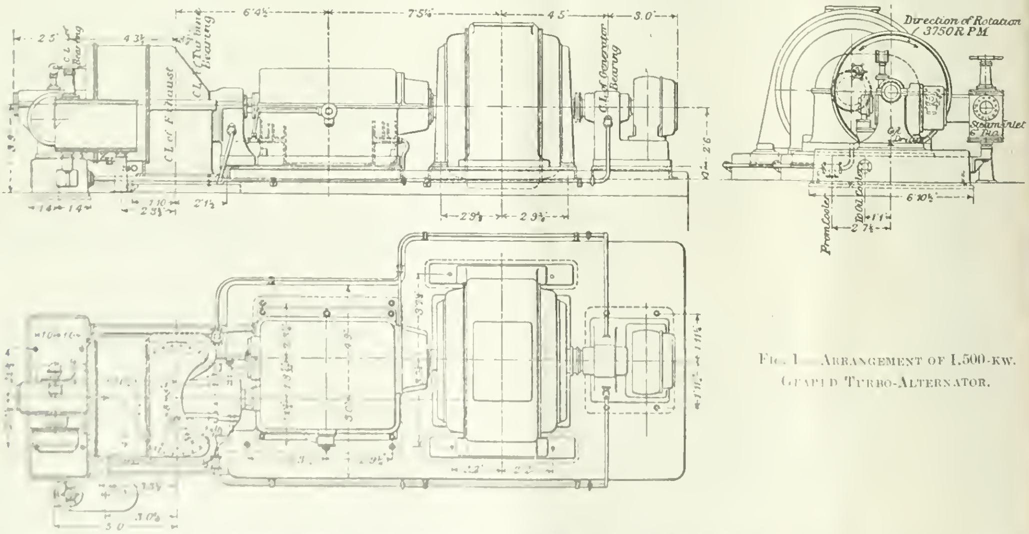

FIG. 1.—ARRANGEMENT OF 1,500-KW. GEARED TURBO-ALTERNATOR.

A general arrangement of the turbine and generator is reproduced in Fig. 1, which shows the principal over all dimensions. The turbine is a Rateau machine comprising one velocity compounded stage, followed by seven simple impulse wheels. The blades are of 5 per cent. nickel steel, and are milled out of the solid. They are forked at the root, and these forks straddle the rim of the wheel on which they are mounted, and are secured in place by rivets. This plan is followed for all the single stage impulse wheels, but the blading for the velocity compounded wheel is secured in a different way, the roots being dovetailed into slots turned in the rim. A very ample factor-of-safety is adhered to throughout, although the mean blade speed is about 675 ft. per second.

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* Abstracted from "Engineering" by kind permission of the Editor.

At the high-pressure end the shaft is fitted with the usual thrust or alignment block. The emergency governor is also fitted at this end. This consists simply of a plug fitting in a hole drilled transversely to the shaft axis. This plug is heavier at one end than at the other, so that under the action of the centrifugal force developed it tends to fly out, and this tendency is resisted by a spring. The strength of this spring is adjusted so that when the shaft speed rises about 10 per cent. above normal it is no longer able to resist the centrifugal force. The plug accordingly moves out and trips a trigger, thus opening a valve on an oil relay, which maintains the engine stop valve open. The oil pressure being thus released, this valve closes automatically.

The pinions have a pitch diameter of $6\frac{3}{4}$ in., that of the wheels with which they gear being approximately $33\frac{3}{4}$ in.; the circumferential pitch is 0·9 in. and the helical angle 30 deg. The main wheels have steel rims secured to cast-iron centres, as indicated in Fig. 2. The pinion is of steel throughout, and is hollow from end to end. It is driven by a shaft passing through its centre, and fixed only at the far end. This shaft being long and flexible, accommodates itself readily to the movements of the floating frame. This is supported on three cylinders, which are fed with oil by the ports and passages shown.

Any horizontal swinging of the frame is prevented by struts which whilst preventing horizontal motion, leave the frame free to tilt in a vertical plane by an amount sufficient to equalise the load passed through each half of the pinion. Axial motion of the whole is possible, because the pistons supporting the frame are not bolted to the casing, but simply rest on plane surfaces, and are thus free to slide.

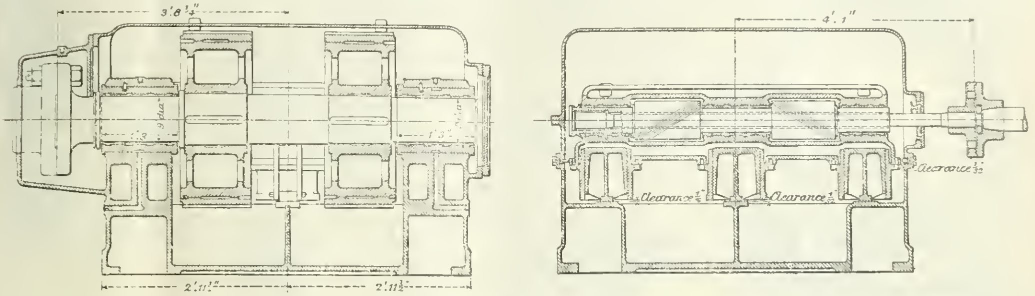


Fig. 2.—Details of Reduction Gear.

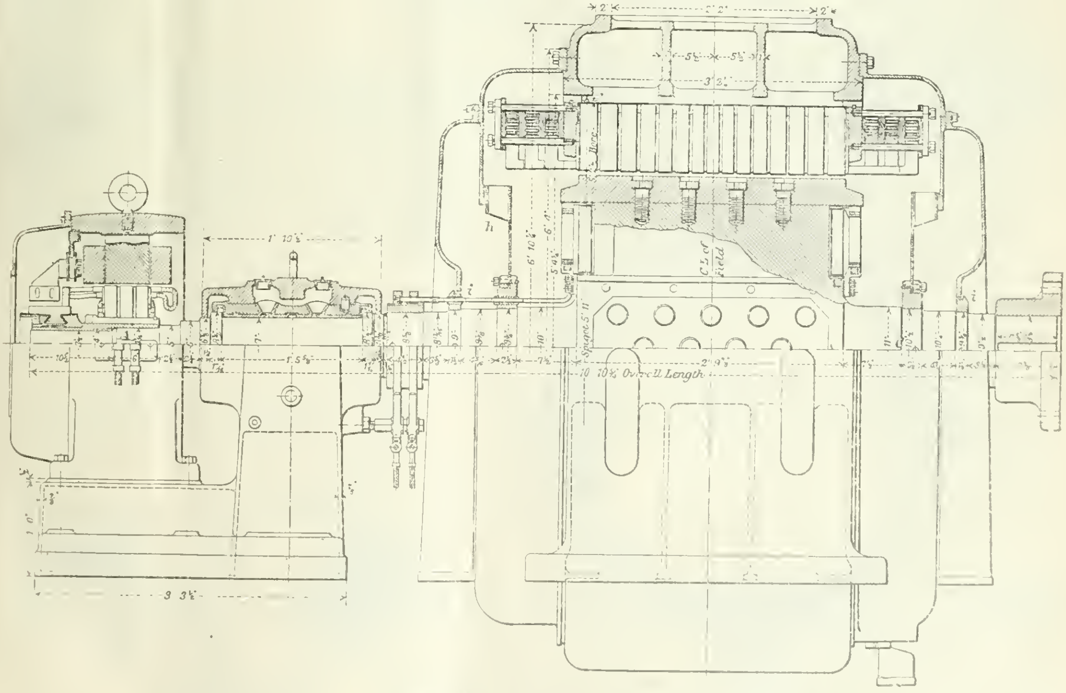


Fig. 3.—1,500-kw. Alternator and Exciter.

Details of the reduction gear are illustrated in Fig. 2. The principal dimensions of the gear relatively to those of the turbine and generator are given in the general elevation and plan, Fig. 1. The gear was purchased from its makers as a complete unit, and the turbine end bearing had to be made to suit. In the future, however, it will be possible to make some saving in the over-all length.

The condensing plant comprises a number of new departures. The surface condenser is of the firm's standard four-pass type, having 2,244 tubes, with a total surface of 4,300 sq. ft. The circulating water is obtained from the Ship Canal, being led to the power-station by a concrete conduit. It is pumped through the condenser by a motor-driven centrifugal pump.

The main air pump is of the Leblanc type, whilst a second centrifugal pump mounted on the same shaft withdraws the condensate. The power necessary is supplied by an electric motor. In principle the action of the Leblanc pump is comparable to that of the Sprengel pump, the high momentum of the plugs of water compensating for their low specific weight.

An important addition to this pump is the new type of "seal" tank, which is a closed tank communicating with the outer air only by an outlet the area through which is varied automatically as the quantity of air to be extracted changes. The pump discharges into this tank, and the gases liberated collect in the upper portion, whence they escape into the atmosphere. If but little air is being extracted, the pressure in the seal tank is practically atmospheric, but if the quantity of air increases the pressure in the tank rises, thus providing the greater head required for maintaining the proper flow into the pump.

The apparatus consists of a casting fitted at the bottom of the bell-mouth pipe through which the discharge from the air pump enters. The supply to the pump leaves through one branch, whilst another branch supplies any "make-up" which may be required. Annexed to the upper part of the tank is a float chamber which controls the valve.

This valve maintains constant the level of water inside the tank. The adjustment is effected by a spring-loaded plunger, subject on the one side to the pressure at the pump inlet, and at the other to the pressure at the top of the tank. The adjustment is such that the difference of these two pressures is maintained constant, and the feed of water to the pump becomes accordingly independent of the amount of air leakage.

The water-extracting pump has but a single stage. A somewhat higher efficiency could have been obtained by compounding this

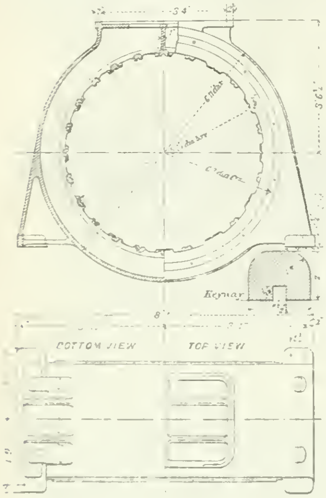


Fig. 6.

Fig. 8.

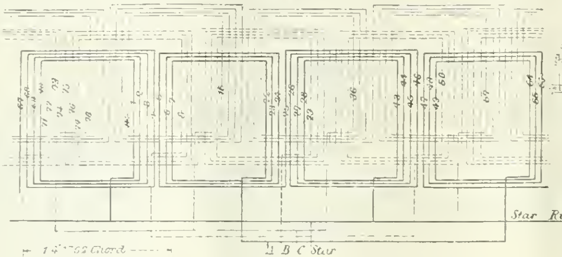


Fig. 5.

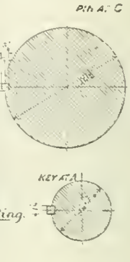
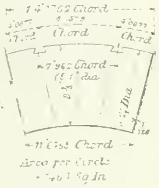


Fig. 9.



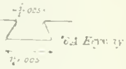


Fig. 10.

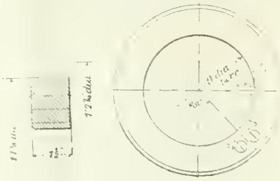


Fig. 4.

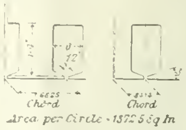


Fig. 14.

Structural Details of Alternator.

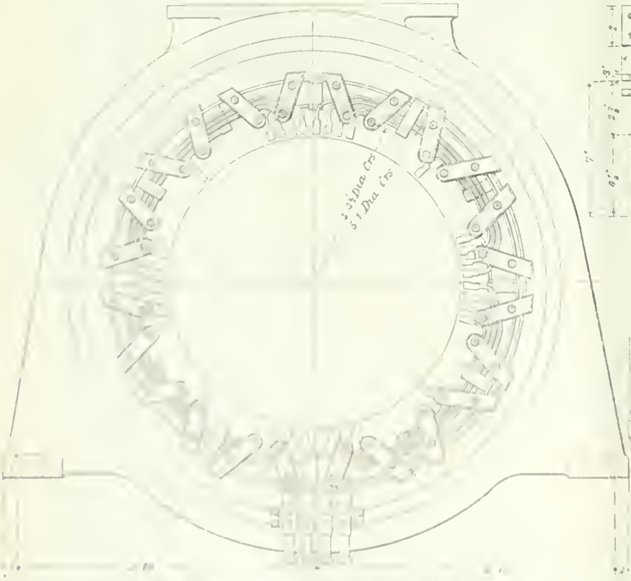


Fig. 7.—Arrangement of End Connections.

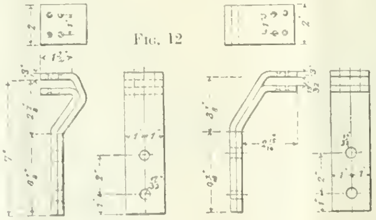


Fig. 12.

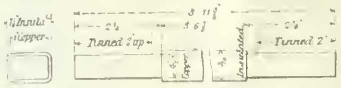


Fig. 13.

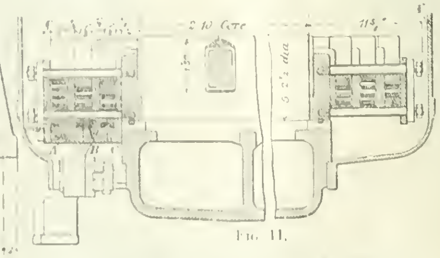


Fig. 11.

Structural Details of Alternator.

pump, but the saving in power would be more than offset by the additional cost and complication.

In addition to the Leblanc air pump, the condenser is also provided as a stand-by with a steam-jet air pump of a novel type. A peculiar feature of this extractor is that a mixed jet of steam and air is employed. The steam jet discharges into a chamber which is in communication with the outer air. The air expands from atmospheric pressure down to the pressure existing in the condenser, partly separately from the steam and partly after mixture with the latter. A mixed jet of the two passes through the second nozzle, sucks the air rom the condenser and discharges it into a third nozzle. This discharges into a chamber, in which a partial vacuum is maintained by additional steam jets. These further compress the air and deliver it to the outer atmosphere. This extractor works equally well at light and at full loads. The steam consumption is about 2½ to 3 per cent. of the main turbine consumption. This is a very reasonable figure for an emergency air pump of such simple construction and containing no moving parts. The steam used for the jets can, moreover, be discharged directly into the hot-well and its heat contents recovered.

Fig. 15. Fig. 16.

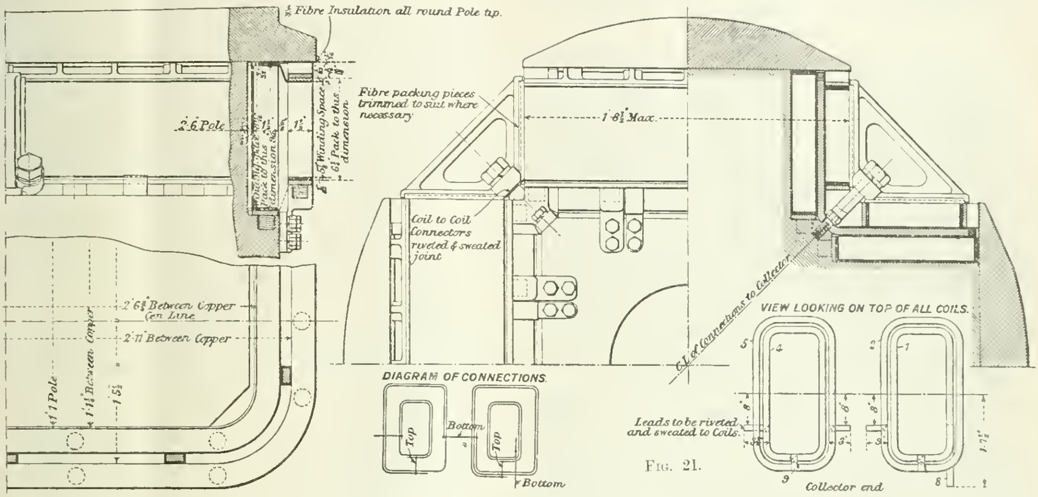

⅛ Fibre Insulation all round Pole tip.
2'6 Pole
Winding Space
Pack to this dimension
Fibre packing pieces trimmed to suit where necessary
1' 8½ Max.
Coil to Coil Connectors riveted & sweated joint
2' 6⅜ Between Copper Cen Line
2' 11 Between Copper
1' 1 Pole
1' 11⅛ Between Copper
1' 5⅞
℄ of connections to collector
VIEW LOOKING ON TOP OF ALL COILS.
DIAGRAM OF CONNECTIONS.
Top
Bottom
Top
Bottom
Leads to be riveted and sweated to Coils.
Collector end

Fig. 21.

Details of Revolving Field.

Fig. 20.

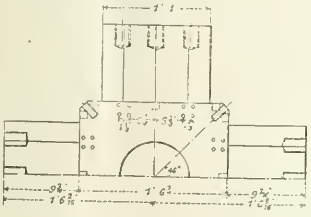
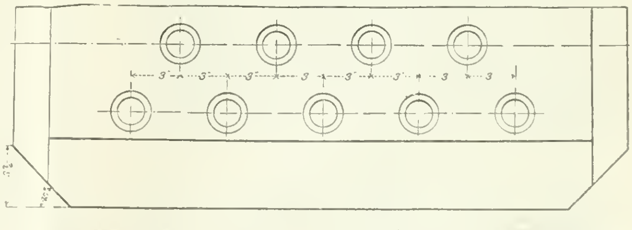
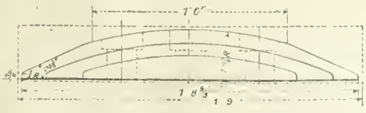


Fig. 18.





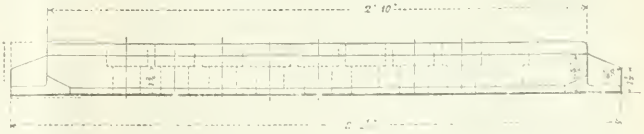


Fig. 17. Revolving Field and Pole Shoes. Fig. 19.

The construction of the generator is illustrated in Figs. 3 to 21. It is rated at 1,875 k.v.a. at 0·8 power-factor, generating three-phase current at 440 volts with a frequency of 25 cycles per second. The machine is, as will be seen from Fig. 3, completely enclosed and is self-ventilating, two fans being mounted as indicated on the rotor shaft at *h h*. To prevent air entering at the points where the shaft passes through the casing, guard-rings are fitted, as shown at *i i*. Details of these rings are given in Fig. 4, whilst Fig. 5 shows typical cross-sections of the rotor shaft. The stator is constructed on the same lines as in the case of direct-connected turbine-driven generators, and is accordingly very robust. The insulation, so far as is practicable, is of mica throughout. An elevation and plan of the stator casing are represented in Fig. 6, whilst Fig. 7 shows the arrangement of the end conductors. A winding diagram is reproduced in Fig. 8. The end windings are very rigidly braced, so as to avoid displacement in the case of a short-circuit. A typical stator stamping is represented in Fig. 9, an enlarged view of the keyway in it being given in Fig. 10. A cross-section through the windings is reproduced in Fig. 11, and shows how the connector-bars are secured. Particulars of these bars are reproduced in Fig. 12. One of the main conductors can be seen in place in Fig. 11. There are 84 of these bars to the complete stator, having the dimensions given in Fig. 13. Particulars of the slots will be found in Fig. 14.

The rotor body and shaft are one solid forging, the pole tips being bolted on, as best seen in Figs. 15 and 16. Details of these pole-pieces are reproduced in Figs. 17 to 19, whilst Fig. 20 shows a half end elevation of the rotor at the poles.

The construction of the field winding is of interest, as it consists of two concentric coils separated from one another by an air space, best seen in Fig. 15 and in the diagram, Fig. 21. Through this space a ventilation current flows when the machine is at work. Between turns the insulation is of asbestos, and the insulation to ground is also, so far as possible, of a fireproof character. The bearings for the shaft are ring-oiled. The original article is profusely illustrated, and the details of construction of the turbine and auxiliaries are discussed at some length.

ON THE WAVE-FORMS OF MAGNETISING CURRENT AND FLUX DENSITY FOR A "STALLOY" MAGNETIC CIRCUIT.

BY B. HAGUE, B.SC., D.I.C., AND S. NEVILLE, B.SC., D.I.C.

Summary.—Hysteresis loops are plotted for unannealed stalloy for various values of maximum flux density, and from these are deduced (1) waves of magnetising force required for sine waves of flux density, (2) waves of flux density produced by sine waves of magnetising force. These are subjected to harmonic analysis, the magnitudes of the harmonics being plotted as functions of the maximum density in the first case and of the maximum magnetising force in the second case.

I. INTRODUCTION.

It is commonly assumed in the theory of electrical machines and apparatus that the time variation and space distribution of the various quantities—such as current, magnetising force, flux density and E.M.F.—are sinusoidal. Since the magnetic circuit consists largely of iron, the sine wave assumption is never true, on account of the effects of hysteresis and magnetic saturation. For example, when the flux density follows a sine wave, the magnetising force assumes the well-known peaked form containing pronounced harmonics; while if the magnetising force varies sinusoidally the flux density produced is a flattened wave containing important harmonics. Either of these statements can apply to a time variation or a space distribution of the quantities concerned; but the former conditions are more commonly found in the case of a time variation, as in the static transformer, whilst the latter case may be more useful in dealing with the space distribution of flux density, such as occurs in the induction motor.

The late Prof. S. P. Thompson has shown* that any actual hysteresis loop may be regarded as made up of a number of component loops (or Lissajous' figures), each due to one harmonic in the magnetising force, the common sine wave treatment assuming the hysteresis loop to be an oblique ellipse. As no theoretical method is at present available for dealing with all the harmonic constituents, the present Paper aims at giving experimental data concerning the magnitude of the various harmonics occurring in the magnetising force when the flux density varies sinusoidally, and also an investigation of the harmonic constituents of the flux density wave produced by a sine wave of magnetising force. The results in the former case will be expressed as functions of the maximum flux density $\bar{B}$, and in the latter as functions of the maximum magnetising force $\bar{H}$ attained in a cycle.

It is proposed to examine in this way all the materials commonly used with alternating fluxes, including annealed and unannealed silicon steel (Stalloy and Lohys) and soft charcoal iron plates. The results given in this Paper are for "unannealed stalloy," in which state the material is not much used in practice; and the main object here is to describe the experimental process and the method of reducing the results which will be followed in the treatment of the other materials. The curves obtained will serve to show the general nature of the phenomena occurring and the relative importance of the various harmonics.

II. MAGNETIC EXPERIMENTS.

A series of magnetic experiments was carried out by the ballistic method with the object of determining a number of hysteresis loops for various values of the maximum flux density from about 5,000 to 15,000 C.G.S. lines per square centimetre, the range of densities found in practice for alternating-current work being within these limits.

The specimen employed was in the form of a narrow ring, 21·9 cm. outside diameter and 20·25 cm. inside diameter, built up of [illegible] stampings to a depth of about 2·8 cm. The weight of the [illegible] metal was afterwards found to be [illegible] grammes, and its density to be 7·83, giving a volume of [illegible] cubic cm. The mean periphery being 65·6 cm., the net cross-sectional area was [illegible] sq. cm.

The built-up ring was tightly wrapped with a layer of thin silk tape, over which was wound the secondary winding consisting of 50 turns of No. 38 S.W.G. D.C.C. wire, distributed uniformly over the whole periphery. The resistance of this winding was 4·3 ohms. The secondary winding was covered with another layer of tape, over which the magnetising winding was wound. This consisted of two layers having 585 and 621 turns respectively of No. 20 S.W.G. D.C.C. wire closely wound, the resistance being 1·528 ohms. The number of turns per centimetre was, therefore, 18·4, so that the magnetising force per ampere was $0{\cdot}4\pi \times 18{\cdot}4 = 23{\cdot}1$ C.G.S. units.

The common method* of carrying out the ballistic test was adopted, the ammeter and galvanometer employed being afterwards calibrated. Commencing with the iron in the demagnetised state, the magnetisation curve was determined up to a density of 4,790, after which a series of nine loops was traced for maximum densities of 5,200, 7,700, 9,250, 10,500, 11,550, 12,700, 13,480, 14,610 and 14,830, H ranging between 4 and 96 C.G.S. units. By plotting the observed points to a large scale it was seen that, with few exceptions, the errors of observation were not large, and the curves were consistently smoothed to give a well-graded series of loops.

III. HARMONICS IN THE MAGNETISING FORCE FOR A SINUSOIDAL WAVE OF FLUX DENSITY.

Let it be assumed that the flux density varies according to the law

$$B = \bar{B} \sin \theta.$$

Taking each loop in turn, values of B were calculated at intervals of 10 deg. over a cycle, and the corresponding values of H read off from the loop and plotted to a base of θ, the result being the peaked waves of magnetising force shown in Fig. 1. The ordinate at $\theta = 0$ represents the coercive force, and the curve reaches a maximum at $\theta = 90$ deg.

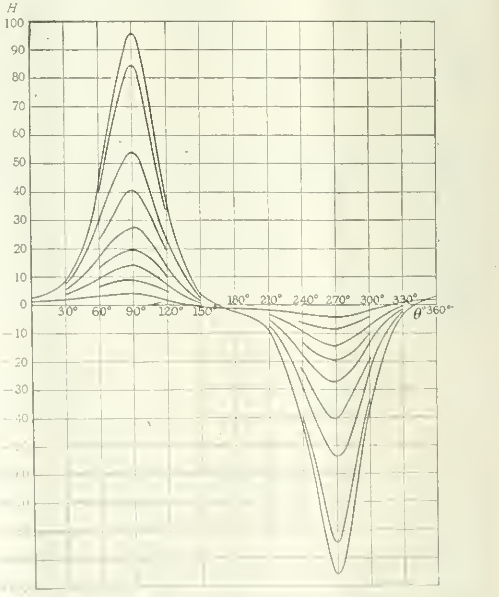


FIG. 1.—WAVES OF MAGNETISING FORCE REQUIRED FOR SINE WAVES OF FLUX DENSITY.

These waves can be resolved into a series of the form

$$H = A_1 \cos \theta + A_3 \cos 3\theta + A_5 \cos 5\theta + \ldots + A_n \cos n\theta + \ldots$$
$$+ B_1 \sin \theta + B_3 \sin 3\theta + B_5 \sin 5\theta + \ldots + B_n \sin n\theta + \ldots$$

where n is odd. To obtain the coefficients A_n and B_n the waves were plotted to a convenient base length and analysed up to the 9th order by means of the Henrici analyser. The results are shown as functions of the maximum density $\bar{B}$ in Figs. 2 and 3.

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* Proc. Physical Society, Vol. XXII., 1910, also Phil. Mag., September 1910.

* J. A. Ewing and Miss Klaassen, "Proc." Roy. Soc., Vol. CLXXXIV., Series A, 1893, pp. 985-1039; and S. G. Starling, "Electricity and Magnetism," p. 275.

The above series may be written as

$$H = \bar{H}_1 \sin(\theta+\varphi_1) + \bar{H}_3 \sin(3\theta+\varphi_3) + \bar{H}_5 \sin(5\theta+\varphi_5) + \dots \dots + \bar{H}_n \sin(n\theta+\varphi_n) + \dots,$$

where $\bar{H}_n^2 = A_n^2 + B_n^2$ and $\tan \varphi_n = A_n/B_n$. The amplitude $\bar{H}_n$ and the phase angles φ_n were calculated from readings taken from the curves of Figs. 2 and 3, and are plotted in Figs. 4(*a*) and 4(*b*) respectively. The wave-length of each harmonic has to be considered as 360 deg., and the corresponding phase angles set off to this scale; thus to the scale of the fundamental the phase angle for the *n*th harmonic would be φ_n/n.

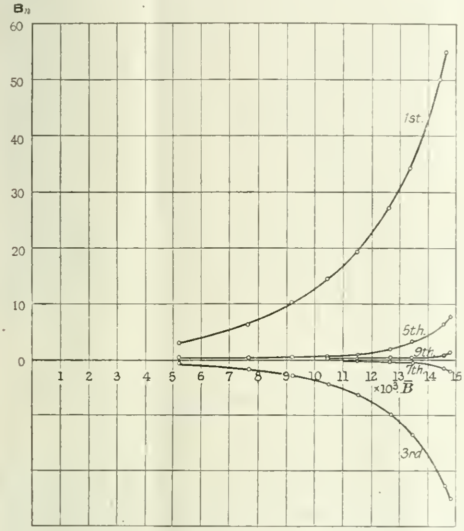

FIG. 2.—SINE TERMS (B_n) IN THE WAVE OF MAGNETISING FORCE REQUIRED FOR A SINE WAVE OF FLUX DENSITY.

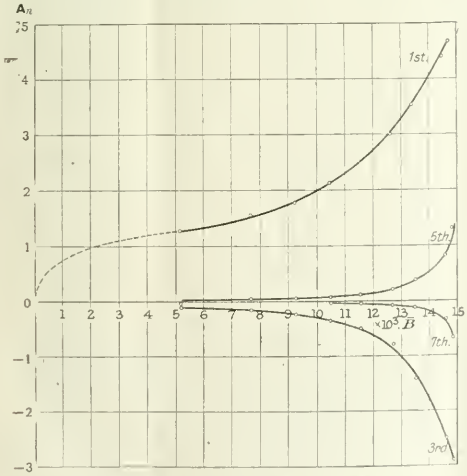

FIG. 3.—COSINE TERMS (A_n) IN THE WAVE OF MAGNETISING FORCE REQUIRED FOR A SINE WAVE OF FLUX DENSITY.

The curve of phase angles afforded some guide in adjusting the curves for the cosine terms to fit the observed points, so as to obtain smooth curves in all cases. It appears from the diagrams that the sine terms are reliable over the range of the experiments down to the 7th harmonic, while the 9th is probably only accurate for the higher values of the maximum density. In the cosine terms the 5th harmonic shows some irregularity at the lowest density, while the 7th appears to be accurate only at the highest densities. It will be shown later that the effect of the 9th harmonic is extremely small. The amplitudes (Fig. 4(*a*)) have probably about the same order of accuracy as the sine terms (since the cosine terms are relatively small), while the phase angles depend largely upon the cosine terms. For this reason no attempt has been made to plot

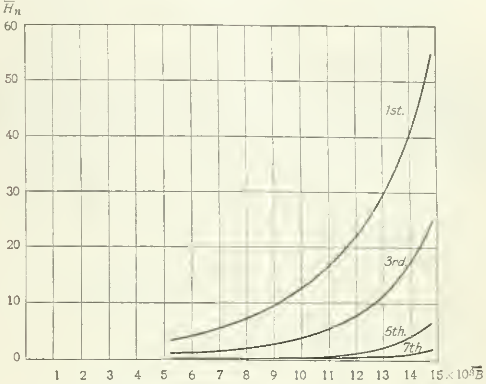

FIG. 4 (*a*).—AMPLITUDES OF HARMONICS ($\bar{H}_n$) IN THE WAVE OF MAGNETISING FORCE REQUIRED FOR A SINE WAVE OF FLUX DENSITY.

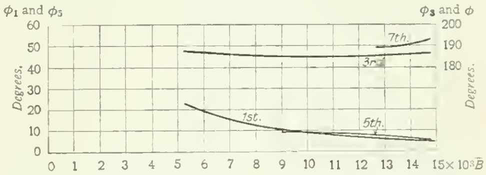

FIG. 4 (*b*).—PHASE ANGLES (ϕ_n) OF THE HARMONICS IN THE WAVE OF MAGNETISING FORCE REQUIRED FOR A SINE WAVE OF FLUX DENSITY.

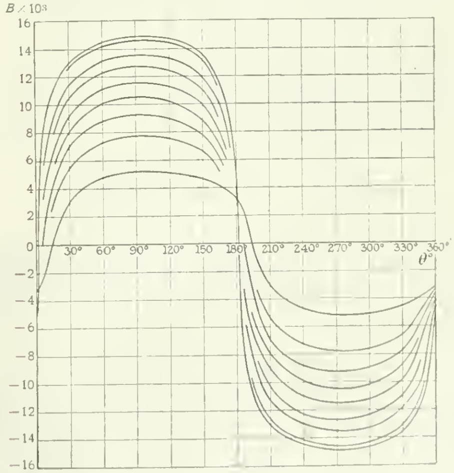

FIG. 5.—WAVES OF FLUX DENSITY PRODUCED BY A SINE WAVE OF MAGNETISING FORCE.

the curves for the 9th harmonic on Figs. 4(*a*) and (*b*). The shape of the curves will be discussed in Section V.

IV. HARMONICS IN THE FLUX DENSITY FOR A SINUSOIDAL WAVE OF MAGNETISING FORCE.

In this case it is supposed that the magnetising force is

$$H=\bar{H}\sin\theta.$$

Taking values of H for every 10 deg. throughout the cycle, and using the hysteresis loops, the values of flux density B are plotted to a base of θ (*see* Fig. 5). Following the previous method, these waves were analysed into a Fourier series

$$B=A_1'\cos\theta-A_3'\cos 3\theta+A_5'\cos 5\theta-\ldots+A_n'\cos n\theta+\ldots$$
$$-B_1'\sin\theta+B_3'\sin 3\theta+B_5'\sin 5\theta+\ \ldots\ +B_n'\sin n\theta+\ldots$$
$$=\bar{B}_1\sin(\theta+\varphi_1')+\bar{B}_3(3\theta+\varphi_3')+\bar{B}_5(5\theta+\varphi_5')+\ \ldots$$
$$\ldots+\bar{B}_n(n\theta+\varphi_n')+\ \ldots$$

for odd terms as far as the 9th harmonic, where

$$\bar{B}_n^2=A_n'^2+B_n'^2 \text{ and } \tan\varphi_n'=A_n'/B_n'.$$

In Figs. 6, 7, 8(*a*) and 8(*b*) these quantities are plotted as functions of the maximum magnetising force $\bar{H}$.

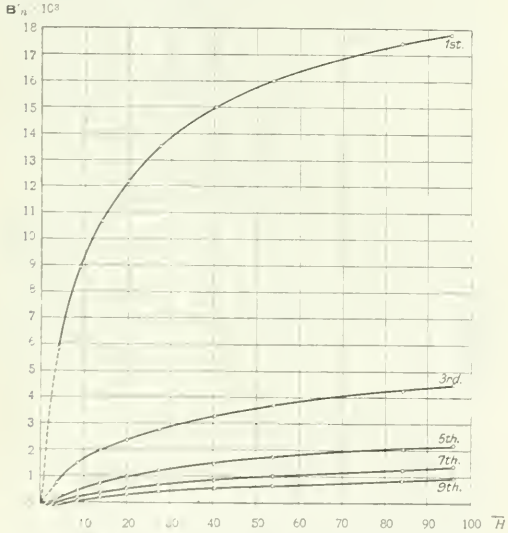

FIG. 6.—SINE TERMS (B'_n) IN WAVES OF FLUX DENSITY PRODUCED BY A SINE WAVE OF MAGNETISING FORCE.

It will be seen that the curves fit the observed points very well and needed little adjustment in any case. Within the range of the experiments the results may be taken as reliable for all harmonics. The shape of the curves will be considered in the next section.

V. DISCUSSION OF RESULTS.

Harmonics in the Magnetising Force.—Referring to Fig. 1(*a*), it is seen that the amplitudes of all the components increase with increasing values of the maximum flux density at first slowly and afterwards very rapidly. The relative values of the harmonics compared with the fundamental at the same time gradually increase, accounting for the increasing deviation of the wave of magnetising force from a sine shape.

Fig. 2 shows that the sine terms as far as the 9th harmonic are alternately positive and negative, but have otherwise the same general shape as the curves of amplitudes shown in Fig. 1(*a*), on account of the relative smallness of the cosine terms.

The cosine terms shown in Fig. 3 are also alternately positive and negative, and fall away to zero in a steady manner as $\bar{B}$ is reduced. A notable exception occurs in the case of the fundamental cosine term, which has been extended to zero below the lower limit of the experiments by a dotted line, the shape of which may be justified by the following approximate argument. Since we have assumed a sine wave of flux density, the E.M.F. produced thereby will follow a cosine law, and hence the fundamental cosine component of magnetising current will be the only term responsible for power, all the other harmonics being wattless. If P be the energy dissipated per cycle by hysteresis, it is known that

$$P=\eta B^n$$

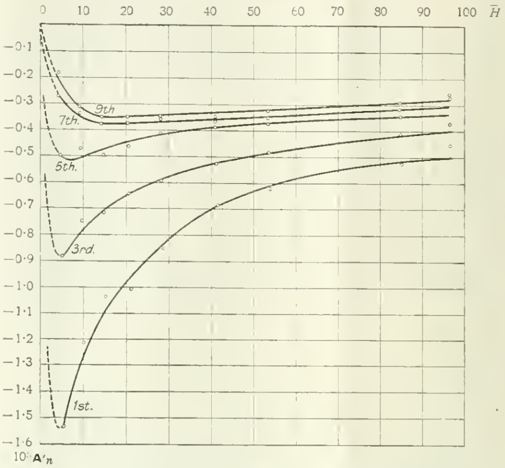

FIG. 7.—COSINE TERMS (A'_n) IN WAVES OF FLUX DENSITY PRODUCED BY A SINE WAVE OF MAGNETISING FORCE.

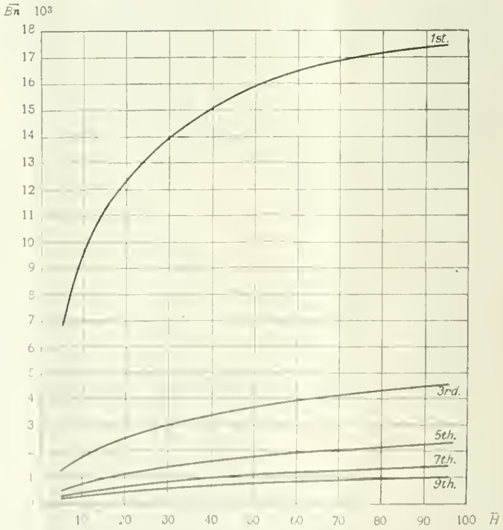

FIG. 8 (*a*).—AMPLITUDES OF HARMONICS ($\bar{B}_n$) IN WAVES OF FLUX DENSITY PRODUCED BY A SINE WAVE OF MAGNETISING FORCE.

represents fairly the observed loss, where η is assumed to be a constant and n an index whose value is altered as B increases, that is, n is a function of $\bar{B}$. By plotting log P against log $\bar{B}$ for our present material it is found that the points obtained lie on a smooth curve whose slope—which is roughly a measure of n—increases as $\bar{B}$ increases. Now the E.M.F. is proportional to B, hence the magnitude of the cosine term is proportional to $\bar{B}^n/\bar{B}$, or $\bar{B}^{n-1}$. The slope of the curve representing the magnitude of the cosine term as a function of B is proportional to $(n-1)\bar{B}^{n-2}$. Now n is always greater than unity; hence, when $\bar{B}$ is small and n not very different from 1, $n-1$ is small and positive, and $B^{n-2}=1/B^{2-n}$ will be large. Hence the curve starts off at the origin with considerable positive slope, which, since $\bar{B}$ increases more rapidly than $n-1$, will become less—at first rapidly and then more slowly. For higher values of $\bar{B}$, n differs considerably from unity, and $2-n$ becomes rapidly smaller, causing the slope to become greater again, thus accounting for the curve turning upward for larger values of $\bar{B}$. The slope may also be increased in addition by n varying more rapidly than a linear function of $\bar{B}$.

In order to show the magnitude of the error introduced by neglecting harmonics of order greater than the seventh, one wave of magnetising force has been constructed by synthesis, using the values of the components read off from Figs. 4(a) and 4(b), for a maximum density B of 13,480, the result being compared with the wave obtained from the hysteresis loop having the same maximum value. In Fig. 9 the full line shows the curve derived by synthesis, and the dotted line the wave obtained from the hysteresis loop. The differences between the true curve and the approximation obtained by taking the 1st, 3rd, 5th and 7th harmonics are everywhere small, showing that the errors involved by neglecting higher terms are very minute. Hence it appears that these peaked magnetising force waves may be very well represented by their harmonic constituents up to the 7th order.

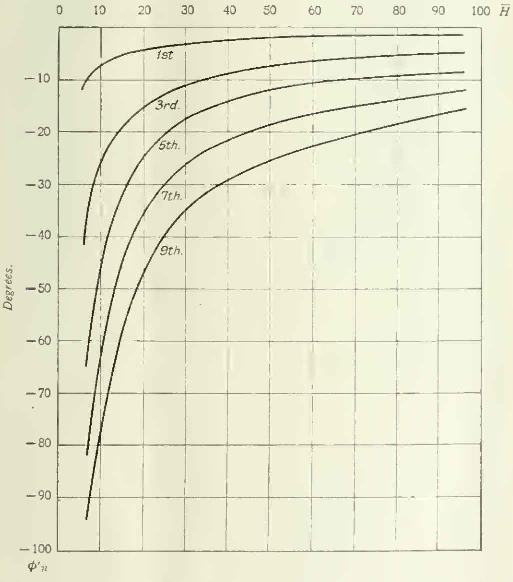

Fig. 8 (b).—Phase Angles (ϕ'_n) of Harmonics in Waves of Flux Density produced by a Sine Wave of Magnetising Force.

In order to demonstrate the effect of the harmonics on the root-mean-square value of a wave of magnetising force the following table has been prepared, showing for various values of B the effective value of the wave in H units. The third column gives the ratio of the root-mean-square value of the wave to that of the fundamental, and gives an indication of the kind of error committed in assuming that the magnetising force follows a sine law. It will be seen that even at low densities the sine wave is some 4 per cent. too low, whilst the error increases uniformly to a figure of about 11 per cent. at higher densities.

$\bar{B}$.	R.M.S. value of wave in H units.	Ratio. $\frac{\text{R.M.S. of wave}}{\text{R.M.S. of fund}}$
5,200	2·40	1·036
7,000	4·10	1·039
9,000	7·05	1·042
11,000	12·56	1·051
13,000	22·65	1·069
14,000	31·80	1·092
14,800	43·00	1·109

Harmonics in the Flux Density.—The amplitudes of the harmonics shown in Fig. 8(a) as functions of H all follow curves of very similar shape, closely resembling that of the ordinary magnetisation curve of the material. The sine terms, as Fig. 6 shows, are all positive, and follow curves similar in shape to those found for the amplitudes, due, of course, to the relatively small value of the cosine terms. There is, however, some slight irregularity in the 7th and 9th harmonics at the very lowest values of $\bar{H}$, where they attain small negative values.

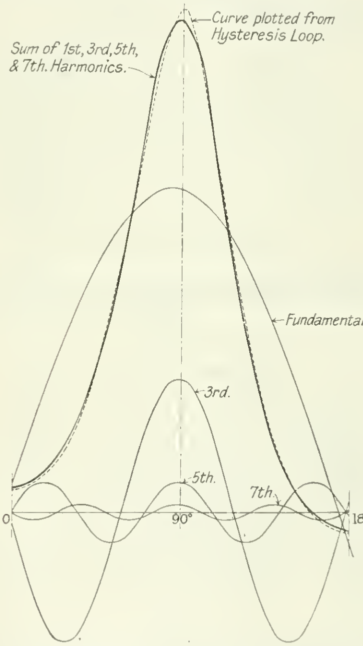

Fig. 9.—Synthesis from its Harmonics of the Wave of Magnetising Force required for a Sine Wave of Flux Density (B =13,480).

The cosine terms are all negative, and, as Fig. 10 indicates, appear to increase at varying rates as $\bar{H}$ is decreased, the 5th, 7th and 9th harmonics reaching maximum values, which for the former harmonic occurs at about $\bar{H}=6$ and for the latter at $\bar{H}=10$, after which they decline rapidly to zero. Within the range of the experiments the fundamental and 3rd harmonic were continually increasing, but must ultimately attain a maximum and fall to zero as $\bar{H}$ tends to zero, after the manner of the higher harmonics. It appears, therefore, that the higher harmonics attain a maximum value at a value of H which is greater as the order of the harmonics is higher, a fact which we shall find useful in explaining a point which will arise later.

As before, the accuracy of making an approximation to the shape of the waves with a finite number of terms of the Fourier series was tested by drawing a wave for $H=53{\cdot}9$ by synthesis, using harmonics up to the 9th order taken from the Figs. 8(*a*) and 8(*b*), the result being shown by the full line in Fig. 10, where the dotted line is the flux density wave deduced from the hysteresis loop. The differences, though not large, are greater than in the former case, and the difference between the two curves has been subjected to harmonic analysis up to the 9th order, from which it was found that the discrepancy consists entirely of harmonics of still higher orders. That these harmonics may be of great importance is indicated by another fact which this synthetic curve brings out. The ordinate at $\theta=0$ is clearly the remanent magnetism of the material, and the actual and synthetic values are seen to be very different. Since this ordinate is the sum of the cosine terms, it follows that the sum of the cosine terms of the neglected harmonics must be very considerable. The fact that the error in the ordinate at $\theta=90$ deg. is not so great points to the fact that the sine terms of these rejected harmonics will be small, a result to be expected when the descending order of magnitude of the higher harmonic sine terms is remembered. It thus appears that although a fair approximation to the shape can be obtained by summing harmonics up to the 9th order, the approximation so obtained neglects important cosines of higher order. Referring to Fig. 5, it will be seen that the remanent magnetism increases with B. The sum of the cosine terms must therefore do likewise, and this can only happen if the neglected cosines are of fairly large size and their peak values occur at higher and higher values of H, as predicted above.

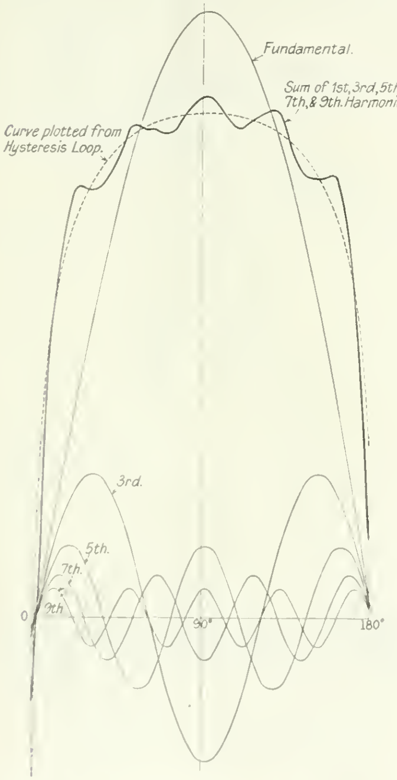

FIG. 10.—SYNTHESIS FROM ITS HARMONICS OF THE WAVE OF FLUX DENSITY PRODUCED BY A SINE WAVE OF MAGNETISING FORCE ($H=53{\cdot}9$).

Remembering that the phase angle measured by $\varphi'_n=\tan^{-1}A'_n/B'_n$ must be divided by n when plotted to the scale of wave-length of the fundamental, Fig. 8(*b*) will show that $\varphi'_1 \simeq \varphi'_3/3 \simeq \varphi'_5/5$, &c., that is, all the harmonics are approximately in phase, a result confirmed in Fig. 10. This leads to the interesting result that if the flux waves produced by a sine current be analysed with respect to their own origin ($B=0$), instead of the origin we have used ($H=0$), the Fourier series would, to a first approximation, contain sine terms only, whose magnitudes would be equal to the amplitudes plotted in Fig. 8(*a*).

In all the present work it will be noticed that the distorting effect exerted on the shape of the hysteresis loop by eddy currents induced in the metal by an alternating flux has been ignored, and so the results must be taken only as a first approximation to the actual problem occurring in electrical machinery. Furthermore, the hysteretic cycles upon which our work is based are performed slowly, whereas in actual cases a cycle is completed in one-fiftieth of a second or less, and the effect of magnetic viscosity will come in also as a disturbing factor. Max Wien* has investigated this effect in some detail, and has shown that the general effect of viscosity on the shape of the hysteresis loop is similar to that of eddy currents—namely, to shorten the loop under constant magnetising force and to increase its area at constant maximum flux density as the speed of the cycle is increased, the effect being a small one even at so high a frequency as 520 cycles per second. The authors, by analysing oscillograms taken on a small ring-type transformer built up of the stampings used in the experiments made for this Paper, have obtained a rough indication of the combined effects of viscosity and eddies on the actual values of the magnetising force harmonics for a sine flux whose maximum value was 8,000, the frequency being 50 cycles per second. It was found that the fundamental cosine term was somewhat larger than that predicted from the curves given in this Paper, indicating the increased loss. The third harmonic was also found to be larger and the higher harmonics smaller than the predicted values, a like remark applying to the sine terms. No exact information as to the distortion of the loop could be deduced from this rough test. It therefore appears that much further work on the shape of the hysteresis loop under rapid reversals of flux density and in the presence of eddy currents is required before the exact prediction of magnetising force and flux-density waves in electrical machines and apparatus is possible; but until such investigations are made it is hoped that the results set out in this Paper will provide a first approximation to the solution of the problem, which will be of greater practical value than could possibly be obtained by assuming the sine wave theory in the case of magnetic circuits containing iron and subjected to alternating fluxes. It will be evident that the present results apply only to the case of a magnetic circuit—such as is found in the static transformer—consisting entirely of magnetic metal, containing no air gaps, and in which the flux density is uniform; but the writers hope to show in a future communication how the results can be applied to magnetic circuits, such as are commonly found in electrical machinery, not fulfilling these conditions. As pointed out earlier in the Paper, the authors propose to publish later results of similar experiments carried out on other materials.

The authors beg to thank Dr. S. P. Smith for reading the manuscript, and wish to state that the work was carried out under the direction of Prof. T. Mather, F.R.S., at the City and Guilds (Engineering) College, South Kensington.

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* Max Wien, Wiedemanns' "Annalen," Vol. LXVI.; also Bragstad and la Cour, "Theory and Calculation of Electric Currents," 1912, p. 356.

THE BETHNAL GREEN ELECTRICITY SUPPLY UNDERTAKING.

Although a provisional order was obtained by the Borough Council so far back as 1899, it was only recently that steps were taken to provide a supply. Some years ago the late Mr. Robert Hammond prepared a scheme for a combined dust destructor and electricity supply station, but this was not carried into effect. In 1912 Sir John Snell submitted a report to the Council recommending that they should take a supply in bulk from some neighbouring authorised distributor, and tenders were obtained from various electrical supply companies and Borough Councils owning electrical undertakings. The tender of the Stepney Borough Council was accepted, and an agreement made for the purchase of electrical energy in bulk for a term of years, the supply to be given at 5,850 volts, three-phase, 50 periods.

A supplementary agreement was subsequently made, under which the Stepney Council undertake to manage the Bethnal Green undertaking for a further payment.

In the summer of 1914 Mr. Harold Couzens was appointed consulting engineer to carry out the scheme on the lines laid down in Sir John Snell's report, and the specifications were duly prepared. In the meantime war broke out, and though the work has been continued the execution and completion of the works have been delayed, owing to more pressing Government work and shortage of staff of the contractors, so that it is only just now completed.

The contractors are the British Insulated & Helsby Cables (Ltd.) for the whole of the mains, and the British Westinghouse Electric Co. (Ltd.) for the sub-station transformers and equipment.

Two sub-stations have been built, one at New Tyssen-street and one at Digby-street, and when the load increases in the northern area it is proposed to put an additional sub-station in that district. The buildings have been designed and constructed under the supervision of the borough engineer and surveyor, Mr. A. E. Darby. The extra-high-tension current is brought by the Stepney Borough Council to the boundary in Brick-lane by means of duplicate cables, and is taken on also by duplicate cables into the sub-station at New Tyssen-street, from whence the cables proceed to the Digby-street sub-station.

The high-tension switchboard is constructed on standard lines, the cubicles being underneath the switchboard platform, and the operating gear above. Each switchboard is divided into two halves by an interconnecting panel, so that in case of breakdown of one of the cables that section can be completely isolated and the supply maintained on the other half of the board.

Distribution cables have been laid through the main streets of the borough, but only on one side of the road, except in Bethnal Green-road, where the cable is laid on both sides, so that the distribution system may be said to be largely of a pioneering nature, as may be gathered by the fact that the total expenditure on the scheme is only £25,000. The low-tension cables are four-core, and all are lead-covered and laid solid in stonework troughing. The pressure of supply to consumers is 415 volts between phases, and 240 volts between phase and neutral.

The outlook for the undertaking is encouraging, as there is a large number of small industries requiring the use of power in the district, and a considerable number of consumers have already received a temporary supply, with the permission of the Council, from Shoreditch and Stepney, on the understanding that they change over to the Bethnal Green supply as soon as this is available.

At the inauguration of the New Tyssen-street and Digby-street sub-stations on Thursday, Oct. 5th, Coun. J. J. Cole (Chairman of the Electricity Committee) presided and the Mayor (Coun. W. J. Lewis, J.P.) performed the opening ceremony at the New Tyssen-street sub-station.

The Mayor welcomed the Mayor of Stepney and other members of the Stepney Council, and Mr. Cole read a letter from Sir John Snell expressing his regret at his inability to attend.

Mr. Cole then gave a short historical account of the undertaking. Delay was partly due to the fact that during the years 1903 to 1910 Parliament discussed the general question of linking up and this principle was accepted as preferable to independent undertakings. Consequently, in 1912, the Council obtained a report from Sir John Snell which provided for obtaining current in bulk on the alternating-current, 50 ∽ three-phase four-wire system. In 1914 an agreement was entered into with Stepney for a supply for the period ending March 31, 1929, and also a supplemental agreement with Stepney for the management of the supply for four years, and Mr. H. W. Couzens was retained as consulting engineer. The high-tension feeders, from the Stepney boundary in Brick-lane, were connected to the high-tension switchboard in duplicate and high-tension feeders in duplicate proceeded to Digby-street. In each of the sub-stations there was a 500 and a 250 k.v.a. transformer. In that station (New Tyssen-street) were the meters that registered the supply from Stepney and from the low-tension side these radiated three feeders, one connecting up to a point in Bethnal Green-road, and the second to a point in Brick-lane, and the third to the western end of Hackney-road. In the case of Digby-street the three feeders connected to the networks at the junction of Cambridge-road and Bethnal Green-road.

Mr. Cole concluded by asking the Mayor to perform the inaugural ceremony.

The Mayor said he was glad that to-day his Council were all united in the opinion that electricity supply was necessary in the borough. It gave greater facilities for letting premises, as it assisted in quicker production in factories. It spoke well for municipal enterprise when boroughs linked up for the interests of their people.

The Mayor then linked up the mains, operated the switch on the low-tension side and declared the two sub-stations open.

Mr. H. H. Gordon, J.P., L.C.C., in proposing a vote of thanks to the Mayor, said that it was 33 years since the first metropolitan local authority (St. Pancras) obtained powers for electricity supply, and Bethnal Green's ceremony to-day might be said to complete the task of giving London a supply, and they not only completed that era, but inaugurated a new period of closer co-operation between manufacturers and distributors of electricity. The action of Bethnal Green and Stepney in co-ordinating their supply formed the best answer to those who had advocated great undertakings rather than local initiative. But while he did not think London would be safe with only one supply, there was no necessity to have 29 supplies. The policy Stepney and Bethnal Green had adopted ruled out the scheme for a great unified supply.

Coun. G. T. Lego (Vice-chairman of Stepney Electricity Committee) seconded the resolution.

The Mayor of Stepney (Ald. J. D. Kiley, J.P.), in acknowledging the vote of thanks, said the trade section of the Chamber of Commerce, of which he was Chairman, had had before it the question of trade after the war. They came to the conclusion that more technical training and more up-to-date methods of manufacture were required, and to-day's ceremony showed that Bethnal Green was taking a step in the right direction by scrapping the old methods of obtaining light and power. In Stepney about 18-million units were supplied last year for power purposes, and there was not a building of any size unoccupied.

Coun. C. E. Fox, J.P., in moving a vote of thanks to Mr. Cole, said even if they lost on the electricity undertaking they would more than make it up by the extra rates they would receive through the present empty premises being let.

The company were subsequently entertained at tea by Mr. Cole.

THE AIR-GAP FIELD OF THE POLYPHASE INDUCTION MOTOR.

BY F. T. CHAPMAN, D.SC.

(*Concluded from page* 12.)

SUMMARY OF CONTENTS.

VI.—Conclusion and Table of Air-gap Dispersion Coefficients.

VI. Conclusion.*

33. We may summarise the results of the previous sections as follows :—

(1) The circle coefficient as defined in equation (53) may be expressed in the form $\sigma=(1+\lambda_1{}')(1+\lambda_2{}')(1+\lambda_1)(1+\lambda_2)-1$, or approximately $\sigma=\lambda_1{}'+\lambda_2{}'+\lambda_1+\lambda_2$, where the coefficients $\lambda_1{}'$ and $\lambda_2{}'$ take account of the air-gap dispersion in stator and rotor respectively, and λ_1 and λ_2 include the remaining dispersion.

(2) When the effects of saturation in the iron and of the reaction of the rotor currents may be neglected, the values of λ' are given rigorously by the simple expressions shown in equations 63, 64 and 65. Numerical values for these quantities are given in columns headed (A) in the tables below ; these are the maximum possible values which λ' may have.

(3) A squirrel-cage secondary winding, by damping the multiple fields which the primary winding tends to produce, decreases the coefficient of air-gap dispersion for that winding. Columns headed (B) in the tables below give values of λ' appropriate to this case, calculated on the basis of a squirrel-cage winding with 10·25 slots per pole. The values in these columns may be taken to represent the maximum reduction which the rotor reaction is likely to effect.

(4) Saturation of the magnetic circuit acts differently on the various teeth and causes the value of λ' to be reduced. This reduction, already marked at no load, probably increases appreciably when the motor is loaded beyond about normal

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* To render this concluding portion more clear, part of the section is reproduced from our last issue.

Table XI.—*Three-phase Windings.*

Slots per pole. q.	Slots per pole pe phase m.	Reduction in span. b.	Q.	K_{m_1}.	λ'. No saturation. Two- or three-phase rotors. (A)		λ'. With saturation. Two- or three-phase rotors. (C)	
					Two- or three-phase rotors. (A)	Squirrel-cage rotors. (B)	Two- or three-phase rotors. (C)	Squirrel-cage rotors. (D)
3	1	0	1·333	1·000	0·097	0·043	0·097	0·043
6	2	0	1·166	0·966	0·029	0·022	0·028	0·022
6	2	1	1·083	0·933	0·024	0·019	0·023	0·019
9	3	0	1·136	0·960	0·014	0·012	0·012	0·011
9	3	1	1·099	0·945	0·012	0·010	0·010	0·009
12	4	0	1·125	0·958	0·0089	0·0069	0·0076	0·0067
12	4	2	1·048	0·925	0·0073	0·0067	0·0065	0·0064
15	5	0	1·120	0·957	0·0065	0·0046	0·0056	0·0043
15	5	2	1·069	0·936	0·0043	0·0039	0·0039	0·0038
18	6	0	1·117	0·956	0·0052	0·0037	0·0046	0·0035
18	6	3	1·040	0·923	0·0029	0·0027	0·0026	0·0026
21	7	0	1·116	0·956	0·0043	0·0033	0·0040	0·0031
21	7	3	1·058	0·932	0·0023	0·0020	0·0020	0·0020
$\infty(\times 3)$	∞	0	1·111	0·955	0·0024	0·0007	0·0021	0·0007
$\infty(\times 3)$	∞	$\infty/2$	1·035	0·922	0·00026	0·0001	0·00023	0·0001

Table XII.—*Two-phase Windings.*

Slots per pole. q.	Slots per pole per phase. m.	Reduction in span. b.	Q.	K_{m_1}.	λ'. No saturation.		λ'. With saturation.	
					Two- or three-phase rotors. (A)	Squirrel-cage rotors. (B)	Two- or three-phase rotors. (C)	Squirrel-cage rotors. (D)
6	3	0	0·704	0·911	0·047	0·025	0·040	0·024
6	3	1	0·648	0·880	0·036	0·024	0·031	0·022
8	4	0	0·687	0·906	0·033	0·017	0·028	0·016
8	4	2	0·578	0·837	0·018	0·014	0·017	0·014
10	5	0	0·680	0·904	0·026	0·012	0·022	0·012
10	5	2	0·608	0·860	0·015	0·0096	0·014	0·0096
12	6	0	0·676	0·903	0·023	0·010	0·018	0·010
12	6	3	0·569	0·834	0·0096	0·0069	0·0094	0·0069

full load. The figures in column (C) below represent the minimum values to which saturation alone is likely to reduce the air-gap dispersion coefficient; they are based on the saturation curve shown in Fig. 11, the maximum value of the ampere-turns per half magnetic line being taken as 450.

(5) The figures in columns (D) have been obtained by considering the effect of the rotor currents on multiple fields already reduced by saturation, and these again represent minimum values.

The value of λ' to be employed in any given case lies between the figures of column (A) and that of the other columns (B), (C) or (D), which applies to the conditions of the design. It will be necessary for the designer to use his experience in choosing an intermediate figure.

(6) Nothing has been said with regard to the modification of λ' for a squirrel-cage winding, because the multiple fields of such a winding are not damped by currents in the stator, and as the fluxes in all the teeth are equal the effect of saturation is the same on all the multiple fields, and the coefficient λ' is unaffected.

(7) The no-load current can be calculated, without the aid of a complete saturation curve, by considering the condition of the magnetic circuit at points 60 deg. from the zero point of the first flux wave, as shown in section 30.

(8) A special group of multiple fields is set up by the triple frequency components of the flux wave, but the effects of these fields are practically confined to distorting the magnetising current.

(9) Limiting values of λ' for windings met with in ordinary practice are set out in Tables X. and XI.

Engineers who employ a circle coefficient defined in a manner different from equation 63 will be able to modify the data given above, and thus obtain figures suitable for their own case, without difficulty.

TECHNICAL EDUCATION FOR THE GERMAN CIVIL SERVICE.

The following translation of a letter from the Institution of German Engineers to the Chancellor of the German Empire is of interest, as showing the German attitude of mind regarding technical education for State officials. Our own Civil Service Commissions would do well to bear in mind the points here given :—

Berlin, June 13, 1916.

Your Excellency: The Committee of the Institution of German Engineers urges that steps should be taken by modification of the law in the confederated States, and particularly in Prussia, by removing the obstructions of the law of 1906 concerning eligibility for the higher posts in the Civil Service so as to make it possible that not only lawyers but also graduates of the technical high schools should be able to take up careers in the higher Civil Service.

Reasoned Argument.

Already before the war, after exhaustive discussions extending over many years, the demand has been expressed that candidates for the higher posts in the Civil Service should be given a scientific academic training, so as to enable them to have a full understanding of the conditions of public life upon which industrial questions and the requirements of trade and commerce exert a preponderating influence at the present day. The war has confronted the State with an unexpected number of new problems that have caused it to call into its service the intellect of the most diverse professions. This extension of admission to the higher careers in the Civil Service that has been introduced under the pressure of the circumstances of the time must be extended: the barriers that still exist in this respect must be removed, if it is to be possible to ensure the full development of the economic forces of the country after the war.

It has now become an imperative necessity that the demand that has been expressed for many uears by the Institution of German Engineers should be fulfilled, and that university graduates, particularly of the technical high schools, should be admitted to the higher grades of the Civil Service, so as to place the selection for this career on a broader basis.

Already 10 years ago, on the occasion of the discussions in the Prussian Diet on the Government proposals concerning the change of the course of study for law (1903) and later, after their rejection, in the discussions on the law concerning eligibility for careers in the higher Civil Service (1906), the Government admitted readily that the training of the higher Civil Service officials did not correspond with the requirements of the day. The removal of this defect was unsuccessfully attempted at that time by a proposed reform of the academic curriculum, and is supposed now to have been achieved by means of the law of 1906 by measures that only take effect subsequent to the adademic study. Later experience has shown that the method that has been adopted is hardly likely to be able to impart to the coming generation of State officials a special understanding of the economic processes that govern life in our days.

The training of the majority of higher grade officials in the Civil Service and Communal bodies that has become customary and has been determined by the law, consists in a secondary school education that has a particular bias towards the humanities, and a short university course which is almost exclusively composed of legal subjects.

The course of study laid down for the lawyers is at the same time and without change also the course of study for the officials of the Civil Service.

This rigid connection of professions, that must be admitted to be very different in their practice, is unique in the whole educational system of Germany. It constitutes an inherent contradiction, and has gradually become an insurmountable obstacle which will in all probability wreck the system that was to be built on the foundation of the law of 1906.

The system of training that has been described above has created the peculiar situation that all young people who have a leaning towards any one of the numerous branches of the Civil Service, whether by family tradition, ideals, or special capacity, are forced, even against their inclination for science, to devote themselves completely to a legal training in order to pass the first law examination, as this provides practically the first documentary evidence obtainable for admission to a Civil Service career in the Empire, the States, the "Communities," and many other posts. This route is closed to the graduates of other faculties, for instance, of all the experimental sciences, by the provisions of the above-mentioned Prussian law, and of similar laws in the other German States, as well as by the custom that is developing in consequence of this law of appointing lawyers for administrative work.

In consequence of the preponderating influence that technical questions and the requirements of industry have to-day on all branches of public life and the increasing participation of the provinces, "communities," and towns in technical and scientific enterprises, Civil servants are called upon to deal with problems, the expert solution of which calls for just the type of mental equipment that is provided by the technical high schools. The greater part of the education of these institutes is not based on retrospection and definition, but is directed forwards and designed with a view to productive activity. An education among such surroundings must give at least as good a training for a Civil Service career as an education, the principal aim of which is to classify the particular requirements of life according to legal conceptions. The knowledge of law and administration that is required by Civil Servants can be acquired to-day in every technical high school.

A large number of eminent men have been produced by a training in science, industry and economics. These men with broad views and organising capacity have been in the past, and are still at the present moment, successful leaders in private industrial enterprises. The forcible exclusion of the intellect that is available amongst these circles from participation in the higher Civil Service constitutes a waste of the intellectual powers of our nation. The monopoly that has been wrongly accorded to the legal course of study must be removed and admission to a career in the higher Civil Service must be made free to graduates of the technical high schools.

(Signed) THE COMMITTEE OF THE "INSTITUTION OF GERMAN ENGINEERS"
Directors { RIEPPEL and TAAKS.
D. MEYER and G. LINDE.

THE EFFECTIVENESS OF THE GROUND ANTENNA IN LONG-DISTANCE RECEPTION.*

BY R. B. WOOLVERTON.

Summary.—Using an antenna several hundred metres long stretched on the ground, signals of an audibility up to more than 100 are received from sustained wave stations 4,000 km. away. Atmospheric disturbances are found by the experimenter to be less troublesome relatively than when using a normal antenna. A further series of development experiments are outlined and will be undertaken.

The subject of this Paper was suggested in October, 1914, when resonance curves were being taken by the writer at Eccles, Cal., on waves emitted by the various high-powered commercial stations situated in the vicinity of San Francisco, at a distance of approximately 100 miles. The antenna used in taking these resonance curves consisted of the top wire of a 5 ft. fence extending in a northwesterly direction for a distance of approximately 4,000 ft. Although the antenna so used was quite aperiodic, as might be expected, the received energy in the secondary circuit was remarkably large, signals being heard from stations in the Hawaiian Islands and Alaska. By using the ordinary crystal detector, full scale deflection was obtained on a Leeds & Northrup portable galvanometer when taking resonance curve data on the wave emitted by the high-powered Marconi station at Bolinas, Cal.

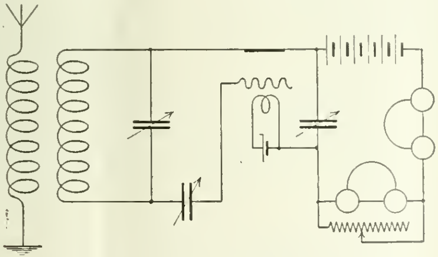

FIG. 1.—DIAGRAM OF CONNECTIONS.

In view of the results obtained at Eccles, the writer conducted on October 9 and 10, 1915, experiments of a somewhat more quantitative character at the Palmer B. Hewlett ranch, situated 90 miles south by east of San Francisco. The receiving apparatus was of the De Forest "ultraudion" type (oscillating audion), using a second step amplifier audion bulb, and the audibilities were read on a "Wireless Specialty" audibility meter. The connections are shown in detail in Fig. 1.

It will be noted that two pairs of telephone receivers are connected in series, thus reducing the audibilities nearly 50 per cent., but it was found that the audion circuit would not oscillate when but one pair of receivers was used, with the audibility meter shunted about it.

Before beginning the experiments, it was thought that a comparatively long single wire antenna would be so directional in effect that it was decided to confine the readings to one particular station; and Sayville, Long Island, was chosen, the antenna being made as nearly directional toward that station as possible. Buildings slightly interfered with this plan, however, and the antenna's true direction from the receiving apparatus was west-south-west, instead of more nearly west. As soon as readings were begun, it became apparent that this directional effect did not exist, as will readily be seen from the Honolulu audibilities in the following "Audibility Table," and the "Direction and Range Chart," Fig. 2. The two antennæ consisted of 500 ft. (160 metres) and 1,000 ft. (320 metres) lengths respectively of a single No. 28 B. & S. cotton covered magnet wire, laid on dry earth without support at any point. The audibilities for the four transmitting stations are shown in Fig. 2.

Table of Audibilities.

Antenna.	Sayville.	Honolulu.	Arlington-Arc.	Arlington-Spark.
500 feet ...	50	100	60	100
1000 feet ...	80	160	80	160

Fig. 2 shows the direction of the antenna with respect to the stations received from, with the distances of the stations plotted to scale; and it immediately suggests experiments to determine the most effective design of a ground antenna. These experiments will shortly be undertaken by the writer, using various lengths, heights from the earth, and high potential ends both open and earthed. In view of the comparatively high ohmic resistance of the antenna wire used in the above tests, the use of a larger wire should give considerably greater audibilities. If such should be the case, and sufficiently high audibilities are obtained for daylight reception, it would seem that the ground antenna may be the solution of the serious problem of eliminating atmospheric interference, not to mention the difference in cost of the construction and maintenance of such an antenna, as compared with that of the present type.

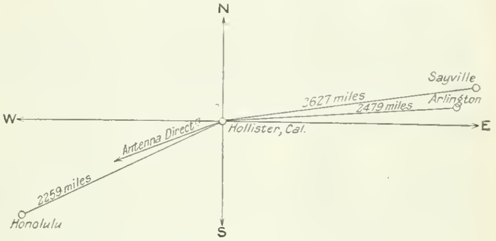

FIG. 2.—DIRECTION AND RANGE CHART.

Experiments with Electric Heating.—An installation of electric heating should preferably operate to a great extent as an "off-peak" load. Systems permitting some heat storage are therefore most promising. In the "Electrical World" J. D. Ross describes some experiments with electric heaters adapted to hot water, steam and other systems, or in combination with them. In this way a greater storage can be secured; also by using coal as an auxiliary during the coldest days only it is possible to work with smaller capacity electric heater, and thus secure a lower rate per unit. Various methods of applying electric heating to water radiators are described. On alternating supply, coils have been wound direct round a section of the pipe, which acts as short-circuited secondary, becoming heated by the hysteresis and eddy currents; but the power factor was low, and objection was taken to the humming noise, which seems to be inseparable from induction heaters. Eventually a resistance type of heater was substituted. Electric heating has been applied to oil-filled radiators. The results resemble those obtained with water heaters, but the storage capacity is less. A hot water system with ample storage tanks, combined with a small centrifugal circulating pump, enables an even temperature to be maintained throughout the house after the electric current is cut off. In these circumstances the load can be taken during the off-peak period. However, as the heating of a house commonly requires about 10 times the power required for the lighting of it, it would require electric heating in about one house in 10 only in order to balance adequately the lighting load. The author calculates that with electricity at ½d. per unit the cost is still 2½ times that of heating by coal (taken at £6 per ton).

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[*] Paper read before the Institute of Radio Engineers, New York, slightly abbreviated.

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STANDARDISATION.

In a Paper read before the Engineering Section of the British Association Mr. C. LE MAISTRE, the secretary of the Engineering Standards Committee, reminds us that although it is scarcely necessary nowadays to insist on the paramount importance of standardisation in relation to economic production, this was not so clearly seen before the advent of the British Engineering Standards Committee, to the founders of which great credit is due. Nearly 16 years ago the Council of the Institution of Civil Engineers appointed a Committee to consider the advisability of standardising iron and steel sections. At the first meeting of this Committee, held in February, 1901, it was decided to recommend that the Councils of the Institutions of Mechanical Engineers and Naval Architects and of the Iron and Steel Institute be invited to nominate members on the Committee. Twelve months later at the suggestion of the late Sir WILLIAM PREECE, K.C.B., the reference to the Committee was enlarged to include the standardisation of electrical plant, and it was decided to invite the Institution of Electrical Engineers to co-operate with the other Institutions in the support of the Committee. During the past 15 years the movement has made substantial progress, and as a result, we are convinced, of the care taken in enlisting the assistance of representatives of all the interests concerned, the work of the Committee has attained a considerable amount of success.

At the British Association meeting emphasis was rightly laid on the large amount of engineering work carried out in accordance with the standard specifications issued by the Committee, as this is, after all, the justification both of its methods and of its existence. Some of the figures are of a striking character. For instance, those relating to Portland cement show that no less than 95 per cent. of the cement made in this country is to British standard. Again, the number of sections of tramway rails in general use has been reduced from 70 to 5, and the percentage of British standard tramway rails to the total tonnage rolled during the year ended March, 1915, was 75 per cent. These are typical results, and they point clearly to the benefits which the public at large must be reaping from the work of the Committee. We say public advisedly, because as long as there is competition among manufacturers, the public get the benefit of all the improvements.

There has not yet been sufficient time for the results of the work of the re-organised Electrical Sectional Committee to become as widely known and adopted as in the cases cited above. Nevertheless, the issue of the Standardisation Rules for Electrical Machinery, the Specifications for Electricity Meters, Ceiling Roses, Wall Plugs and Electric Vehicle Charging Plugs show clearly that this section is getting into its stride, and there can be little doubt that, as the various interests concerned get familiar with the idea of co-operation and its imperative demand for give and take between apparently diverse interests, its work will prove of increasing value.

There is, however, one point to which we have on previous occasions directed attention, the importance of which is not diminishing. The valuable work of the Committee can only become known through its Reports, and these, in our opinion, are issued at prohibitive prices. For example, the Standardisation Rules for Electrical Machinery, a work of the greatest importance to all electrical engineers and to purchasers of electrical machinery in particular, is issued at 10s. 6d. per copy! Contrast this with the handy-sized volume of the corresponding rules issued free of cost to their members by the American Institute of Electrical Engineers, and obtainable by those who are not members at 1s. per copy.

The importance of the work here is clearly recognised by both manufacturers and purchasers, who give the services of their ablest men freely, as well as, we believe, substantial financial support. Their work is of national importance, yet from the last Annual Report issued by the Committee, it appears that the Government grant is no more than £500. In all likelihood a sum greatly in excess of the total grant has been saved by the State on a single war contract by working to the Committee's specifications. An organisation doing a public work of such importance naturally requires considerable funds to enable it to carry out its work on a high level of efficiency, and the smallness of the Government Grant perhaps excuses or, rather, accounts for, the high prices hitherto charged for the Reports. But in order that our people may get the full benefit from the work of its ablest engineers, the specifications and reports should be issued in such a form and at such a price as to ensure a world-wide distribution.

In some respects we think it would be preferable before issuing any Reports to give the whole of the members of the engineering institutions concerned an opportunity of discussing them. Under existing conditions, although the engineering institutions are represented on the Engineering Standards Committee, it by no means follows that the views of their representatives will be acceptable to their members. Take, for example, the Standardisation Rules for Electrical Machinery. It surely would be better first to discuss the rules drafted by the Sectional Committee of the Engineering Standards Committee at ordinary meetings of the Institution of Electrical Engineers and other electrical associations before attempting to put the rules into their final form. Had we to be asked to draft standardisation rules for, say, welded chains we should endeavour in the first place to get the several societies representing the makers and users of such chains to do the bulk of the work for themselves, and then bring the several sets of recommendations into line by appointing a committee representing the whole of the parties concerned.

From a single Committee, consisting originally of seven members, has grown the present far-reaching organisation with its 61 committees and sub-committees, as well as numerous panels, including over 500 members. Hitherto the work of the Committee has been confined to questions dealing with materials. We look forward to the time when its activities will be vastly increased, not only as regards material, but also as regards *personnel*. Such questions as standardising methods of production, and hours and conditions of employment in various trades, as well as many other questions which affect the relations between capital and labour are matters for an enlarged Committee to tackle. We doubt not that in this equally important work the Committee would be at least as successful as it has been in the past.

THE INTERCONNECTION OF LANCASHIRE AND CHESHIRE ELECTRICITY SUPPLY SYSTEMS.

INTERIM REPORT OF THE COMMITTEE.*

The following report does not profess to deal with questions of general policy, nor does it advocate any comprehensive scheme of centralisation. Its object is rather to indicate the means which can be adopted at once for utilising existing facilities to the fullest extent, so as to meet the present abnormal conditions, and to prepare for the situation which will arise after the war.

To cope with the conditions arising out of the war (*e.g.*, restrictions on capital expenditure, high cost of fuel and greater use of electric power) the Committee have drawn up a scheme for the interconnection of existing electrical undertakings in certain districts in Lancashire and Cheshire, as a result of which it is believed that the following immediate benefits will be derived :—

(*a*) The supply from existing stations could be greatly increased.

NOTE.—It is estimated that if the generating systems in the areas under review were interconnected the aggregate maximum demand on the whole system could, under normal working conditions, be increased by 30 per cent.

(*b*) The risk of interruption to supply would be materially diminished.

(*c*) By making the fullest use of the efficient plant on each system, and only running the less efficient plant at times of heavy demand, a considerable saving could be effected in fuel, and to a lesser degree in wages, repairs and other items of expenditure.

(*d*) A number of the generating stations in each district could be shut down at week-ends and at times of light load.

(*e*) The interconnection of electrical undertakings by reducing the amount of standby plant would greatly conduce to economy of capital expenditure in future.

The Institution of Electrical Engineers had under consideration during the early part of this year "The Present Position of Electricity Supply in the United Kingdom." In the discussion on this subject at Manchester, on April 18, 1916, a suggestion was made that a scheme for interconnecting some of the principal supply undertakings in Lancashire and Cheshire was feasible, and would lead to very beneficial results. At the instance of the Association of Municipal Electrical Engineers of Lancashire and Cheshire, a meeting was held in Manchester on May 9, 1916, which was attended by the engineers of the majority of electricity supply undertakings (municipal and company), together with representatives of the railway companies interested in the scheme. At this meeting the following committee was appointed to consider and report on a scheme for interconnecting the various supply undertakings, or such undertakings as could be shown to be practicable from an engineering point of view, as well as being commercially feasible :—

Mr. S. L. PEARCE	Manchester (*chairman*).
Mr. B. WELBOURN	Prescot (*vice-chairman*).
Mr. J. A. ROBERTSON	Salford (*hon. secretary*).
Mr. J. A. F. ASPINALL	Lancashire & Yorkshire Railway.
Mr. C. C. ATCHISON	Rochdale.
Mr. R. BLACKMORE	Stalybridge.
Mr. S. E. BRITTON	Chester.
Mr. H. DICKINSON	Liverpool.
Mr. E. H. EDWARDES	South Lancashire tramways.
Mr. J. PURRETT	Lancashire Electric Power Co.
Mr. S. J. WATSON..................	Bury.
Mr. P. P. WHEELWRIGHT	Blackburn.

On May 25, 1916, the Board of Trade issued a circular letter to all the electrical supply authorities throughout the United Kingdom calling attention to the desirability of interconnection of undertaknigs. This letter emphasised and gave added point to the movement which had been started in Lancashire a few weeks prior to the issue of the Board's letter.

The Committee held their first meeting on May 16, 1916, and decided to consider the problem in the first place from its engineering aspect. For the purpose of the scheme the undertakings in the area were divided into six groups, namely :—

GROUP A.

Altrincham Electric Supply Co.
Eccles Corporation.
Lancashire & Yorkshire Railway.
Middleton Corporation.
Manchester Corporation.
Salford Corporation.
Sale Urban District Council.
Stretford Urban District Council.
Stockport Corporation.
Trafford Power & Light Supply (Ltd.)

GROUP B.

Bolton Corporation.
Bury Corporation.
Heywood Urban District Council.
Lancashire Electric Power Co. (Radcliffe).
Leigh Corporation.
Radcliffe Urban District Council.
Rochdale Corporation.
South Lancashire Tramways Co. (Atherton).
Wigan Corporation.

GROUP C.

Ashton-under-Lyne Corporation.
Glossop Supply Co.
Oldham Corporation.
Stalybridge, Hyde, &c. (Joint Board)

GROUP D.

Accrington Corporation
Blackburn Corporation.
Burnley Corporation.
Colne Corporation.
Darwen Corporation
Nelson Corporation.
Preston Corporation Tramways.
Preston Electric Light Co.
Rawtenstall Corporation.

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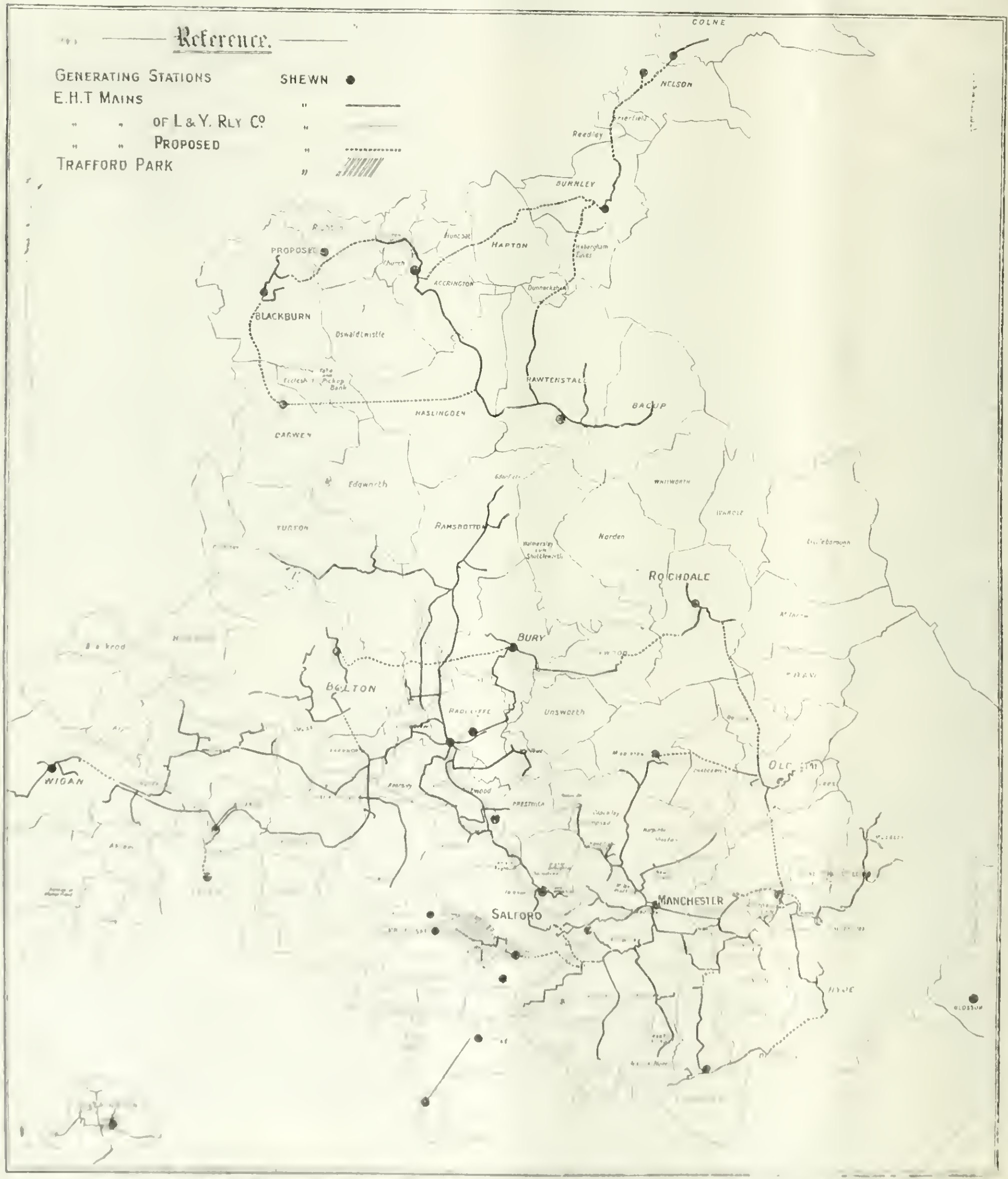
* Abstract.

GROUP E.

Birkdale & District Electric Supply Co.
Birkenhead Corporation.
Bootle Corporation.
Hoylake & West Kirby U.D.C.
L. & Y. Railway (Formby).
Liverpool Corporation.
Liverpool & District Co.
Liverpool Overhead Railway Co.
Mersey Railway Co.
Mersey Power Company (Runcorn).
Ormskirk (Company).
Prescot & District Lighting Co.
St. Helens Corporation.
Southport Corporation.
Wallasey Corporation.
Warrington Corporation.



Interconnection of Electricity Supply Systems. E.H.T. Mains Laid and Proposed in Groups 1, 2, 3, and 4.

GROUP F.

Alderley & Wilmslow Electric Supply Co. (Ltd.)
Crewe Corporation.
Chester Corporation.
Macclesfield Electricity Co. (Ltd.)
Northwich Electric Supply Co.

A technical survey of these undertakings has been made, and the tabulated results obtained (with four exceptions) are shown in an appendix to the report. The map also hereto attached shows the position of the generating stations and the extent to which extra-high-pressure mains have already been laid in the area of supply under consideration.

At an early stage in their proceedings the Committee came to the conclusion that no useful purpose would be served by the inclusion of the five undertakings of Group F, and consequently these have been dropped out of the scheme.

A reference to the map will show that extra-high-pressure mains have been laid to a much greater extent in the districts included in Groups A, B and C than in the others, and that a scheme for interconnecting the undertakings within these groups could be carried out at a comparatively small cost and with little delay. The majority of the undertakings included in Group D can also be conveniently linked up with each other, but the interconnecting of the Group with Groups A, B and C is not provided for at present. The district within which the undertakings included in Group E are situated is a very wide one, and to interconnec all these undertakings at the present time would entail a capital expenditure out of proportion to the realisable savings. This does not, however, rule out the possibility of adjacent undertakings in this district linking up by mutual agreement.

The Committee, after careful consideration, therefore, have decided for the present, and for the purpose of this interim report, to confine their proposals to the four groups A, B, C and D, comprising 32 undertakings. In Group A, the cost of linking up Sale and Altrincham with the other undertakings in the group could not be justified at present, and this also applies to the two Preston undertakings in Group D. There remain, therefore, 28 undertakings, which include the Lancashire & Yorkshire Railway Co.'s 25 cycle system and the undertaking of the Borough of Eccles. The Committee make no proposals for dealing with these two undertakings in this report, the first named on the ground of expenditure involved, and the last named on account of the necessary information being withheld. Of the remaining 26 undertakings the majority are operating on the three-phase alternating current supply system, with 6,600 volts as the pressure of generation and transmission, and 50 periods as the frequency of the system. Appendix 6 (not reproduced) shows *inter alia* the generating stations which conform to these standards.

The estimates in Appendix 3 are based on the abnormal prices now ruling for materials, and, with one or two exceptions, allow a section of not less than 0·15 sq. in. of copper on all new mains, and sufficient capacity of transforming plant to enable any undertaking to receive not less than 3,000 kw. from the adjacent undertakings with which it is connected.

The Committee, after careful consideration, have come to the conclusion that if the undertakings in Groups A, B, C and D are interconnected as indicated in Clause 12 the average coal consumption per unit generated—viz., 3·24 lb., as shown in Appendix 5—could be reduced by not less than 0·5 lb. of coal per unit.

With coal at 17s. 6d. per ton, this reduction represents an annual saving on the present output of the undertakings of about £82,000.

Having arrived at these preliminary conclusions, the Committee considered it desirable to ascertain more definitely the views of the Government Departments concerned on this question, and particularly the steps which should be taken to give effect to the desires of the Board of Trade, as set forth in their circular letter of May 25, 1916. Accordingly a communication was sent to the Board of Trade suggesting an interview. A reply was received from the Board of Trade intimating that they would be pleased to receive representatives from the Committee. A deputation consisting of Mr. Pearce, Mr. Purrett, Mr. Welbourn, Mr. Robertson, Mr. Watson and Mr. Wheelwright accordingly attended at the Board of Trade offices on July 13th, and were received by representatives of the Board of Trade, the Local Government Board and the Treasury.

In view of the importance of this interview, the Committee consider it desirable to set forth at some length an account of the proceedings.

The deputation in the first place fully explained the steps they had taken, as set out earlier in this report, and expressed their desire to receive the guidance or to ascertain the attitude of the Government Departments concerned, so that the Committee might be better able to report on this subject to their respective councils or boards.

The view was advanced that as the whole scheme was part of a national effort to effect economies, and as the return on the outlay involved was so substantial, the Government might favourably consider the question of providing the necessary capital to effect the interconnection proposals on such terms as would prove a strong inducement to the several parties interested to proceed with the scheme.

Mr. Marwood, of the Board of Trade, replied that there was no hope of this being done, but a representative from the Treasury stated he was authorised to say that the Treasury would favourably consider the expenditure of moneys required for the scheme, provided the Local Government Board and the Board of Trade were satisfied with the proposals which might hereafter be submitted to them.

With regard to the coal saving, a representative of the Board of Trade pointed out that, viewed from the national standpoint, the annual saving to the country would be substantially greater than the sum of £82,000 estimated by the Committee, as the present day export value of coal was 45s. to 50s. per ton.

Considerable discussion ensued with regard to the procedure which would be necessary to give effect to the Committee's proposals.

The deputation, while being of opinion that much could be done by voluntary co-operation amongst the various authorities, favoured the appointment of a joint committee or joint board representative of the whole of the supply undertakings, as such a body would be in a better position to give effect to a properly co-ordinated system of electrical supplies than could be attained by voluntary effort on the part of the several undertakings only. The representative of the Government Departments replied that it was extremely difficult, if not altogether impossible, to set up statutory joint boards on which power companies, railway companies and local authorities should be represented. Under section 8 of the 1909 Act, the Board of Trade had power by Provisional Order to set up joint boards or joint committees of local authorities, and the representatives of the Government inquired if the power companies were essential to the scheme. The deputation replied that the power companies were considered to be an essential factor to the scheme, and that it was very desirable in the national interest that some working scheme should be evolved that would include the whole of the supply authorities, and not simply one section only.

The deputation considered that powers should be given to a joint committee or joint board, with a view to co-ordinating the electrical supplies in the various districts on the following lines :—

(*a*) To raise capital from time to time for the provision of linking up mains, transformers and such other works as may be required for interconnecting purposes, and to allocate all expenditure on the joint scheme on an equitable basis between the undertakings participating in the joint scheme.

(*b*) To adjust the running hours of the existing generating stations in such a way that the maximum fuel saving might be effected. This would entail the shutting down of certain stations during the night or week-ends, or at times of light load, the supply being furnished by the stations possessing the more economical plant.

(*c*) To lay down general rules for determining the charges to be made for :—

1. Reciprocal supplies.
2. Stand-by supplies.
3. Bulk supplies.

(*d*) To act in an advisory capacity in regard to future extensions of plant—that is to say, to recommend where such extensions could be carried out to the greatest advantage.

(*e*) To appoint from time to time such officials as may be necessary to act in an advisory capacity to the board, and to carry out the instructions of the board under powers which may hereafter be conferred by the Government.

The representatives of the Government Departments recognised that some measure of control should be vested in such a joint committee if the best results were to be obtained from the scheme.

A representative from the Treasury stated that they would not sanction the expenditure of monies unless they were assured that substantial economies were to be realised both in money and in labour.

As a result of this interview, the Committee considered the difficulties incidental to the setting up of a statutory board comprising companies and local authorities, which would require fresh legislation, and in order to save the loss of any further time they are of opinion that it is desirable to proceed under section 8 of the 1909 Act, by means of which joint boards or joint committees representative of the local authorities may be constituted. The Committee further consider that this joint committee should be empowered to enter into working arrangements with the power companies, including the use of the company's existing mains, and with regard to the laying of mains in the areas of the companies.

The Committee also recommend that a conference of all local supply authorities interested in the scheme should be held, with a view to developing the proposals set forth in this report.

SUMMARY OF THE COMMITTEE'S RECOMMENDATIONS.

As a result of their investigation the Committee are satisfied that very substantial economies can be effected by the interconnection of the various electrical undertakings comprised in Groups A, B, C and D.

(*a*) In order to bring the scheme before the local authorities and others concerned, the Committee recommend that a conference should be held at an early date of all the statutory supply authorities included in Groups A, B, C and D. Such conference to be presided over by a Government official.

(*b*) That, subject to general approval being given to the scheme by the authorities concerned, an application should be made to the Board of Trade to set up a joint committe or board under section 8 of the Electric Lighting Act, 1909, with general powers on the lines recommended in the report (page 12), and with the addition of further powers, if required, to enable agreements to be entered into with the power companies whose inclusion in the scheme is regarded as essential.

(*c*) That pending the appointment of such a joint committee or board, undertakings favourably situated may enter into voluntary arrangements for joint working. Provided that where existing works or works to be laid down for the purpose of interconnecting are suitable and sufficient to form part of the whole co-ordinated scheme at a later date, the capital expenditure on such works, or the annual charges on same, shall be recoverable from the joint committee or board.

(*d*) In order to ensure that any local scheme for interconnecting shall be carried out in such a way as to conform with the requirements of the scheme as a whole, the Committee recommend that if the proposals contained in this report are adopted, the local authorities interested should temporarily appoint a joint committee, to whom all proposals for the provision of mains or other interconnecting works shall be submitted for approval or otherwise before such works are commenced.

Signed on behalf of the Committee,

S. L. PEARCE, *Chairman.*
J. A. ROBERTSON, *Hon. Secretary.*

APPENDIX 1.

CAPITAL EXPENDITURE AND PLANT CAPACITY.

Supply Authority.	Capital expenditure at Mar. 31, 1916.	Plant capacity.	
		Generating plant.	Boiler plant
GROUP A.		Kw.	Kw.
*Eccles Corporation	...	...	.
†Lancashire & Yorkshire Railway ...	...	..	...
Manchester Corporation	£3,112,406	93,000	90,000
Middleton Corporation	50,900	1,068	1,200
Salford Corporation	735,394	18,000	14,700
Stretford Corporation	112,245	4,500	2,380
Stockport Corporation	200,000	10,000	9,000
Trafford Power & Light Supply, Ltd.	172,803	8,400	6,000
Totals	£4,383,748	131,968	123,680

* Information withheld. † Complete year's working not available.

Supply Authority.	Capital expenditure at Mar. 31, 1916.	Plant Capacity. Generating Plant.	Plant Capacity. Boiler Plant.
Group B.		Kw.	Kw.
Bolton Corporation	£569,389	14,600	12,800
Bury Corporation	203,356	8,700	6,000
Heywood Corporation	82,760	900	900
Lancashire Electric Power Co.	580,000	15,200	16,000
Leigh Corporation	70,000	2,700	3,300
Radcliffe District Council	56,333	840	900
[illegible] Corporation	227,673	11,476	11,000
South Lancashire Tramways	153,962	6,400	5,000
Wigan Corporation	208,742	4,820	3,000
Totals	£2,112,015	65,636	58,900
Group C.			
Ashton Corporation	£140,000	4,700	3,500
[illegible] Corporation	52,729	425	530
Oldham Corporation	383,813	9,900	9,000
Stalybridge Joint Board	319,186	18,000	10,500
Totals	£895,728	33,085	23,530
Group D.			
Accrington Corporation	£164,201	6,868	6,000
Blackburn Corporation	329,073	8,000	5,000
Burnley Corporation	167,038	6,000	4,250
Colne Corporation	55,838	1,150	1,000
Darwen Corporation	82,129	1,900	1,400
Nelson Corporation	81,385	1,000	950
Rawtenstall Corporation	74,333	5,331	4,000
Totals	£954,097	30,229	22,000

APPENDIX 2.

Units Generated and Coal Consumption.

Supply Authority.	Units generated 1915-16.	Coal consumed 1915-16.	Lbs. of coal per unit generated.
Group A.		Tons.	
*Leeds Corporation	...	...	...
*Lancashire & Yorkshire Railway			
[illegible]	181,722,835	226,167	Varies from 2.79 lb. to 5.42 lb. per unit
[illegible]	1,727,791	3,700	
[illegible]	29,117,290	13,970	
[illegible]	2,671,000	6,705	
[illegible]	17,767,000	23,000	
[illegible]	11,718,211	18,190	
Totals	[illegible]	[illegible]	Av. 2.95
Group B.			
[illegible]	[illegible]	[illegible]	Varies from [illegible] lb. to [illegible] lb. per unit
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
Totals	[illegible]	[illegible]	[illegible]
Group C.			
[illegible]	[illegible]	[illegible]	Varies from [illegible] lb. to [illegible] lb. per unit
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
Totals	[illegible]	[illegible]	[illegible]
Group D.			
[illegible]	[illegible]	[illegible]	Varies from [illegible] lb. to [illegible] lb. per unit
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
Totals	[illegible]	[illegible]	[illegible]

* [illegible]

† [illegible]

APPENDIX 3.

Estimated Expenditure.

1. Estimate of cost to interconnect existing systems in Group A	£58,839
2. Estimate of cost to interconnect existing systems in Group B	31,375
3. Estimate of cost to interconnect existing systems in Group C	23,900
4. Estimate of cost to interconnect Group A with Group B and Group C	83,783
5. Estimate of cost to interconnect existing systems in Group D	83,500
Total	£281,397

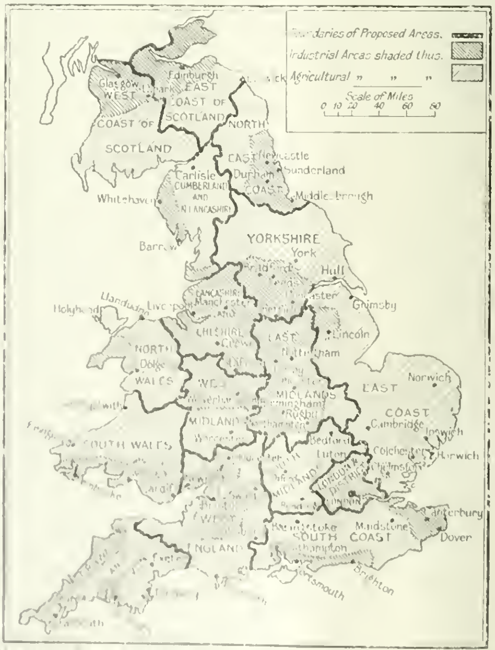
Further information is given in three other appendices.

NATIONAL ELECTRIC POWER SUPPLY JOINT COMMITTEE.

The following memorandum has been issued by this Committee, which has been formed jointly by the Incorporated Municipal Electrical Association and by the Incorporated Association of Electric Power Companies. It has been sent out to the various town clerks and engineers of municipal supply undertakings and to the secretaries and engineers of company supply undertakings, with a covering letter stating that the engineer of one of the undertakings in each of the areas into which the country has been divided has been asked to act as convener for the area, and that he will invite the engineers to attend a general meeting to appoint a local committee. It is proposed to form these local committees for the purpose of considering the problems presented in their respective areas, and to report their views to the Joint Committee, in order that any recommendations put forward in one area may be co-ordinated with those of other areas. Such problems include:—

(i.) The consideration of the areas shown on the accompanying map with a view to their better division if considered desirable.

(ii.) The best method of inter-linking the existing generating stations with a view to their more economical operation, and to the better security of the supply.



National Electric Supply: Suggested Subdivision into Areas for each of which a Local Committee [illegible] Information.

(iii.) The best means of providing the capital required for the plant and mains that are necessary, and for the equitable allocation of the same.

(iv.) The best methods of payment between undertakings for any current supplied or interchanged.

(v.) Any special local arrangements that are considered desirable.

The memorandum is as follows :—

In view of the importance to the electric supply industry of the Board of Trade circular letter dated May 25, 1916, addressed to all the public electric supply authorities regarding the interconnecting of electric supply stations, a Joint Committee has been appointed by the Incorporated Municipal Electrical Association and the Incorporated Association of Electric Power Companies to consider the question of linking up in all its aspects.

The brief explanatory note attached hereto gives shortly the present position of the public supply of electricity, and may help to elucidate the problem of how to bring about improved results in the future so as to utilise existing plant and mains to the best advantage.

The importance of linking up several large stations, and equally of linking up large stations with small ones, where such linking up can be carried out without undue capital expenditure, is now becoming more generally realised.

The Joint Committee has arrived at the following conclusions with regard to the suggestion contained in the Board of Trade letter :—

1. That linking up is important for the purposes of saving fuel, saving labour and increasing the security of supply, and in the future making for economy of capital.

2. That the question of linking up should be considered broadly from the national point of view, and having in mind not only the saving of fuel but the interests of consumers in obtaining a cheap supply of electricity for all purposes.

3. That while the generation of electricity as distinct from its distribution must be considered broadly and irrespective of the present areas of electricity supply undertakings, clearly all existing rights must be respected and existing areas must not be interfered with as regards distribution.

4. That the linking up of many existing stations could be carried out immediately without further legislation.

5. That in order to arrive at a better understanding of the problem, committees of engineers representative of local electricity supply interests should be appointed in various parts of the country.

To facilitate the formation and work of the local committees the accompanying map has been prepared, showing a provisional subdivision of the country into areas; but if local circumstances (known better to the engineers) in any area make it desirable to alter the definition of these areas, it is of course open to them to suggest any such alteration.

A local committee has already commenced work in the Lancashire area, and the attached schedule shows the information that that committee decided to obtain.

If the local committees will communicate from time to time to the Joint Committee the results of their labours, the experience gained by each local committee can be made available for the use of all, and the Joint Committee is prepared to assist in every possible way.

In Appendix "A" are given two examples showing advantages which in practice have been realised by linking up, and in Appendix "B" a diagram and description illustrating an arrangement likely to be found applicable to many actual cases.

J. H. Bowden.
W. A. Chamen (*Chairman*).
R. A. Chattock.
J. S. Highfield.
W. W. Lackie.
Charles H. Merz
S. L. Pearce.
Thos. Roles.
D. A. Starr.
W. B. Woodhouse.

Hon. Secretaries.

H. Faraday Proctor,
The Exchange,
Bristol.

A. de Turckheim,
Caxton House,
Westminster, S.W.

September, 1916.

The memorandum is followed by an explanatory historical note, the schedule above mentioned and two appendices on the effect of linking up. In the first of these the following examples are given :—

Actual Results of Linking Up.

I.—*Two power stations, each carrying about* 7,000 *kw. of load were linked up at a cost of* £3,000, *the link having a capacity of* 3,000 *kw. to* 4,000 *kw.*

The following advantages were shown :—

By shutting down one station each night (12 midnight to 6 a.m.) and week-ends (from noon Saturday to 6 a.m. Monday)—

1. The plant load factor at each station has been increased from 67 to 72 per cent.

2. The total saving of coal per annum in both stations has been 2,000 tons, and it is anticipated that this saving will be increased to 3,000 tons.

II.—*A power station having a maximum load of* 2,000 *kw. was linked up with another power station having a maximum load of* 15,000 *kw.*

The following was the economy in coal consumption :—

1. During the second year of working "linked up" the coal consumption of the smaller station was reduced by 2¼ lb. of coal per unit on all units generated by that station.

2. The combined saving of coal due to interchange of current in the second year of working amounted to 5,500 tons.

In addition to the saving of coal, linking up has resulted in the following further advantages :—

1. Greater security of supply.
2. Reduction in the number of shifts run and wages paid.
3. Reduced maintenance charges due to fewer plant hours run.
4. Facility for carrying out repairs when stations are shut down.
5. A saving in future capital expenditure owing to reduced amount of stand-by plant and the use of larger generating sets.

Linking-up Proposal.

A power station (A) *having a maximum load of* 3,000 *kw. links up with another power station* (B) *having a maximum load of* 20,000 *kw.*

(A) runs for eight hours (one shift) a day only (and possibly not at all on Sundays), (B) taking the load during the remaining 16 hours. During the eight hours when (A) is running, which would include (A's) peak load, (B) would transfer to (A) sufficient load to keep (A) at a uniform load of 2,800 kw. except at the hours when (A's) own load is 2,800 kw. and over. Such a division of load would result in maintaining (A's) output at 5½ million units while increasing his plant load factor threefold, (B's) load factor remaining unaltered, while the units delivered from (A) to (B) during the eight hours when (A) is running would be returned by (B) to (A) during the remaining 16 hours.

Advantages.—(1) *Fuel Saved;* because (A's) load is always sufficient to enable all machines running to be run at most economical load, and (B) gets a better load during the slack hours. A saving of 1 lb. of coal per unit on 5½ million units is equivalent to 2,500 tons per annum, or at present prices say £1,500 to £3,000, depending upon the locality.

(2) *Wages Saved;* because (A) works one shift instead of three, thereby saving more than half his wages bill and reducing his maintenance charges (because of fewer plant hours).

It will be seen that such arrangement would not only result in a saving to the nation of 2,500 tons of coal per annum, but a saving to the two electric supply undertakings of, say, £3,000 per annum, including wages, &c., which would give a return of 10 per cent. even if it cost £30,000 to connect up.

CORRESPONDENCE.

CONCENTRIC-FIELD WATT-METERS.

TO THE EDITORS OF THE ELECTRICIAN.

In an article in your issue for September 15th, Dr. Drysdale refers to a concentric-field watt-meter at the Bureau of Standards at Washington. The present writer wishes to draw attention to the fact that he has been working for some time on a heavy current concentric-field watt-meter, the general design of which is set forth in the patent specification No. 16,095/1911. Many difficulties have had to be overcome in perfecting the design, and other causes, including the war, have contributed to the delay in the production of commercial instruments. An instrument which has been in use for some time at the Manchester School of Technology has given very satisfactory results with currents of upwards of 1,500 amperes. A description of the difficulties to be overcome, and the construction of the various models with which the writer experimented before satisfactory results were obtained, is in preparation, and is intended for early publication. Messrs. Kelvin, Bottomley & Baird (Ltd.) have recently taken up the manufacture of the instruments, and are constructing watt-meters of the deflectional and torsion-head types, and also watt balances on the concentric system.

Manchester, Oct. 3. A. E. Moore.

THE CITY GUILDS' WORKS OF REFERENCE.

TO THE EDITORS OF THE ELECTRICIAN.

Any modification of the peculiar lists of works of reference in the City Guilds' "Programme," referred to by Messrs. Landberg in their letter a fortnight ago, appears (in some cases at any rate) to rest with the "young man in the office," so to speak.

Not long ago, a firm of publishers requested that a new book might be considered with a view to its inclusion in one of the lists, and the reply was something to the effect that there was no room for any more! The merits or demerits of the book apparently received no consideration whatever.

Oct. 10. "D'Auvergne."

THE EVOLUTION OF THE ELECTRIC LAMP.

TO THE EDITORS OF THE ELECTRICIAN.

I note Mr. Willcox's comments on my statement that it has never been found possible to put tungsten filament vacuum lamps in general on the market at a higher efficiency than about 0·8 candle per watt. Mr. Willcox gives data to show that actual efficiencies at the present day are better than this, but his figures are based, I think, on values of mean horizontal candles. When considering the relative efficiencies of different lamps one must take the total light flux, and I therefore based my figures on values of mean spherical candles. Mr. Willcox would, I think, agree that this is the only valid criterion by which one ought to compare lamps of different kinds for efficiency and operating temperature. The article in question would have been misleading if any other basis had been adopted.

On the basis of total light flux there is, I think, no real discrepancy between my general statement and Mr. Willcox's detailed figures.

It is obvious that the data which I gave could only be of a very general and approximate character, and it is well that Mr. Willcox has put on record the fuller and more precise data regarding the different types of vacuum metal lamps at present supplied. But it must be remembered that the figures he gives are in terms of mean horizontal candle power, and that a reduction of some 15 per cent. is required if it is desired to put them into mean spherical candles.

Teddington, Oct. 9. C. C. PATERSON.

THE ELECTRICITY SUPPLY PROBLEM.

TO THE EDITORS OF THE ELECTRICIAN.

Mr. Williams' letter in your last week's issue is very interesting as following the considerable amount of discussion, both public and private, that has taken place on the subject of the recommendation of the Institution of Electrical Engineers as [illegible] under control of the Government.

It is apparently on this latter point, viz., Government control, that the real discussion has taken place. It is claimed on the side of the investors in electric supply companies that practically any form of Government control would mean interfering, perhaps seriously, with their profits and depreciating the value of their investments. The undertakings of the local authorities would also, in such case, be equally affected as trading concerns. The subject, therefore, is of very wide interest and, more than that, of very practical significance. It is the only point in Mr. Williams' letter which touches on anything of immediate moment. The rest of the subject in Mr. Williams' letter is (and is likely for some time to remain) in the nature of pure discussion. The question, however, of the [illegible] of existing undertakings by Government has been transferred to the region of action. It [illegible] that the Government are being asked to take this step. In consequence it would be of very great [illegible] the views of the undertakings them [illegible]. Perhaps some of the engineers of the [illegible] would give the views they consider [illegible]. The views, too, of the supply companies would be equally to the point.

The [illegible] of your journal would make it a very [illegible] for the expression of views on this special problem.

[illegible] A. I. E. E.

FUTURE OF INDUSTRY.

[illegible]

[illegible] tions of employment, earnings and their distribution, capital and credit, emergency measures connected with demobilisation, constructive measures relating to industrial efficiency and markets, and agricultural development; and the fundamental problems of increasing production and of the functions of capital, management and labour with a view to securing their loyal co-operation.

In a preface to the memorandum it is stated that after it had been privately circulated, a large number of criticisms and suggestions had been received, which have been collated, carefully examined, and (in many cases) incorporated in the memorandum. As a result of their inquiries and of correspondence and discussion with representatives of all parties to industry, the authors became convinced that the return from war to peace conditions would inevitably involve great difficulties "which might result, if not carefully and skilfully handled, in a grave outbreak of industrial disorder." On the situation as it is to-day, the authors express the opinion that the success with which our national organisation and activities were adapted to the circumstances of the war give a fair promise of similar success in the readjustments necessitated by peace. "There is a prevalent belief that the 'brotherhood of the trenches' and workshops . . . will remain as a permanent factor in our national life." The authors realise that the war has not put an end to industrial unrest. They state that every one of the old causes of dispute remain, and that others of a most serious nature have been added by the course of war. "The very moderation and unselfishness shown by the responsible leaders of organised labour are looked upon by important sections of their following as a betrayal of the cause and by some employers as a tactical opportunity."

After dealing with the prospects of employment after demobilisation and the incidence of war taxation towards the redemption of loans, the memorandum touches upon the spirit and temper of labour, and states that we shall undoubtedly have to meet a demand that men returning to civil life shall be placed in a position no worse than that which they occupied before the war. Since the cost of living has risen, and will remain high, this will involve a demand for proportionately increased wages. It is stated that the foundation of industrial prosperity is production. The part played by capital, plant and labour are next reviewed. The limitation of output by labour arises partly from the legitimate desire to restrict the hours of work in the interest of health, education, family life and enjoyment. "These are considerations of social welfare which cannot be set aside. We must look for greater production rather from increased efficiency than from an increase in the number of hours worked. There are, however, large sections of labour by whom a further limitation of output is deliberately practised in the assumed interests of their class as a whole." It is pointed out that the fallacy of this policy lies in the conception of an inelastic "wages fund." The remedy must be sought in a better organisation of the industries concerned which will give the workman greater security of tenure and remove the fear of unemployment or relegation to lower-paid work as a result of exercising his maximum effort.

In emphasising how essential is the co-operation of labour as a party to industry, it is stated that "the great obstacle to co-operation is the question of status. The ill will of labour towards capital and management is not wholly a question of their respective share of earnings. Friction arising over the distribution of earnings is in itself due quite as much to a sense of injustice in the machinery of distribution as to the desire for actual increase of wages. The fundamental grievance of labour is that while all three are necessary parties to production, the actual conditions of industry have given to capital and management control not only over the mechanism of production, but also over labour itself. They feel that the concentration of capital in a comparatively few hands has rendered fair bargaining between the parties impossible. . . . The grievances of the employers are no less valid. They complain of deliberate limitation of output, slackness and inefficiency in work, short time and malingering, the lack of any feeling of responsibility."

The memorandum advocates the replacing of sectional treatment of industrial questions by the active co-operation of labour, management and capital to raise the general level of productive capacity, to maintain a high standard of workmanship, and to improve working conditions. "It is essential to the securing of such co-operation that labour, as a party to industry, should have a voice in matters directly concerning its special interests, such as rates of pay and conditions of employment." Whatever part the State may play in the future of industry, it cannot (it is said) move in advance of the general level of opinion among those concerned. The problem is to settle the question of the status of labour in some way which shall give the workman the sense of self respect and responsibility which he desires without interfering unduly with the employer's exercise of the necessary functions of management. "The trade union regulations which have been so largely suspended by agreement for the period of the war were mostly directed towards this end—the assumption by labour of some measure of control over the conditions under which it works."

The memorandum [illegible] the outlines of a settlement, and states that "in its simplest form the new machinery would consist of joint committees representing both management and works staff. . . . At the meetings of such committees any questions affecting working methods and conditions could be brought up for discussion by either side." The representatives of the management would be required to explain the nature and extent of any proposed innovation designed to increase output or economise effort and its effect upon the earnings of the firm and of the individual worker. If necessary, the workers' representatives would put forward modifications or safeguards for the protection of the interests of the employees. In the simple trades the method of works committee, would require to be replaced or supplemented by joint boards composed of representatives of the employers' associations and the trade unions. "Having regard to the differentiation of functions between management and labour and the large number of problems affecting one or both parties which arise in a big industry, two co-equal boards might be created in each industry, one representing the management and the other labour, with a supreme board of control co-ordinating the work of both. The functions of the management board would cover the 'business' side of the industry; those of the labour board would relate to conditions and hours of labour, the demarcation of tasks and everything that touched most nearly the life of the worker. Representatives of these boards, meeting with the Supreme Board of Control, would deal jointly with all matters by which the interests of both parties were affected. Such questions as the dilution of labour, which is becoming increasingly important, yet which cannot be dealt with satisfactorily so long as it is approached from one side only, would be discussed by the Joint Board of Control, both from the point of view of efficiency in production and from that of the interests of the workers and the position of the trade unions." In its most ambitious form the Supreme Board of Control would resolve itself into a National Industrial Council for each of the staple industries or groups of allied industries. Such industrial councils would in no sense supersede the existing employers' associations and trade unions, many sides of whose present activities would be unaffected by the creation of the new bodies.

EFFECT OF IMPERFECT DIELECTRICS IN THE FIELD OF A RADIOTELEGRAPHIC ANTENNA.*

BY JOHN M. MILLER.

Summary.—The increase of antenna resistance with increasing wave-length is proved to be due to dielectric absorption by imperfect dielectrics in the electric field of the antenna. It is shown that absorption does not take place in the ground, but in imperfect neighbouring conductors. The practical importance of this is clearly indicated.

Starting from the wave-length corresponding to the fundamental of the antenna, the equivalent resistance of the antenna rapidly decreases with increasing wave-length, and reaches a minimum. As the wave-length is still further increased, the resistance rises again, but in a linear manner (Fig. 1, B). The decrease in resistance is explained by a decrease in the energy radiated in the form of electromagnetic waves as the wave-length increases. This so-called radiation resistance varies, as it should, inversely as the square of the wave-length. It has been difficult, however, to account for the linear increase which takes place at the longer wave-lengths, and it is with the explanation of this feature that the present Paper is concerned.

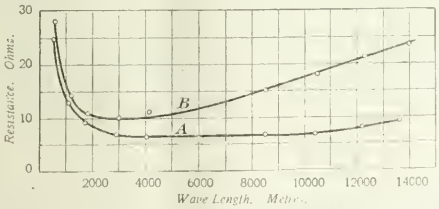


FIG. 1.—A, RESISTANCE CURVE FOR ANTENNA WITH EXTREMELY SMALL ABSORPTION; B, EFFECT OF ADDING SMALL IMPERFECT CAPACITY THROUGH THE WOODEN SUPPORTS.

Austin pointed out the similarity in the linear increase in resistance of an antenna at long wave-lengths with the behaviour of an absorbing condenser, and hence concluded that dielectric absorption was a probable explanation of the phenomenon. The fact that in the curves which he had obtained for ship stations the rise in resistance was less marked than for land stations led him to believe that the absorption was probably caused by the ground acting as an imperfect dielectric. Further confirmation of this view was apparently afforded by the curve for the high-power station at Arlington, Va. In this case only a slight increase in resistance with wave-length was noticed. Austin pointed out the ground might be considered as a dielectric, the ground water being regarded as the lower plate. The measurements described show the effect is one of dielectric absorption, but do not confirm the suggestion that the dielectric is the ground. Using a small flat topped antenna and wave lengths from 100 km. to 750 km., the resistance increased from 1,000 to 9,000 ohms, which is the about order to be expected from Austin's measurements.

It seemed impossible, however, to ascribe this absorption to the ground acting as an imperfect dielectric. The effect persisted at telephone frequencies while the calculations of True and Reich based upon the measurements of conductivity and dielectric constant of the ground as given by Zenneck show that even for so high a frequency as would correspond to a wave-length of 1,000 metres the magnitude of the conduction current in the ground exceeds by 100 times that of the displacement current. The absence of absorption in the ground was also shown by measurements at telephone frequencies upon a guard plate condenser with part air and part clay between the plates. This condenser behaved as a perfect condenser with a series resistance that was independent of the frequency. Only when the clay was exceedingly dry and particularly when it was loosely packed was there any indication of absorption.

Accordingly, an experimental antenna was built in which the bad effects of poor dielectrics in the neighbourhood were carefully avoided but in which any absorption that might be caused by the ground would be considerably magnified. The main capacity of the antenna consisted of six parallel wires at a distance of about 0·3 of a metre above the surface of the ground and located at a considerable distance from the nearest building or tree. The antenna was supported by four wooden posts, but was insulated from them by double porcelain insulators spaced about a metre apart. A single lead, similarly insulated, ran to the building in which the measurements were made. The earth connection was made to the water pipes of the building.

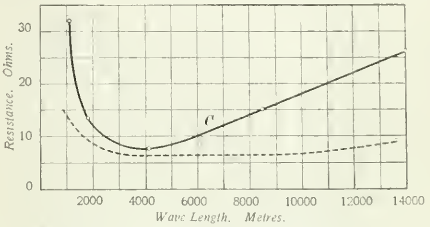


FIG. 2.—C, ABSORPTION EFFECT PRODUCED BY THE PORTION OF THE LEADS TO AN ANTENNA INSIDE A BUILDING.

The resistance measurements were made by the "artificial antenna" method in which a small inductance and a condenser with a resistance in series are substituted for the antenna. The series resistance is so adjusted as to give the same current effect when the substitution is made. The resulting resistance curve, for measurements made just within the window of the building, is shown in curve A of Fig. 1.

Curve B of the same figure shows the effect produced by adding a small capacity through the wooden supports. Wires were run from the insulated portion of the antenna to porcelain insulators on three of the stakes, the total capacity being increased by only 40 micro-mfds. or less than 5 per cent. The linear increase in resistance becomes pronounced, and brings with it an increase in the resistance of the antenna at all wave-lengths. Austin's measurements upon ship stations were made upon battleships, where the antennæ were supported from steel masts, and it is probable that this fact may explain the slight rise of the curves obtained for such stations.

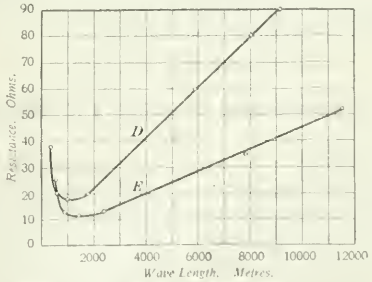


FIG. 3. RESISTANCE CURVES FOR ANTENNÆ COMPLETELY WITHIN A BUILDING. THE CAPACITY FOR E IS TWICE THAT FOR D.

The effect of running the lead wires to an antenna inside a building was also investigated. Curve C of Fig. 2 shows the results upon the above described antenna under the same conditions as those obtaining for curve A of Fig. 1 (reproduced in dash lines in Fig. 2), excepting that the measurements were made within the room at a distance of about 5 metres from the window. The increase in capacity in this case was 60 micro-mfds. Curves D and E of Fig. 3 were obtained for antennæ completely within the building (using the same water pipe ground as before), the former having a capacity of 290 micro-mfds., the latter having double the capacity. In this figure the scale of resistances has been doubled. It is of interest to note that the equivalent series resistance in the case of the smaller capacity is approximately double that for the capacity of twice the size, which is the requisite condition for absorbing condensers with the same phase difference.

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* Abstract of a Paper in the "Bulletin" of the Bureau of Standards.

Finally, the effect of a tree upon the absorption of an antenna was investigated. An antenna consisting of two parallel wires was strung from a building to a tree 20 metres distant at an average height of about 5 metres from the ground. The antenna terminated in a section of about 6 metres of wire which ran from limb to limb of the tree, but was insulated from it by porcelain insulators. At a distance of about 2 metres from the tree double porcelain insulators were interposed in each antenna wire, so that measurements could be made with the section in the tree included or excluded (using the same water-pipe ground as before). Curve F of Fig. 4 was obtained

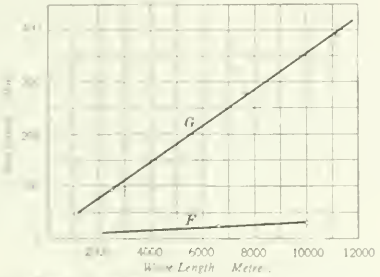

Fig. 4.—Curve G shows the enormous Absorption caused by a Tree. Curve F is the same Antenna with portion in Tree excluded.

for the latter case, while curve G shows the enormous absorption produced by including the portion of the antenna in the tree. The capacity was increased from 390 to 540 micro-mfds., and the phase difference of the condenser with the portion in the tree included was roughly 2 deg. The measurements were made this winter when the tree was free from foliage.

From the above it is evident that in the design of an antenna it is a matter of importance to keep the dielectric absorption of the antenna regarded as a condenser as low as possible in order to minimise the waste of energy in the antenna and so improve its efficiency as a radiator. There is a possibility of greatly improving upon the design of existing antennæ in this respect. The requirement is that the capacity through wooden masts, trees, buildings, [illegible] must be made extremely small in comparison to the capacity of the antenna through unobstructed air.

VISIT OF JOURNALISTS TO LEEDS AND SHEFFIELD.

By the invitation of the Universities of Leeds and Sheffield, a party of journalists visited those cities on Oct. 8-10. The party was representative of the Institute of Journalists, the Circle of Scientific, Technical and Trade Journalists, and the British Association of Trade and Technical Journalists. With a view to promoting closer co-operation between the universities and the press a similar visit was paid to the Imperial College of Science, in London, some months since, and the [illegible] being extended to various provincial [illegible]

On arrival on the evening of Oct. 8 the party were received by the Vice-Chancellor of Leeds University, Prof. M. E. Sadler, and by [illegible] some of whom joined in the [illegible] The co-operation of local journals [illegible]

[illegible] the party to the University [illegible] In the course of his address he traced the development of the University [illegible] He pointed out, however, that there [illegible] in the progress.

The departments of organic and tinctorial chemistry, leather, textile and fuel industries were then visited. In the chemical section special interest attached to the experiments that had recently been initiated on dye-stuffs and drugs. A collection of drugs and colours, entirely made in this country, was on view. More than 100 drugs required by the medical profession had been sent out from the laboratory, including chloramines, various antiseptics and the local anæsthetics eucaine and novocaine.

Similarly in the leather section a number of materials and processes of great industrial importance have been developed, while in the gas and fuel department the testing of T.N.T., picric acid, and the distillates for their manufacture supplied by the gasworks, is constantly going on. The textile department has been developed on a very extensive scale, and since the outbreak of war many special investigations have been made on the clothing supplied to the forces and the fabrics of aeroplanes and airships. A series of investigations is now in progress on the electrification of fibres.

Lunch was taken by the party at the Hotel Metropole as guests of the Leeds Luncheon Club. During the afternoon visits were made to the Leeds Army Clothing Depot, the works of Messrs. Albrecht & Albrecht (manufacturers of khaki garments), and the Cardigan Boot Factory. Many of the processes in these factories were highly ingenious and interesting; the works were specially selected as being representative of those industries with which the University is in close touch. Finally the party were invited to tea by the Lord Mayor, who gave a short description of some of the principal industries in Leeds.

The party then proceeded to Sheffield, where they were welcomed by the Vice-Chancellor of the University, Mr. H. A. L. Fisher. The chemical and medical departments of the University were visited under the guidance of the Vice-Chancellor, who also addressed those present on the work of the University. Dr. Ripper described some of the special work bearing on the manufacture and testing of steel in the applied science section.

A large section of the metallurgy department is given up to special researches in connection with the war, and over 1,200 students have been trained and sent out on munition work. One object of interest that deserves mention in this department is a special lathe built for tests of high speed steel tools. The method of test is to run each tool at a uniformly increasing speed, the output before it breaks being taken as an indication of its value. Other special lines of work include experiments in the production of cupronickel for munition work, steel microscopy, &c.

An important departure since the outbreak of war is the establishment of a special department to deal with chemical and optical glass. The buildings are in course of erection, and it is hoped that the department will be in full working order by the end of the year.

After passing through part of the armament works of Messrs. John Brown & Co. (Ltd.), lunch was taken at the works by invitation of the Master Cutler. In his unavoidable absence an address was given by Mr. Archibald Dixon, a director, who remarked that, in the general admiration of German industrial progress, the pioneering work carried on by the steel industry at Sheffield was apt to be overlooked. At the works of the leading steel makers experiments were constantly being made. They were in close touch with the University, and every effort was made to keep in the front.

The rest of the day was spent in the shell factory of a leading manufacturer, where enormous numbers of shells of all sizes were being manufactured.

The visitors carried away with them the impression that co-operation between the University and the manufacturer has been carried in an exceptionally complete manner at Leeds and Sheffield, and in these cities there appears to be a genuine pride in the work which these Universities are now doing; this is a hopeful augury for industrial progress after the war.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Engineering Applications of Higher Mathematics." Part V. Problems on Electrical Engineering. By V. Karapetoff. (London: Chapman & Hall.) Pp. vii. + 65. 3s.

"Electrical Measurements and Testing Direct and Alternating Current." By C. L. Dawes. (Chapman & Hall.) Pp. 65. 3s.

"Eclipse or Empire?" By H. B. Gray and Samuel Turner. (London: Nisbet & Co., Ltd.) Pp. x + 316. 2s. net.

"La Chimie des Éléments Radioactifs." By F. Soddy. Translated from the English by E. Philippi. (Paris: Gauthier-Villars et Cie.) Pp. 173. 5 fr.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

Commercial Intelligence. In reply to a question in the House of Commons on Tuesday, the President of the Board of Trade (Mr. Runciman) said he had decided to combine the existing Commercial Intelligence Branch of the Board of Trade and the Exhibitions Branch into a new and enlarged Commercial Intelligence Department. The reorganisation of the department was proceeding

We welcome this announcement as evidence of increased interest in a subject of great imperial importance, but the Board of Trade will have to go much further if it is to satisfy the public that it is in earnest about the collection and dissemination of items of commercial intelligence. The Commercial Intelligence Branch of the Board, as hitherto controlled, has not been of great value to British manufacturers and exporters. For instance, the circulation of consular reports has been suppressed in the interests of economy, but extracts from them are given in the "Board of Trade Journal." Frequently the original reports are obsolete when issued, and those parts which relate to the engineering or the chemical industries are often so brief or so ambiguous in style as to be almost unintelligible. When extracts are made from these reports by men who have little technical or commercial training the result must be disappointing to British manufacturers. We suggest that a better plan would be to improve the consular service by a leavening of good technical and commercial experts, by publishing their reports *in full* promptly, and leaving the editors of technical journals to make their own extracts. Perhaps the new Commercial Intelligence Department of the Board will be an improvement upon its predecessor.

* * * *

British Trade Development. At a meeting of the Advisory Committee of the Board of Trade on commercial intelligence, which was held last week, Sir H. Llewellyn Smith presiding, it was reported that Mr. Thomas Worthington, who had been Director of the Commercial Intelligence Branch of the Board of Trade since its formation, had recently retired, and the committee recorded their appreciation of the valuable services which Mr. Worthington had rendered to British commerce in that capacity.

Among the matters considered by the committee were proposals for the amendment of the existing law relating to patents and designs; proposals for the despatch of a special commercial mission to investigate the conditions and prospects of trade in Spain and Portugal; and questions relating to the promotion of British trade with Russia and Italy, and the employment of foreigners as commercial travellers.

* * * *

Controlled Establishments. It is announced that there are now 4,319 establishments controlled by the Ministry of Munitions, an increase of 107 since the last announcement was made.

* * * *

Alien Enemy Contracts in Australia. It is announced that the Australian Commonwealth Premier (Mr. Hughes) has annulled many contracts with enemy firms for the supply of goods to Australia.

* * * *

British Chemical Organisation. In an address on organisation to the Association of British Chemical Manufacturers at Edinburgh, on the 4th inst., Sir Chas. Bedford, the general secretary of the Association, referred to the recent combination of all the German chemical firms with the view of waging an industrial war after the war.

Sir Charles said that it was to counter such plans, and in other ways to develop and protect the interests of the British chemical industry, that the Manufacturers' Association had been formed. Most of the leading chemical firms in this country were already members of it, and a strong council had been formed, the members being selected on grounds of personal fitness, and in no way as representative of the largest interests alone. The smaller chemical manufacturers stood to gain in a relatively far greater degree by membership than even the larger concerns. Collective research was very often, for a number of reasons, too speculative in time and money for the small concern, and it was only by pooling interests that such enterprises would be possible for such firms. The funds were derived from a pro rata subscription based on capitalisation and ranged from 25 to 250 guineas a year. The management was vested to a council limited to 20, of whom four were appointed from British firms connected with chemical or closely allied industries. The industry had been classified in 10 groups, each of which had been represented by a special conference, and he emphasised the necessity for the committees getting to work without delay, so as to put forward in order of urgency their industrial problems for action by the council. Mutual co-operation would prevent overlapping of effort, duplication of researches and plant, and would promote effective dealing with general problems.

Action regarding the after-war position and the utilisation of munition plant, equipment and works, with their staffs, including chemists, must be organised so as to secure the utmost private and national advantage. Assistance to new industries and a large increase in the productiveness of essential and "key" industries was another feature of the association's work, and they would also take concerted action regarding legislation affecting the industry, including patent law reform. Co-operation between manufacturers and the universities and the technical institutions would be another sphere of their activities. Among the other subjects the association would deal with were transport facilities and the improvement of the consular, diplomatic and commercial intelligence agencies.

* * * *

Army Contracts and Bribery. We have received a communication from Mr. D. Howard, of the Bribery and Secret Commissions Prevention League, on the recent prosecution of a Government official for accepting a bribe.

The letter states: "So many inquiries have been made of the Bribery and Secret Commissions Prevention League (Incorporated) relating to the recent scandals in connection with the Royal Army Clothing Factory, that public attention may be profitably directed to a few points. Mr. R. D. Muir, at the beginning of Asseling's trial, expressly stated that

> 'The difficult question had to be considered and decided in regard to the contractors. After great deliberation, it was decided that there was not sufficient evidence without that of the contractors, and that it was right it should be the servants of the Crown who should be placed upon their trial.'

This has often been a vexed question for the League. According to the Prevention of Corruption Act it is as criminal to offer or to give as it is to ask for or accept a bribe, but in practice it is generally found that if there are two rogues one must be allowed the comparative freedom of the witness box, so that the other may be placed in the dock and convicted. Although there have been upwards of 120 convictions under the Act, on only three occasions has the evidence permitted the punishment of both the briber and the bribed. The League has gained much experience in the 10 years of its existence, and its committee is convinced that the penalties provided by the Prevention of Corruption Act are sufficient — on indictment the maximum penalty is two years' hard labour and, in addition, a fine of £500 — if they are ever imposed. As a rule, however, the sentences have been very light. Even since the war began a viewer of saddlery who sought bribes, was only fined £5 by the Walsall magistrates, and notwithstanding a natural outcry, the same Bench, three months later fined another viewer £5 for a similar offence. So far only one contractor (or rather his agent) has been convicted for attempted bribery — this was in connection with the supply of forage; but another contractor is now under remand on bail of £1,000.

The League advocates the abolition of the fiat of a Law Officer of the Crown, and a simplification of the preliminaries to and the mode of trial.

* * * *

British Trade with Italy. The movement for developing our commercial relations with Italy is making steady progress. At a recent meeting, which was attended and addressed by the President of the Board of Trade, an economic branch of the British-Italian League was inaugurated.

A "Lega Italo-Britannica" has already been established in Italy, with a corresponding British-Italian League in Great Britain, under the patronage of the British and Italian Ambassadors, whose province is [illegible] the two nations. The Earl of [illegible] and the Earl of Lytton chairman of the [illegible] Literary Branch, of which Mrs. Geo. T[illegible]. The meeting subsequently elected Mr. [illegible] of the Economic Branch Executive, with Mr. [illegible] secretary, at Gwydyr House, Whitehall, S.W.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Sept. 30, 1916, *to* Oct. 6, 1916.

IMPORTS.

[illegible]

EXPORTS.

[illegible]

FOREIGN GOODS [illegible] and free).

[illegible]

[illegible] under the [illegible] to what is described as [illegible]

PARLIAMENTARY INTELLIGENCE.

KEY INDUSTRIES.

[illegible]

LEGAL INTELLIGENCE.

Workman's Compensation.

At Lambeth (London) County Court last week, before Judge Parry, Thomas Woolley, electrician, sought an award of compensation for injuries against Messrs. Watson, Marsh & Co.

Mr. F. A. Bronholm (for applicant) said that on May 4 he was working at Pike's Circuit Cinema, which was in course of reconstruction. He was running steel tubing through the building to carry the electric light wires. Requiring some tubing he went to get some from the back of the building, and on the way he met the foreman (Wilson), who stopped him to give some fresh instructions to run three instead of five points. As they were talking a man came along with a barrow of cement, and a bag of cement fell on his knee, knocking him down. He was picked up by the foreman, and taken by Mr. Marsh to the hospital in a taxi cab. He had been unable to work since, and could neither kneel nor climb ladders. He had been sent 9s. 10d. for the time he worked up to the accident.

Judge Parry: And I see from the bill they deducted 2s. 6d. for the cab fare to the hospital and for the man's insurance.

Applicant bore out this statement, and in cross-examination denied that he met the foreman some way from where the accident occurred, or that he helped the labourer with the barrow to go up an inclined plank. That story was a pure invention. His wages averaged £2. 4s. 2d. a week.

Medical evidence was to the effect that an X-ray photograph of applicant's knee had been taken: that the internal cartilage was injured, and a fragment of bone had been separated in the knee joint. Applicant was well on in years, and there would be no cure without an operation.

Mr. Aden (for respondents) said applicant had left off work for them when the accident happened, and was assisting the labourer with his barrow, who was working for another firm, and, therefore, the accident did not arise out of or in the course of his employment.

John Wilson and applicant's mate (Wm. H. Donovan) gave evidence. The foreman said the conversation with applicant took place some distance away from where the accident occurred. Applicant was going to help the labourer with the barrow of cement when the bag fell on him.

Medical evidence was to the effect that the condition of applicant's knee was partly due to rheumatism.

Judge Parry said he did not accept Donovan's account of how the accident occurred, but that of applicant, who he did not think was helping with the barrow. Had he been doing so, respondents could have called the labourer in support of their story. He deprecated all those quibbling points that were so often raised in cases of that kind; they were very bad for business. A man ought to go about his work attended by a well-advised solicitor and counsel, asking them if he should do this or that, and if he did would he lose his rights under the Act. He gave an award for the applicant of £1 a week from the date of the accident, with costs.

EDUCATIONAL.

Armstrong College (University of Durham), Newcastle-on-Tyne.—The new session commenced on Sept. 25. Full particulars relating to the departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce may be obtained from the secretary, Mr. F. H. Pruen, M.A.

Northampton Polytechnic Institute.—Classes for engineer-salesmen and other technically trained men engaged in the commercial side of electrical engineering have been arranged for the session 1916-17. The work of these classes will cover the syllabus of the City and Guilds of London Institute examination to be held in 1917 in the subject of electrical engineering quantities and estimates. The lecturer is Mr. J. W. Holliday, superintendent of construction of sub-stations to the County of London Electric Supply Co. The lectures are given on Friday, from 7 to 8.30 p.m. Applications for admission to the Principal, Dr. R. Mullineux Walmsley, Northampton Polytechnic Institute, Clerkenwell, London, E.C.

BUSINESS NOTICES.

We are informed that Mr. Fred John Roden resigned his position as a director of the Electrical Supplies Co. as from the 23rd ult., and that his entire interest in the business has been taken over by the [illegible] director, Mr. F. Cecil Feman, in whom the sole responsibility for the direction and control of the E. S. Co. (Ltd.) will, for the present, be vested.

[illegible] that the Chloride Electrical Storage Co. have [illegible] offices at Wallace House, 6, Bankshall-street, Calcutta; and [illegible] Buildings, Hornby-road, Bombay.

[illegible] Day and Arthur Walter Day, chartered patent agents, [illegible] High Holborn, London, W.C., have dissolved partnership. Mr. A. W. Day continues as Day, Davies & Hunt, at the same address.

Sale by Tender.—Messrs. Wheatley, Kirk, Price & Co. have been [illegible] by the Controller of the Electrical Company (Ltd.) (Mr. [illegible], F.C.A.) to offer for sale by public tender, as detailed in the [illegible] of the catalogue, the entire stock of electrical supplies, equipment and accessories, at the offices and showrooms, 122 1, Charing Cross-road, London, W.C. The stock includes generating and testing plant, motors, arc and incandescent lamps, fans, cable, insulators, carbons, meters, switches, electrical accessories, &c., and will be on view for two weeks commencing Monday, Oct. 2, from 10 a.m. to 5 p.m. daily. Catalogues from the selling agents, Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and at Manchester and Newcastle-on-Tyne. Tenders must be sent in to the firm at 46, Watling-street, E.C., by noon Oct. 17.

Further particulars are given in an advertisement.

Electric Heating Utensils.—Messrs. Isenthal & Co., Denzil Works, Willesden, N.W., notify that they have a quantity of new electric heating utensils (" Elektra " make) which they desire to clear at low prices.

Sherardising. Sherardising is now undertaken by the Cowper-Coles Mfg. Co., Sunbury-on-Thames, who also undertake the erection of sherardising plants for every description of iron work which it is desired to render rustless.

BANKRUPTCY.

At the London Bankruptcy Court last week the public examination of Mr. Thomas Makinson Sanders, company promoter, took place. Liabilities were £27,412 (unsecured £1,237), and assets valued at £92,864.

Replying to Mr. E. S. Grey, O.R., the debtor stated that he held various appointments in South America until 1907, when he went to Canada, and was president and general manager of a railway company at £6,000 per annum. In 1910 he started a banking business at Rio de Janeiro. He contracted to purchase for £350,000 an option for the supply of hydro-electric current in bulk to various undertakings in Mexico. Companies were formed, in one of which he received a shareholding of £1,000,000, and arrangements were made for a bond issue of £6,000,000. Owing to the disturbed state of affairs in Mexico, the issue was held up, and in May, 1912, witness assigned the whole of his interest for £48,000, which he still regarded as a good debt. When he went into the Mexican business he was worth a million, and he came out with only £100,000. His creditors had accepted an offer of 20s. in the £, to be paid in cash.

The examination was concluded after debtor had explained that his failure was entirely due to the war, which suspended all financial operations.

ELECTRICITY SUPPLY.

EXTENSIONS.

Chesterfield.—On Tuesday the Council approved of a scheme for the extension of the electric supply works and decided to apply for sanction to borrow £20,600 for the work.

A letter from the L. G. Board stated that it had been in consultation with another Government department with regard to the matter, and they would be prepared to sanction loans for the extensions on receipt of a copy of a resolution of the Council applying for sanction to borrow the sum required, and on being informed what amount for the air filter was included in the item of £9,500 for turbo-alternators, and whether the filter was to be a wet or a dry one. The work might be put in hand at once.

Keighley. By eight votes to seven the Council resolved on Tuesday to apply for sanction to borrow £2,000 for laying an extra-high-tension cable in Cavendish-street, Lawkholme-lane and Bradford-road to a junction with the existing cable near Messrs. G. Wilkinson & Sons' works.

Mr. WHITEHEAD, in moving the recommendation, said that the cable was required to complete a circuit in order that extra current required for works might be adequately met. The extra cable would obviate any stoppage of work in the event of a breakdown of the existing cable.

Newport (Mon.). The borough electrical engineer (Mr. A. Nicholls Moore) is in negotiation with a firm on the east side of the river for taking a supply of energy, estimated on a maximum demand of 300 kw.

The Council is recommended to approve a draft agreement with Messrs. Smiths (Newport) (Ltd.) for a bulk supply.

The Markets Committee has asked the electricity department to instal in the Market Hall 12 600 c.p. metal filament lamps, in lieu of the existing arc lamps, the hire of the new lamps to be 5s. per lamp per quarter, and the charge for current and maintenance to be 1½d. per lamp per hour such lamps, however, being intended to be a stand by in case the lighting of the stalls failed at any time.

Rotherham. Last week considerable discussion arose at the Council meeting on the proposal of the Electric Light and Tramways Committee that the Corporation should purchase for electricity supply purposes at the price of 5s. per yard, approximately 21,702 yds. of land, together with the land and buildings known as Don Work, at total estimated cost of £7,175.

The owners were willing to postpone the completion of the purchase until 12 months after the termination of the war, the Corporation to take possession of the land on the execution of the contract, and to pay 5 per cent. per annum on the purchase money until completion.

The chairman (Ald. WINTER) referred to the urgency of facilities for extending the generating plant. The demands for electric current were likely to extend very rapidly, and it was therefore most desirable they should be in readiness for any future developments.

Ald. GUMMER said they all agreed that the Electricity Committee had a great duty before them, and that extensions were necessary. Before entering into a scheme of that magnitude they should ask an outside opinion on the value and suitability for buildings such as they would have to erect. It might also be necessary to build a river retaining wall at a cost of £18,000 for stone, or £6,000 for concrete. In such an event the Council could easily see that the land would amount to 10s. per yard. The land was three times the size of the site of the present works. If they were likely to expand in the way forecasted it was a question whether the works should not be in another position.

Councillor GREEN moved an amendment to refer back the whole question.

Ald. WINTER, in reply, said there was no immediate necessity for a river retaining wall, and if one was built it would not cost £18,000 or £6,000. The vendors were not prepared to sell a portion of the site. He was informed that if the Council did not purchase the land now the option would be lost. The committee were not the only people who had been after the land. By means of an aerial railway the difficulty of getting the coal to the works would be overcome, and such facilities might also be of benefit to the gasworks. In the vicinity they had some of the largest collieries in South Yorkshire, laid out for an output of 6,000 tons per day.

The amendment was carried by 22 to 8, and it was understood the question would come up at a special meeting of the Council in committee.

Sheffield. Mains are to be extended at an estimated total cost of £1,740.

An additional war allowance is to be paid those employees of the Electric Supply Committee affected by the award of the Engineering Trades Committee on Production.

Stockton-on-Tees.—The L.G. Board has authorised the borrowing of £805 for electric supply mains.

The Board is not prepared to sanction loans in respect of the expenditure since March 25, 1915, on mains and services, except for expenditure incurred on account of war requirements. In this connection sanction has not been given for £685 for mains and £202 for services, and information is being obtained with regard to these items of expenditure with a view to further details being placed before the Board.

Worcester.—The Council have applied for sanction to a loan of £1,000 for ten 60 kw. transformers (at £75 each) and for switchgear, &c., to give a supply of electrical energy to a factory at Blackpole.

The Council have also applied to the L. G. Board for sanction to borrow £500 further in respect of the loan of £13,000, referred to in the Council's resolution of July 4, 1916.

Mr. HILL explained that the difference in the cost was due to a mistake in a telegram sent by the company, who supplied the cables. A portion of the increase would be chargeable to the King's Norton Metal Co. for the cable outside the boundary, and the other portion would be borne by the city.

GENERAL.

Balbriggan (Co. Dublin).—An improvement scheme, including the introduction of electricity supply, is under consideration by the local Council.

Burton-on-Trent.—The Electricity Committee has resolved to pay increases in wages, to fall in line with the Engineering Trades Committee of Production award.

Bolton. The Electricity Committee suggest a joint meeting of the Gas and Electricity Committees at an early date to consider the question of the control and supervision of the street lighting arrangements.

Coal Prices.—At the last meeting of Worcester Corporation there was a discussion on the price of coals.

Mr. FAIRBAIRN moved that a list of the comparative prices now being paid by the Corporation for coal in all departments as compared with pre-war prices should be tabled and sent to the L. G. Board, calling their attention to the Council's position in relation to the Prices Limitation Act, and asking whether the Government could assist them in the matter by further legislation. He said it was a serious matter, because at the next meeting of the Electricity Committee they would be asked to consider a probable increase in the charges for electricity in order to meet those extra charges.

The resolution was passed and a copy of it was sent to the Municipal Corporations Association, asking for their assistance in the matter.

Colchester. Stokers at the electricity works are to get a bonus of 2s. a week conditional on the stoking being satisfactory. Complaints have been made as to an alleged nuisance by smoke from the shaft at the works.

Crompton. The Council have appointed two delegates to meet the Oldham Electricity Committee in order to discuss [illegible] for the supply of electric current in the district.

Edinburgh.—The electric lighting department has [illegible] figures as to the output during the summer.

The decrease in lighting for the period from May 21 last, during which the Summer Time Act has been in operation is 13 per cent., compared with the corresponding period of last year. This is equivalent to a saving in the consumption of coal of 600 tons. This saving is not entirely due to the Summer Time Act. It is partly the result of the reduced public lighting, but the amount of saving due to this cause cannot be exactly calculated. Against the decrease in public lighting, owing to speeding-up and the extension of power supply there has been a larger consumption of electric light for night shifts, and there has been a large increase in the amount of electricity required for power. This increase has not only balanced the decrease in the amount of electricity used for lighting, but has actually exceeded it to a considerable amount. The final result is that there has been a net increase of 8 per cent. in the amount of electricity supplied by the department during the period under survey.

Electric Driving in Laundries. The School Committee of the Bethnal Green (London) Board of Guardians reports that for some time past it has experienced considerable difficulty in coping with the laundry work, owing to the impossibility of obtaining the services of a laundryman to work the hydro and to do the heavier work.

As it is of the utmost importance that the children should be regularly supplied with clean clothing, the chief engineer was asked to report upon the possibility of running the plant by means of electricity or gas, and in his report the chief engineer says the present plant was put down about 31 years ago; it is worked by hand, and although the plant is in working order, parts are now well worn, and if power were put in a saving in labour would result. There are two washing machines and one hydro worked by hand which he would replace by one 150-shirt washing machine and one 20-in. hydro extractor, and the box mangle and roller mangle could be converted at a small cost to power machines. These would be driven by overhead shafting from an electric motor. He had seen the electric supply company, and they informed him that the cable which passes the [illegible] in Whipps Cross-road was only a small lighting cable, but they would be willing to extend the power mains from the Green Man [illegible] free of charge, and would lay the mains inside the [illegible] £[illegible], a distance of about 230 yds. The cost of a motor-driven plant complete would be about £200, and for a gas engine plant about £2[illegible]. These figures are made up of the following items:—

Electricity.		*Gas.*	
Motor	£36	Gas engine, with foundation	£90
Cable	27	Washing machine	64
Washing machine	64	Hydro	40
Hydro	40	Shafting, &c.	23
Shafting	23	Erection	10
Erection	10		
Total	£200	Total	£227

The following weekly saving would be effected by the adoption of electricity for the purpose of motive power, compared with present cost:—

[illegible]. Two laundrymen at 17s. and one laundryman at 27s., £3. [illegible] weekly saving, £1. 13s., or £[illegible] per annum.

[illegible] at 17s. £1 [illegible] 11s.; net [illegible] £41 1[illegible] per annum.

The committee [illegible] subject to the sanction of the L.G. Board, [illegible] the suggestion to run the plant by electricity.

Glasgow. The Electricity, Water and Cleansing Committee, [illegible] the grant of a bonus of 2s. per week to male workers, [illegible] and 1s. to female employees.

Holmfirth. [illegible] is now available in the district, and [illegible] supply is being given to over 1000 lights by the Urban Council.

Increased Charges for Electricity Supply.—The following increases of charges for electrical energy are announced:—

[illegible]

Newmarket. [illegible]

Street Lighting. [illegible] lamps throughout London to be extinguished at 10 p.m., also that as an experiment during the ensuing month, all street lamps throughout Wandsworth be extinguished at 10 p.m.

Wolverhampton.—We are informed that Messrs. Courtaulds (Ltd.), of Coventry, have acquired a site of over 70 acres at Wolverhampton upon which they propose to erect a factory for the purpose of meeting the heavy demand for their manufactures of mercerised silk goods. No doubt this will mean an increased demand upon the local electric supply works.

Walsall.—The rotary on order for Darwall-street sub-station has been released. Certain obsolete plant has been sold to Kilmarnock Burgh for £88.

Wigan. The Special Committee appointed to inquire into the cause of the breakdown of the electricity supply in December last has issued a report. Certain recommendations are made, including suggestions for the management of the electric supply department, the relations of the electrical engineer to the Electricity Committee, &c.

Woolwich. The Electricity Committee has arranged to give a supply of electrical energy to a large firm of manufacturers in the borough.

Worcester.—The electrical engineer (Mr. C. M. Shaw) and the chairman of the Electricity Committee (Mr. W. J. Hill) recently submitted to the Severn Board of Conservators plans of suggested alterations for extending the conversion of some old water-power mills at Powick near the junction of the Teme and Severn into a power station, and thereby obtaining a larger volume of water.

The plans had already been laid before the Board of Agriculture and Fisheries. The Severn Fishery Board, while not desiring to hamper any legitimate development of the works, consider the proposals will tend to divert the water from the Powick weir and obstruct the existing fish passes.

Mr. Hill, in submitting the proposals, said his committee had no desire to enter into conflict with the Board, but rather desired to carry out the proposed work in such a way as to preserve a community of interests.

On the proposal of Mr. G. Bullock (Birmingham), representing the fishing interests in Gloucestershire, the Board passed a resolution declaring that they viewed with apprehension the proposal of Worcester Corporation to widen the leat between the River Teme and their electric power station at Powick, and otherwise to alter the existing waterway; that, in consequence, a representation be made to the Board of Agriculture and Fisheries, with a request that they take steps to prevent the Severn fishery district being prejudiced by the alteration in the mill leat or the alterations already made by the Worcester Corporation to the old mill buildings; further, that the Board of Agriculture and Fisheries be requested to withhold their consent to any raising of the Powick weir, and that in the alternative the Board take such steps as they may be advised to oppose the scheme.

TRACTION NOTES.

Aberdeen. The Tramways Committee is considering an application of the tramway employees for an increase in their wages of 1d. per hour.

Belfast. The new general manager of the tramways (Mr. J. S. D. Moffet) entered upon his duties on the 2nd inst.

Birmingham. At a special meeting of the Electric Supply Committee held last week, the question of the recent stoppages on certain tramway routes through the failure of the electric current was thoroughly discussed.

In view of the criticism of members of the Council and others, the committee resolved not to make any communication to the press, but to present a full statement to the Council at their next meeting.

The Watch Committee have sanctioned the application of the Tramways Committee that women of 18 and upwards be licenced to act as conductors. Hitherto the age has been 21.

Bradford. The Tramways Committee, have reconsidered the application of the employees for a revision of the entire scale of wages, which involves a substantial increase on present rates.

The tramwaymen are receiving a war bonus of from 3s. to 4s. a week, and a revision of the wage scale in accordance with their demands would cost about £21,000 a year. There are over 1,000 workers whose application for an advance is put forward on the ground of the increased cost of living.

As the city tramways are a certified undertaking, the committee have referred the question for settlement to the Minister of Munitions' Committee on Production.

Darlington. The Electricity and Light Railways Committee have curtailed and modified week-day tramcar services owing to the difficulty of keeping to the time table with new drivers and darkened streets.

Doncaster.—A dispute has arisen with Bentley Urban Council over the proposed improvement of the tramway track through Bentley old village.

Plans of the work were prepared some time ago and were approved by West Riding County Council and the Board of Trade. The L.G. Board also gave its consent, and considerable progress had been made with the work when Bentley Council refused to agree to the plans as it objected to a cut-out in front of the church being on the church side of the original track. The work has been standing for several weeks and travellers between Bentley village and the New Colliery Village have to change cars. The Board of Trade have offered Major Brewitt as arbitrator, which Bentley Council have agreed to accept, but the Corporation have refused to fall in with that suggestion, and so the deadlock continues.

Edinburgh.—The Tramway Committee has decided that the disputed points between itself and the tramway lessees should be submitted to arbitration.

The principal point in dispute has reference to the condition of the tramway lines at the termination of the lease, which expires in June, 1919.

In the report prepared by the borough engineer (Mr. Campbell), in consultation with Mr. J. B. Hamilton and Mr. J. A. Brodie, it is stated that it would be possible to have a new system of tramways running in Edinburgh six hours after midnight on June 30, 1919, without the city having received any facilities from the Edinburgh & District Tramway Co. The new tramway system recommended is the overhead trolley system. It is stated to be the cheapest and most convenient, and would lend itself not only to extensions into the country, but also to linking up with the existing electric systems of Leith and Musselburgh. For Princes-street it is recommended that before introducing the conduit system there overhead wires should be installed on the south (or Garden) side of the street, where they will be largely hidden by the foliage of the trees. If, after practical experience of that, the citizens make up their minds not to have it, the overhead can be taken down and the conduit introduced. It is emphatically declared that it is not advisable to continue the cable tramways for the city or for any part of it after the expiry of the tramway lease.

Hartlepool.—In response to the L.G. Board's inquiries as to works likely to be undertaken after the war, the Council has decided to include the relaying of the Foggy Furze section of the tramways and the laying of a line on the south side of the Municipal Buildings.

Liverpool.—Up to last week the Tramway Committee had issued 8,546,000 free passes to soldiers and sailors, 240,000 passes to officers and 153,000 to nurses, a total of 8,939,000 free passes.

Newcastle-on-Tyne.—A settlement has been effected on the question of the assessment of the tramway undertaking. By agreement the valuation has been reduced from £50,000 to £40,606.

Newport (Mon.). The tramways manager reports that the female conductors are performing their duties very well. There are 15 of them in charge of cars, and 10 learning.

Rotherham. The necessary sanctions for doubling the tramway track in Westgate have been received.

Application is to be made to the Board of Trade for sanction to pay the cost of purchasing 12 tramcars from Oldham Corporation out of the tramway capital account over a short term of years.

The Tramway Committee recommends the purchase of two new car bodies to replace damaged bodies, the cost to be defrayed out of revenue.

Sheffield.—The City Council is recommended to authorise the tramways manager to obtain tenders at an early date for 25 additional tramcars.

Plans and estimates for tramway passenger shelters at the Hurst Park Lodge Moor termini are to be prepared.

An additional war allowance is to be paid to those employees in the tramways department affected by the recent award of the Committee on Production (Engineering Trades).

Stretford.—The Urban Council has applied to the Board of Trade for a further extension of the period limited for the construction of the tramways referred to in sec. 31 of the Manchester Corporation Act, 1911.

Woolwich.—The Borough Council will offer no objection to the London County Council's new proposals for doubling the tramway tracks in Beresford-street and Plumstead-road.

TELEGRAPH AND TELEPHONE NOTES.

Automatic Telephones.—At the meeting of the Liverpool Chamber of Commerce last week, Mr. Chas. Lancaster said that it had been in contemplation to establish in Liverpool an automatic or, in the alternative, a semi-automatic telephone system, for trunk calls, but for the time being the proposal was in abeyance, owing to the congested state of the Central Exchange and the cost involved.

Mr. Lancaster said that many of the lines to that exchange had now been transferred to the more commodious Bank exchange with the view to the ultimate amalgamation of the two exchanges, and it was hoped that that arrangement would improve the facilities.

Australian State Telephones.—The number of telephone subscribers in Victoria increased during the last financial year from 34,905 to 35,197. In 1913-14 the number was only 31,677, showing an increase for the following year of 3,228. Revenue from subscribers last year was £270,464 (increase £22,324). The increase of the previous year was £31,582. The number of public slot telephones in the State was increased last year from 587 to 621, being 34 additional, against 53 in the previous year, though the receipts increased by £2,179, as compared with £1,754.

The Telephone in Commerce.—A London grain firm states in "The Times" that some credit for the growing importance of London as a grain centre is due to the improvements in the telephone system, which have made communication with all the principal ports a comparatively simple matter, and also, in the years immediately preceding the war, greatly facilitated business with the Continent.

"The Times" states that there is no doubt that the development of the telephone has made the control of business at the ports from London an easier matter, but the growth in recent years of the Argentine trade with this country, which is entirely transacted through London, and the increased exports to the Continent have exerted a very great influence. The dominating factors are that the City remains the hub of the financial machinery, and that the chartering business for all cargo steamers has been directed there to an ever-increasing extent.

Trans-Pacific Radio Communication.—It is announced that in the course of a preliminary test direct wireless communication has taken place between San Francisco and the Japanese Government station at Ochiishi.

EMPIRE NOTES.

Australasia.—An Order in Council has been issued by the New Zealand Government prohibiting the importation of goods manufactured in the enemy's territory.

The Victorian Railway Commissioners state in regard to the electrification of the Melbourne suburban railways that Mr. Jones, Railways Commissioner, who is visiting England to co-operate with Mr. Merz the consulting engineer, with a view to overcoming the difficulties that have arisen through the war in obtaining certain electrical equipment, has cabled that arrangements have been made for the supply of certain switchgear and sub-station converting plant of British manufacture, which was to have been supplied by Messrs. Siemens Bros., but which that firm cannot supply within the prescribed time, and for the acceleration of the deliveries of plant under other contracts, to enable the Sandringham-Essendon line to be worked electrically in January, 1918. The Williamstown, Port Melbourne and St. Kilda lines will be operated in quick succession thereafter. The erection of the overhead equipment on the Sandringham-Essendon and Williamstown lines is in progress, whilst the h.t. cables for the transmission of power from the power station to the sub-stations are being linked up. The Jolimont car-shed has been practically finished and is now being used for the electrical equipment of the rolling-stock, ample supplies of which will be available when the erection of the switchgear and sub-station plant are ready.

The Amalgamated Wireless of Australasia (Ltd.) made a net profit of £4,692 during the first six months of 1916, which added to balance brought forward (£3,331) makes a total of £8,023 available. £7,000 will be absorbed by the payment of a dividend at the rate of 5 per cent. per annum, leaving £1,023 to carry forward. There has been a large falling off in ships' messages, and consequent loss of revenue. The report announces that the company has secured the sole licence and agency in Australasia for the Poulsen system of radio-telegraphy and for the automatic relay telephone.

Canada.—The High Commissioner for Canada is informed by the Minister of the Interior, Ottawa, that a large number of farmers within a radius of 50 miles of Lethbridge, Alberta, will shortly instal electrical plants for various purposes on their farms. The plants are to be run by small petrol engines, and will cost from £62 to £103 each.

MISCELLANEOUS NOTES.

Enemy Firm Wound Up.—Claims against the Switchgear Construction Co. (Ltd.), of London and Birmingham, are to be sent to the Controller, Mr. J. H. Stephens, 6, Clement's-lane, London, E.C., by Nov. 15.

Excess Profits Tax.—The September issue of the "Journal" of the Tramways and Light Railways Association announces that the Board of Referees appointed under the Finance (No. 2) Act, 1915, heard on Sept. 28 the application of the Association on behalf of its company members under sec. 12 (1) of the Act for an increase of the statutory percentage from 6 to 12 per cent. No decision has been given yet.

Exports to China. The "London Gazette" of Oct. 10 contains a further list of firms and persons in China to whom goods may be consigned from the United Kingdom.

Laboratory Porcelain. On the 5th inst. the Lord Mayor paid a visit to the Royal Doulton Pottery Works at Lambeth, in order to inspect an exhibition of samples of laboratory porcelain which is now being produced by Messrs. Doulton & Co. (Ltd.) to take the place of supplies previously obtainable only from German sources.

The managing Director of the company (Mr. H. Lewis Doulton) received the Lord Mayor, and the processes of manufacture were demonstrated to him by Mr. J. H. Mott, the art director, and Mr. W. Thomason, the [illegible] of the firm. It was explained that after experiment the firm had succeeded in discovering the composition of the German article and in producing similar ware from such materials as were available. Crucibles, [illegible] dishes, filtering funnels, a variety of special vessels used for [illegible] and assaying purposes, and known only by the names of their German inventors, and other articles of hard porcelain [illegible] had been manufactured; and according to reports from chemists and analysts who have used them they are equal, if not actually superior, to the ware produced by the Imperial factory at Charlottenburg. They are supplied at prices practically identical with those of the German articles before the war. In order to concentrate on the task of supplying laboratory needs the firm have had practically to suspend their manufacture of art ware, but they are now building two large kilns for manufacturing artistic ware of hard porcelain which, it is believed, will rival that of Charlottenburg.

Register of Employees. Regulation 41A of the Defence of the Realm Regulations (requiring employers to make and display prominently on their premises registers of male employees between 18 and 41) has been amended in such a manner as to require employers to revise such lists as often as may be necessary to maintain accuracy, and ordering that particulars of persons who have not been employed for more than a week need not be entered on registers, but that these should be separately recorded.

Trading with the Enemy. A consolidating list, containing the names of over 2,000 persons and firms with whom persons in the United Kingdom are now forbidden to trade, has been issued by the Foreign Trade Department.

TENDERS INVITED.

Telephone and Telegraph Material, &c.

Tenders are invited up to Dec. 22 for the supply to the Australian Commonwealth Postmaster-General's Dept. (State of Western Australia), at the Telegraph Office, Eucla, of 200 Accumulators, with associated apparatus, as per schedule No. 152. Specifications, &c., from the Commonwealth Offices, London. [illegible]

Tenders are invited up to Nov. 15 by the Postmaster-General's Dept., State of South Australia, for the supply and erection at the telephone exchanges of Glenelg and Brighton, of Automatic Switchboards and all associated apparatus (as per schedule No. 126). Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are also required by 3 p.m. Nov. 8 for the supply of Accumulators (one 100 positive and 21 negative plates) to the Australian Commonwealth Postmaster-General's Dept., Perth (W.A.) (schedule No. 527, W.A.). Specification, &c., from the Deputy Postmaster-General, Perth, Western Australia.

The Deputy Postmaster-General, Melbourne, will receive tenders [illegible] for the supply of Telephone Parts [illegible] and for the supply of Switchboard and Telegraph [illegible] and [illegible] Nov. 8 for the supply of [illegible] Morse Keys and Galvanometers [illegible] for the Australian Commonwealth Postmaster-General's Dept. Specifications, &c., from the Deputy Postmaster-General, Melbourne.

Carbons.

The Victorian Government Railways Dept. requires tenders by 11 a.m. on Nov. 1 for the supply of 50,000 Yellow Flame Arc Carbons. (Contract No. 30,[illegible].) Specification, &c., from the Victorian Railways Commissioners, Spencer-street, Melbourne.

Coal Transporter Plant.

Tenders are invited for the supply, delivery and erection in Melbourne of a Coal Transporter Plant of the travelling tower type and electrically controlled. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Pty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders close on Dec. 11.

Converter Plant, Batteries, Booster Plant and Switchboards.

[illegible]

[illegible]

[illegible]

Tramway Material.

[illegible]

TENDERS RECEIVED AND ACCEPTED.

Rotherham.—An order has been placed with the British Westinghouse Electric & Mfg. Co. (at £23,700) for a 5,500 kw. turbo-alternator, and the tender of the British Niclausse (Ltd.) has been accepted for the supply and erection of two water tube boilers for £13,2[illegible].

The Council has decided not to enter into contracts for tramway stores, but the manager will purchase goods as required during the year; and that there will be no contracts for cable during the year, the Electrical [illegible] purchasing as required.

Dewsbury.—The Electricity and Tramways Committee has accepted the tender of Callender's Cable & Construction Co. for the supply and laying of cables.

[illegible].—The electric supply department has accepted the tender of Dewhurst's Engineering Co. for steel boiler tubes.

The City Council is recommended to accept the tenders of the undermentioned firms for the supply of spare apparatus for the auxiliary plant at [illegible]: India Electrical & Mfg. Co., motors, £2,[illegible]; Siemens Bros. Dynamo Works (Ltd.), motors and control gear, £2,3[illegible]; British Westinghouse

Co., motors, £135; Dick, Kerr & Co., motors, £280; J. P. Hall & Co., motors, £70; Igranic Electric Co., motor starters, £240.

Sheffield Electric Supply Committee has also accepted the tenders of A. Reyrolle & Co., for 12 h.t. switches (£209), and of the Chatteris Engineering Co., for the electrification of the 20 ton overhead travelling crane in the engine room at Neepsend (£902).

The Council is also recommended to authorise the general manager of the electric supply department to place an order for 50 tons of electrolytic copper wire bars to be made up into cables as and when required.

The general manager of the water department has purchased from Fred. Spivey a 12 in. electrically-driven pump, for £55; and from T. Oxley (Ltd.) a 100 H.P. motor, with starter, cables, &c., for £215.

WOLVERHAMPTON.—The Electricity Committee has accepted the tenders of Gibbons Bros. for supplying and fixing a steel roof to the boiler house (at £383); and of Melville, Dundas & Whitson, for supplying and fixing a crane gantry at the electricity works (at £811).

WOOLWICH. The Borough Council has accepted the following tenders:

Ferranti (Ltd.), one 200 k.v.a. three phase transformer, £188, and instrument transformers, oil switches, ammeters and copper rod, £285. 1s. 10d.; General Electric Co., cables, £7 4; Ferguson, Pailin & Co., watt-hour meter; Holden & Brooke, feed-water heater, £84.

CONDENSING PLANTS.—The Mirrlees Watson Co. have recently received orders for 34 sets of condensing plants, practically all for war service work, and of varying steam duties up to 130,000 lb. steam per hour.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bournemouth.—The accounts of the Corporation tramways department for the year ended March 31, show total capital expenditure £477,176 (increase £10,103) apart from the cost of the Poole Corporation's tramways, which are leased to Bournemouth Corporation.

Revenue was £107,821 and working expenses were £51,794, leaving gross profit £56,027, or £56,720 including net revenue additions. Interest required £10,877, sinking fund and repayment £16,799, rent of lines £7,737, allowances to dependents of men on H.M. Service £4,173, and other net revenue charges £2,038, the net profit being £15,094, minus £1,037 loss on motor-'bus account. Of the net balance £10,000 is placed to renewals and £1,000 to reserve. Average total revenue per car-mile was 15·48d., and working expenses, including power, were 7·46d. Passengers carried were 17,577,580, car-miles run 1,670,702, and units used 3,025,719.

Hove.—The following is an abstract of the accounts of the electricity supply department for the year ended March 31 last.

Section A, *Hove.*—Total capital expenditure, £184,852 (increase £2,103), of which £7,082 has been repaid. Revenue was £22,325, and gross profit £10,801. After providing for interest, instalment of principal and income tax, the net profit was £119. Units generated were 1,314,491 and sold 1,024,031. Total maximum supply demanded was 707 kw.

On the B (*Aldrington*) Section the capital expenditure is £11,523 (increase £583), of which £7,991 is outstanding. Revenue was £1,678, and gross profit £433. After meeting capital charges the net result was a deficiency of £252. Units purchased were 91,705 and sold 84,148. Total maximum demand was 53·7 kw.

The net deficit on the whole undertaking was £133.

Kingston-on-Thames.—The accounts of the electricity department for the year ended March 31, which were adopted at the Council meeting on Sept. 26, show gross capital expenditure £130,146 (increase £802), of which £59,111 has been repaid.

Revenue was £16,822 (compared with £1,295 in previous year), working and general expenses were £8,903 (£8,588), leaving gross profit £7,919 (£6,684). Interest required £3,430 (£3,219), and repayment of capital £5,118 (£4,760), the net result being a deficit of £629 (£1,295). Total costs exclusive of capital charges were 1·848d. (1·773d.) per unit sold, or including capital charges 3·622d. (3·4219d.). Units sold were 1,156,207 (1,162,001). Total connections are equivalent to 83,395 32 watt lamps (increase 3,918). Of the units sold 181,987 were generated by the steam plant, the fuel cost being 3·286d. per unit, and 974,220 by the oil plant, the fuel costing 0·164d. per unit.

St. Pancras (London).—The accounts of the electricity undertaking for the year ended March 31 show total capital expenditure out of loans £574,572, of which £174,010 has been repaid, while £34,316 has been written off in respect of assets sold or discarded.

Revenue was £98,441 (compared with £87,050 in previous year), and working expenses and special charges amounted to £59,004 (£51,979), leaving gross profit £39,437 (£35,072). Interest required £14,620 (£14,713), and instalments of loans £14,566 (£13,853), the net profit being £10,337 (£6,619). Units generated were 13,956,400 (12,578,870) and sold 10,649,038 (11,760,186). Total maximum supply demanded was 5,550 kw. (5,150 kw.). An addition of 10 per cent. to the charges for current was in force during three-quarters of the year. The number of consumers increased from 4,456 to 4,732. The year's increase in connections was 2,652 kw., of which motors accounted for 1,772 kw. and heating and cooking apparatus 2,652 kw.

Wimbledon.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £267,677 (increase £5,454), and outstanding debt, after deducting sinking fund in hand, is £154,329.

Revenue was £37,914 (compared with £38,731 in previous year), and principal and sinking fund required £11,703 (£11,565), and interest £6,343 (£5,922), the net result being a deficit of £2,525 (against a profit of £2,183). Average price obtained for private lighting was 3·846d. (3·778d.) per unit, and total cost, including capital charges, &c., was 2·568d. (2·454d.). Units generated were 4,941,140 (4,666,801), and sold 3,781,744 (3,569,217). Total maximum supply demanded was 2,208 kw. (2,120 kw.).

COMPANIES' MEETINGS AND REPORTS.

BRITISH DYES (LTD.)—The accounts for the year ended April 30 show that, after providing £200,000 for increased cost of construction during the war, depreciation and obsolescence of buildings and plant, the trading profit was £65,982. 11s. 6d. After deducting proportion of profit payable to vendors under agreement of sale (£12,000), preliminary expenses written off (£8,984), interest of Government debenture (£29,639), the balance is £15,359. The directors recommend the declaration of a dividend at the maximum rate allowed—namely, 6 per cent. per annum (£11,300)—leaving to be carried forward £4,059. [illegible]s. 1d.

MEXICO TRAMWAYS SCHEME.—Sir Alex. Roger presided at meetings of the first and second mortgage bondholders and of bondholders in the Pachuca Light & Power Co. last week, when a series of resolutions were submitted embodying approval of the recommendations and suggestions of the National Trust Co., of the bondholders' committee and of the policy proposed by them, as outlined in their circular letter of June 27 last. The scheme ratified the action of the trustee in not having taken steps to enforce any of the rights in respect of the shares or securities held by them as trustees. The chairman said he thought it had been established to the satisfaction of the bondholders that all the companies were intimately related and inter-dependent, and that under existing conditions the failure of any one company of the group to comply with the franchise and other obligations might well have disastrous consequences to all. It was of paramount importance, for the present at least, that all the companies should stand together for mutual protection. Under the resolution power was given to raise a limited sum if it should be necessary. It should be clearly understood that the policy laid down was purely a temporary expedient to bridge over the present time of difficulty in Mexico. Since the meeting in July aaffirs in Mexico could not be said to have improved, and it seemed unlikely that any permanent stability would be reached unless some form of intervention and financial control came about. They had a long way to go before conditions became normal, but after a year's experience they were more than ever convinced that the policy of central control of all the groups of companies, the pooling of the resources, and the showing of a united front was undoubtedly the right one, and, indeed, the only one.

SPANISH & GENERAL WIRELESS TRUST (LTD.)—At the meeting last week the chairman (Mr. Godfrey C. Isaacs) said that, for the most part, their holding consisted of the converted shares in the Spanish company. That company had not developed quite as rapidly as they had hoped, owing to difficulties which had arisen in regard to the concession. There had been a matter of negotiation with the Spanish Government. Some progress had been made, but the negotiations had not yet reached finality. There was also the matter of remuneration and compensation in connection with work done since the outbreak of hostilities, not only from the Spanish Government, but from other Governments. There was reason to believe that the Spanish company would receive considerable payment from different sources for work which had been done. Apart from their holding in the Spanish company, and the sources of revenue they looked to from it, there had been, prior to the war, work in which they had achieved a certain amount of success, but that was [illegible] a standstill. Since June 30 they had been able to [illegible] and he had great hopes that between now and the end of the financial year they would be able to complete certain business which would materially assist the company.

CITY NOTES.

MEMORANDA (Oct. 11).—Bank rate 6 per cent. (since July 13, 1916). Consols 5s [illegible]. Consols Pay Day, Nov. 2. Stocks and Shares Ticket Days Oct. 2[illegible] and Nov. 14. Pay Days, Oct. 27 and Nov. 15. Price of silver, 32⅜.

BRITISH THOMSON-HOUSTON CO. (LTD.)—At a recent board meeting of this company Mr. J. F. Nauheim retired from the chairmanship as from Sept. 2[illegible]. [illegible] Mr. H. C. Levis, the managing director, was appointed [illegible], but he also retains the managing directorship of [illegible].

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—A half-yearly dividend [illegible] per annum (less tax) has been declared on the pre-[illegible].

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved t[illegible] dividend of 2s. per share (less tax at 5s.), such dividend to be [illegible] after the 31st inst., making with the interim dividend [illegible] paid a total distribution of 1 per cent. for the half-year ended [illegible].

INDO EUROPEAN TELEGRAPH CO. (LTD.)—The directors have de-[illegible] dividend for half-year ended June 30 last at rate of 5 per [illegible] tax free, payable on the 1st prox.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.).—The Directors have d[illegible] the following interim dividends: 3 per cent. on the 6 per cent. [illegible] preference shares for the current year (less tax) and 4 per [illegible] shares (tax free).

SUBMARINE CABLES TRUST.—Notice is given that on the 16th inst. [illegible] the 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67 Lombard-street, London, E.C.

METAL PRICES.

[illegible] 132 Upper Thames-street, London, E.C., quote under [illegible] prices of—

	Per ton
English Lead	£31 5 0
Antimony	Nominal.
OLD METALS.	Per ton.
Clean Copper Scrap	£104 0 0
Clean Brass Scrap	62 0 0
Braziery Copper Scrap	90 0 0
Old Lead	27 0 0
Old Zinc	38 0 0
Hollow Pewter	120 0 0
Black Pewter	9[illegible] 0 0
Gun Metal	82 0 0

[illegible] Southwark, London, S.E., quotes under date [illegible] Old Metals:—

	Per ton.
Old Lead	£3 1[illegible] under English lead price
Old Zinc	4[illegible] 0 0
Hollow Pewter	1[illegible] 0 0
[illegible] Black Pewter	90 0 0

[illegible] Plumbers' Solder in bar [illegible], Blowpipe Solder, £107.

ELECTRICAL COMPANIES' SHARE LIST.

[illegible] prices at which actual transactions took place [illegible]

[illegible]	[illegible]	NAME	Price, Tues., Oct. 10	[illegible] Yielded	Dividend Due
		Electricity Supply.			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

‡ Ex[illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Oct. 10	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6⅞	6 5 6	Feb, Aug
5	7%	Do. do. Pref.	5 13/16	6 0 5	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72¼	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1⅛	6 14 8	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6⅜	5 5 11	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4⅛	5 4 1	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	83	6 4 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	79	7 11 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	72	5 11 1	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82¼	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	76	5 5 3	Jan, July
St.	4%	City & S. London Deb.	74¾	5 7 0	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1¼%	London Electric Ry. Ord.	2 3/16	5 15 4	Jan, July
St.	4%	Do. 4% Pref.	65	6 3 1	Mar, Sept
St.	4%	Do. 4% Debs.	74½	5 7 5	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23⅛	4 5 4	Feb, Aug
St.	3½%	Do. 3½% Pref.	61	5 14 9	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	58	6 0 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	67½	5 3 8	Jan, July
St.	3½%	Do. 3½% Debs.	66½	5 5 3	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	17	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	70	6 8 7	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	70⅛	5 14 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	3	5 0 0	Apl, Oct
1	6%	Do. 6% Pref.	1 11/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1 13/32	4 18 0	Mar
100	5%	Do. Prior Lien Debs.	93½	5 6 11	Jan, July
1	6%	Do. 6% Pref.	15/16	6 8 0	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12¼	7 2 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 3/16	5 15 8	Jan. July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 7 5	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2½	6 0 0	April
100	6%	Do. 6% Prior Lien Debs.	99¾	6 0 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	67½	5 18 6	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12⅝	7 18 5	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	¾	8 0 0	Sept.
5	..	Edison & Swan U. Elec. Lt. A. £3 pd.	½	..	Feb, Aug
St.	4%	Do. 4% Deb.	61¼	6 10 7	Jun, Dec
1	7½%	Elec. Construction Ord.	15/16	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
10	6%	Do. 6% Pref.	9¾	6 1 6	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16	6 5 0	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4 5/16	5 10 9	..
St.	4½%	Do. 4½% Db.	88½	5 1 8	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	12 1/16	8 5 10	Feb, Aug
10	5%	Do. Pref.	7⅞	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38½	6 4 8	Mar, July
100	4%	Do. 4% Debs.	95½	4 4 1	Jan, July
1	7½%	Vickers Ord.	1 [illegible]	3 18 8	May, Aug
1	6d.	Do. 5% Pref.	[illegible]	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	75	5 6 8	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¼	4 10 8	June, Dec
St.	4½%	Willans & Robinson B. Cm. Pref.	41½	9 18 10	..
St.	4%	Do. 1st Mt. Deb. St.	56¾	7 1 0	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100⅞	5 19 0	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23¾	6 18 8	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70½	5 14 2	Ja. Ap. Jly,O
10	5%	Cuba Submarine Ord.	8 [illegible]	6 0 9	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6[illegible]	5 18 6	Ja.Ap.Jly.O
St.	8%	Eastern Tel. Co. Ord.	144½	5 10 11	Ja.My.Jly,O
[illegible]	3½%	Do. 3½% Pref.	66	5 6 1	Ja.My.Jly,O
[illegible]	4%	Do. 4% Debs.	79	5 1 3	May, Nov
[illegible]	4%	Eastern Extension Tel Co., 4% Debs.	77	5 3 10	Feb. Aug
10	[illegible]	Do. Ord.	14⅛	5 13 3	Ja,Ap,Jly,O
10	[illegible]	Gt. Northern Tel Co. With Coup. 11	39 [illegible]	5 11 7	Ja, My, Jly
[illegible]	13%	Indo-European	50⅛	6 14 8	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2 [illegible]	3 7 1	April
[illegible]	7%	Do. 7% Pref.	2½	2 16 0	July
[illegible]	1%	West India & Panama Ord.	[illegible]	10 6 5	May, Nov
[illegible]	6%	Do. 1st Pref.	7 [illegible]	6 11 9	May, Nov
10	[illegible]	Western Telegh Co.	14 [illegible]	5 9 10	Mr.Jly.O.Dec
[illegible]	4%	Do. 4% Deb. St.	77	5 3 11	June, Dec
[illegible]	[illegible]	Western Union 50-yr. Bds.	99½	4 10 10	May, Nov
		Telephones.			
1	[illegible]	Monte Video Teleph. Ord.	[illegible]	9 2 10	Nov
1	10%	Oriental Telephone Ord.	[illegible]	4 8 10	Apl, Oct
[illegible]	[illegible]	Do. [illegible] St.	79	5 1 3	Jan, July
[illegible]	[illegible]	[illegible] Db. St.	83	5 8 5	Jan. July
[illegible]	[illegible]	United River Plate Ord.	[illegible]	5 18 0	Apl, Oct
[illegible]	[illegible]	Do. [illegible] Cum. Pref.	[illegible]	5 4 7	Jan, July
[illegible]	[illegible]	Do. Deb. St.	[illegible]	5 5 3	Jan, July
		Financial and Investment.			
[illegible]	[illegible]	[illegible] Telegraph & Trust	[illegible]	4 16 0	Sp.Dc Mr.Jn
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[illegible]	[illegible]	[illegible]	[illegible]	5 17 6	Ja.Apl.Jly.O
[illegible]	[illegible]	[illegible]	[illegible]	5 14 3	Ja.Apl.Jly.O
[illegible]	[illegible]	[illegible] Cable Trust [illegible]	[illegible]	4 13 5	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
[illegible]	[illegible]	[illegible]	4 [illegible]	6 1 6	Mar, Sept
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‡ Ex dividend or Interest.

THE ELECTRICIAN:

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NOTES.

The Breakdown at Birmingham.

A SERIOUS breakdown which occurred in the electric supply department at Birmingham last week emphasises a point to which we have repeatedly called attention. It is hopeless to suppose that overloaded plant can run indefinitely. If there is an insufficient margin for safety, then a breakdown must occur sooner or later, and the longer this state of things is allowed to continue the worse it must become. So far, the breakdown appears only to have affected the tramway service, but in these days the nation cannot afford to do without services to which it has become accustomed and on which it depends, and if the means of transit for munition workers is cut off the efficiency of their work must necessarily suffer. It will be necessary for the Government to realise that the policy of starving electric generating stations is penny wise and pound foolish, and that it is a mistaken policy which cannot be set right in a day. Turbo-generator sets of, say, 10,000 kw. cannot be supplied at a moment's notice, and even when they are supplied time is required for their erection and to put them into commission. We trust that the breakdown to which we have referred will cause the Government to take a more rational view of the whole matter.

Combined Electricity and Gas Undertakings.

IN an interesting Paper read by Mr. J. W. NAPIER before the North British Association of Gas Managers the question whether gas authorities should also run electricity works is considered at some length, and is illustrated by a description of what has been done at Alloa. Some years ago the undertaking at Alloa purchased energy in bulk at rates which appear to have given no chance of the development of a power load. This is unfortunate, for the policy in these days should be towards bulk supply rather than towards the erection of small stations. In this particular instance the power company apparently did not see their way to arrange suitable terms, and consequently the agreement was terminated. The Council then decided to erect electrical plant at the gas works, power being obtained from gas engines using producer gas, and the producers being supplied with coke from the gas works. The gas and electricity stations are under the same management, and consequently there is a considerable economy under that heading. The result of the new policy has been a rapid extension of the power load: in 1916 the total number of units sold amounted to 780,963, as compared with 178,557 in 1912.

FROM the abstract which we give elsewhere it will be seen that the total working costs amount to 0·90d. per unit sold, and it will be admitted that this is a low figure for a comparatively small undertaking. Comparison with undertakings of a similar size operating with steam plant shows at once that the fuel cost of 0·23d. per unit is where the chief gain is to be found, though in the management also, which stands at 0·05d., there is considerable saving, as might be anticipated. On the other hand, the cost of oil, water, waste and stores amounts to 0·11d., and is more than double the figure which is usually found. Wages are somewhat on the high side, but repairs and maintenance are rather lower than usual, and have probably not yet reached a stationary figure. So far, non-recovery plant has been used, but in the extensions which are now contemplated it is the intention to include Mond plant, and in that event the cost of fuel should be still lower. In the case of small undertakings there seems to be a great deal to be said in favour of combined undertakings of this kind, as the cost of production can be reduced and the outside staff can be employed in dealing with both electricity and gas. On the other hand, if an undertaking reaches any considerable size, it is probably better that the conflicting interests should be quite separate, for the greatest progress is generally made where there is keen competition.

Co-operation Between Engineering Institutions.

THOSE who question either the advisability or practicability of active co-operation between our engineering institutions are advised to study the results which have been obtained by such co-operation in the United States. After 12 years the American Society of Civil Engineers has decided to co-operate with the United Engineering Society and to become one of the founder societies with a one-fourth interest in the Engineering Societies' Building. The library of the "Civils" is to be added to the Engineering Societies' library, and the whole is to be conducted as one public library under the management of the

United Engineering Society. The American Society of Civil Engineers is to be complimented in making what we consider to be a wise decision, and beyond question such co-operation will serve to strengthen the voice of engineers in the United States. That our engineers stand in need of similar co-operation has been made evident during the last two years, and in some quarters the view is held that the close proximity of the Houses of Parliament acts as a "deadening hand" on our Engineering Institutions. To enable the latter to make progress and to add to the dignity of the profession we would have them [illegible] prejudice and work hard and work together. It must be discouraging to many of our engineers to feel that the Institutions and Societies to which they belong are regarded by the powers "over the way" as a species of glorified trade union, and as such to be ignored or given little encouragement.

◆

Compulsory Use of Electricity.

In an address to the Birmingham Association of Mechanical Engineers Mr. R. A. Chattock complained that the very slow development of the electric supply business in the past did not hold out much hope of any real progress being made by natural development. We believe that Mr. Chattock is a little too pessimistic. Although the development in many cases has undoubtedly been slow, in the industrial towns the development during the last decade has been fairly satisfactory, and in some towns has even been phenomenal. Compulsion at its best is an ugly word, and we doubt whether some form of compulsion as suggested by Mr. Chattock, will help to accelerate electrical development in such a way as to be beneficial to the industry. It is not so much the fault of the small station and the lack of initiative on the part of electrical engineers as the absurd restrictions that have been imposed by the State that accounts for the slow rate of progress. And, in spite of these restrictions, in many industrial areas it has been found necessary by power users to adopt the electric drive on account of the high price of coal. Had facilities to be granted for the subdivision of the country into a number of areas, with relatively few interlinked power stations of large size, and had Parliament [illegible] colliery proprietors supplying coal to them at reasonable rates, the question of compelling people to [illegible] would not arise. The difficulty, we venture to think, would be in coping with the demand. We already have [illegible] and some of the shackles imposed by [illegible] administrators must be removed [illegible] manufacturers.

◆

Research Extraordinary

[illegible] Chattock [illegible] suggestion which [illegible] happen [illegible] It is rightly [illegible] should be installed [illegible] Chattock [illegible] probably [illegible] should be [illegible] from the Govern[illegible] benefit [illegible] what [illegible] the results [illegible]

Memorial to Sir William Ramsay.—A meeting to consider the steps to be taken to raise a memorial to the late Prof. Sir William Ramsay will be held at University College, London, on the 31st inst., at 4.30 p.m. After the meeting, the Director of the University College Chemical Laboratories, Prof. Sir Norman Collie, F.R.S., will deliver a memorial lecture on "The Scientific Work of Sir William Ramsay," at 5.30 p.m.

Complex Quantities in Alternating-Current Theory.—In our issue of September 29th we published a note summarising a Paper read by Mr. N. S. Diamant before the American Institute of Electrical Engineers upon the use of the operator j^n. Mr. C. Turnbull calls our attention to the fact that he suggested the use of fractional powers of j in the way described last year. The letter of Mr. Turnbull dealing with this subject will be found in THE ELECTRICIAN of April 9, 1915.

Lifting Magnets for Unloading Vessels.—Electric lifting magnets have been used for some time at the docks on the American Lakes for unloading pig-iron, but until this year none of the vessels carried such magnets: the 65 lb. chunks of metal were handled by hand. The Charcoal Iron Co. has, however, now purchased a lake-freighter and installed on board three 36-in. circular type magnets. The new method was first applied at the Ashland Docks, Wis. The net weight of pig-iron lifted with all three magnets working is 4,500 lb. It is stated that the entire cost of loading a cargo of 2,000 tons is now only £20, whereas the cost with hand-labour would have been £100 to £120.

Bakery and Electrical Engineering Laboratory.—A recent issue of the "Architect's and Builder's Journal" contains an account of the new Bakery and Electrical Engineering Laboratory at the Cardiff Technical Institute. The laboratory will be used for demonstrations of bakery including the preparation of bread and confectionery. Gas and electricity are available, and a feature is the arrangements of the switchboard so that all connections can be easily followed by the student. The room receives continuous roof light by day and is lighted with indirect arcs by night; no doubt, in selecting the latter method of illumination consideration has been paid to the correct observation of tints of the materials treated, on which judgment in bakery largely depends.

Electric Pumps in Mines.—According to the "Mining and Scientific Press" (San Francisco) electric pumping is being largely installed in the mines of Michigan. Thus in one case a motor-driven horizontal plunger-pump with a capacity of 125 gallons per minute is now used, while in another mine two motor-pumps with a combined capacity of 220 gallons per minute have been adopted. The following figures are given for the comparative maintenance costs of eight centrifugal and steam pumps during one year in one of these mines:—

	Electric Centrifugal.		Steam.
Shop labour	$717	......	$760
Labour on pumps	690	......	590
Supplies	503	......	2,021
	$1,910	......	$,3371

In this case each of the pumps had a rated capacity of 900 gallons per minute. One advantage of the centrifugal pump is that the flow of water can be readily regulated within wide limits.

Variable Self and Mutual Induction.—A recent scientific Paper by Messrs. H. B. Brooks and F. C. Weaver, of the Bureau of Standards, outlines the development of a new form of instrument for varying the self-inductance of a circuit, or the mutual inductance between two circuits. It consists of two pairs of fixed coils held in stationary ebonite discs, between which a third disc carrying two coils is arranged to be rotated. The form and the spacing of the coils were determined so as to secure the following advantages: (*a*) High ratio of inductance to resistance; (*b*) scale divisions of uniform length reading directly in units of inductance; (*c*) astatic arrangement of the coils which reduces the liability of errors caused by the proximity of other instruments or of conductors carrying currents. Diagrams and data are given from which instruments of this type can be designed for given uses. Comparison is made of the new instrument and of some other older forms of variable inductor, including the Ayrton-Perry.

Extraction of Radium.—A bulletin issued by the Department of the Interior, Washington, describes the extraction and recovery of radium, uranium and vanadium from carnotite. The report was prepared in co-operation with the National Radium Institute, which was formed shortly after 1912 with a view to conserving the ores containing radium in the United States. The discussion of various methods of treating radium ores and measuring radio-activity are very full, the whole report occupying over 100 pages and provided with index and bibliography. As a result of experiments over several years, the average cost of one gramme of radium element works out to $37,599 (£7,520). On the other hand, for several years the market price has been in the neighbourhood of $120,000 (£24,000) per gramme of radium element. It is not anticipated that for some time to come diminution of cost of extraction will materially lower this price. The amount of radium in Nature is very small, and the case is analogous to that of gold and other precious materials, which occur only in such small quantities that improved methods of extraction do not readily affect their market value.

A Ministry of Science.—That those who live by science are not enthusiastic over the proposal that the State should be responsible for the administration of scientific matters is evident from the following note in the "Journal of Chemical Technology": "With the proposal that a Ministry of Science should be formed we have little sympathy. It is distinctly undesirable that the State should be put into the position of being able to control, or to interfere, in the administration of scientific matters. Moreover, nothing could be done by a Ministry of Science that could not be more effectively, quickly and more cheaply accomplished by a representative body of scientific men themselves. Government departments are all stereotyped in their methods and there is no reason to expect that the proposed Ministry of Science would prove an exception to the rule. It is impossible to associate red-tape with the advancement of science, and as the Ministry would necessarily be invested with a large measure of authority it would almost certainly be found to be much less a benefit than an actual obstacle to progress." We compliment the Institution of Chemical Technologists on its outspokenness.

High-Frequency Spectrum of Tungsten.—A Paper on this subject was contributed to the "Proceedings" of the National Academy of Sciences by Messrs. A. W. Hull and M. Rice. The spectrum of tungsten at voltages up to 150,000 has been studied, and photographs are given showing the first, second and third order reflections of the $K\alpha$ and $K\beta$ lines. The position of the K lines in relation to the general radiation at various voltages has been studied by means of the ionisation chamber and is shown on curves of intensity for seven voltages between 40,000 and 103,000. The lines first appear at 80,000 volts, increasing in intensity with rising voltage. Kossel's quantum relations between the frequencies of K and L lines hold true for the tungsten lines. All the lines, including tungsten, can be expressed by the empirical formulæ:

$$\gamma\alpha = 1{\cdot}64 \times 10^{15} N^{2{\cdot}10} \text{ for the } \alpha \text{ lines}$$
$$\gamma\beta = 1{\cdot}56 \times 10^{15} N^{2{\cdot}15} \text{ for the } \beta \text{ lines,}$$

where γ is the frequency and N the atomic number. The shortest wave-length observed was 0·08 A.U. The proportionality between frequency and voltage observed by Duane and Hunt holds accurately up to 100,000 volts and less accurate measurements indicate its constancy up to 150,000 volts.

World's Largest Direct Current Station. According to the "Electrical World," the power plant now installed at the Detroit works of the Ford Motor Co. (U.S.A.) is considered to be the largest purely direct-current installation in the world. The plant, when completed, will consist of 14 6,000 H.P. and one 4,000 H.P. reciprocating engines of the composite gas-steam type, and one 1,500 H.P. steam engine. These are connected to 250-volt direct-current Crocker-Wheeler generators of 4,000 kw., 2,500 kw. and 1,000 kw. respectively, operated in parallel and giving the station a maximum rating of 65,000 kw. The parallelling of these large units necessitates special arrangements, a feature being the provision for transferring the load of any unit from the gas to the steam side should the action of the gas engine become irregular. Another feature is the regulation of the voltage of all the generators from a centralised control board by means of I-T-E motor-operated field rheostats. The switchboard is 424 ft. long, and contains 222 panels, about 165 tons of copper being used between station switchboard and distribution centres. More than 8,000 machines are operated over a floor area of 47·5 acres from a distribution system requiring 178 feeders.

Linking-up the Engineering Societies.—The August "Proceedings" of the American Society of Civil Engineers contains the final agreement between the governing board of that society and the United Engineering Society, under which the former becomes one of the founder societies, and acquires the ownership of a one-fourth interest in the Engineering Societies' Building at New York, with the ground on which it stands. The building is to be enlarged by the addition of three more stories, making a total height of 15 stories. The building committee has awarded the contract for the preliminary structural work, and the contractor began work on August 1st. The American Society of Civil Engineers is to pay the cost of adding these three additional stories, provided the cost is not in excess of £50,000, in which case the balance will be paid by the United Engineering Society. The library now owned by the American Society of Civil Engineers is to be added to the Engineering Societies' library, the whole to be conducted as one public library under the management of the United Engineering Society. Suitable changes have been made in the constitution and by-laws of the United Engineering Society, so that the four societies stand on an equal footing in it, exactly as would have been the case had the American Society of Civil Engineers joined the other three societies in the building enterprise 12 years ago.

Greater London Linking Up Scheme. At a meeting of the Joint Committee of Engineers appointed by the Engineers' Committee of the Conference of Local Authorities in Greater London owning electricity undertakings, held at the Institution of Electrical Engineers on the 13th inst., Mr. J. S. Highfield (Metropolitan Electric Supply Co.) stated that the National Power Supply Joint Committee did not propose to convene a committee for Greater London area, as they hoped that the Committee appointed by the conference would act in conjunction with the National Committee.

It was resolved that "A formal notice be sent to the secretaries of the National Committee stating that a conference had been formed of representatives of private and public interests to consider the best method of linking up generating stations in Greater London area." The Joint Committee is constituted as follows:—

Companies.—Charing Cross, West End & City Electric Supply Co., City of London Electric Lighting Co., County of London Electric Supply Co., Kensington & Knightsbridge Electric Lighting Co., London Electric Supply Corpn., Metropolitan Electric Supply Co. and the Westminster Electric Supply Corpn.

Municipalities.—Messrs. G. G. Bell (Hammersmith), F. A. Bond (Battersea), E. Calvert (Finchley), A. C. Cramb (Croydon), L. L. Robinson (Hackney) and W. C. P. Tapper (Stepney).

Other Representatives.—Mr. C. A. Baker (London County Council), Mr. E. T. Ruthven Murray (North Metropolitan Power Supply Co.) and Mr H. W. Firth (Great Eastern Railway), with Messrs. F. J. Walker (St. James' & Pall Mall Co.) and Fred Tait (Poplar), joint hon. secretaries.

Correction of Echoes and Reverberations in an Auditorium. Some interesting experiments on the acoustic properties of an auditorium are described by Messrs. F. R. Watson and J. M. White in a recent bulletin issued by the University of Illinois. In the auditorium at this university echoes and reverberations had given trouble, and for several years experiments have been in progress with a view to ascertaining their cause. Various devices, sounding boards, wires spanning the building, &c., were considered, but it was decided that the most hopeful method of cure was to cover portions of the walls with material capable of absorbing sound. The acoustic properties of the room were first studied by tracing the path pursued by a small bundle of sound transmitted in a given direction, and observing what became of it after reflection. The most conclusive results were obtained by using as a source of sound a hissing arc backed by a reflector. In this way the chief surfaces giving rise to echoes were quickly noted. Ultimately a considerable proportion of the wall-area was padded with special sound-absorbing felt, mounted on ribbing, so as to stand away from the wall. In this way the inconvenient echoes were almost entirely eliminated, and the reverberations, or undue prolongation of sound, were also much reduced. Experience has shown that the time of reverberation (which is calculated from the formula $t=0{\cdot}164V/a$, where V = volume of the room, and a the total absorbing power of its surfaces) should not exceed about 1·8 seconds for good acoustic results. The use of sound absorbing padding for the walls of a room was recommended many years ago by Lord Rayleigh. But apart from this, the shape of the room and its volume in relation to the sound produced deserve study. In general a room which is entirely suited to the voice of an average speaker is not adapted for loud organ music. Jäger has suggested that the ratio S/W (where S is the total surface of walls, furniture, fixtures, &c., exposed to the sound, and W the volume of the interior) should be large, in order to obtain good acoustic results. This ratio is least for a sphere; poor results may, therefore, be expected from halls that are approximately hemispherical in section. Generally speaking, curved surfaces, domes, &c., are less satisfactory than plane walls, as they tend to create undesirable concentrations of sound. Ventilation openings, on the other hand, are sometimes serviceable in diminishing echoes and reverberation.

OBITUARY.

KILLED IN ACTION.—The following deaths in action or of wounds are reported:—

[illegible] (R.E.), who was killed on the eve of his [illegible] birthday, was a member of the Electrical Engineers' Corps at [illegible] until the outbreak of the war. He [illegible].

[illegible] F. L. [illegible], 19 years of age, who has died of [illegible], was [illegible] at the Armstrong College when war was [illegible].

[illegible] Captain [illegible] J. Smith (Duke of Wellington's [illegible]), [illegible] was 27 years of age. He was a [illegible] at Nantwich Grammar School.

[illegible] E. L. [illegible] (Liverpool Regt.), who has been [illegible]. He was engaged in the Liverpool Corpora[illegible] the Army.

[illegible] (R.E.), formerly employed in the Bolton [illegible].

[illegible] 18, formerly a Blackburn [illegible].

PERSONAL.

[illegible] has appointed Mr. Stephenson Kent to [illegible] Labour Supply, and Mr. [illegible] Wolff [illegible] Secretary to the Ministry.

[illegible] acting manager of the [illegible] has just been promoted [illegible] near East, and was [illegible].

Mr. W. Bangor Jones, [illegible] engineer to Bettws-y-Coed [illegible] during his absence Mr. Targett, of Llanrwst, [illegible].

[illegible]

[illegible] H. [illegible]

[illegible] Lieutenant [illegible]

APPOINTMENTS VACANT AND FILLED.

A [illegible] is wanted by [illegible] Tramways Corporation. Applications to the borough electrical engineer (Mr. C. H. [illegible]) [illegible]. See [illegible].

An estimating clerk is wanted by a leading firm of electric accumulator makers for their London office. *See an advertisement.*

An advertiser requires a foreman thoroughly conversant with the manufacture of electrical resistances.

A chief engineer is required for the Port of Dublin. Must have experience of management of electrical and steam and dredging plant. Applications, stating salary required, &c., to the Secretary, Dublin Port and Docks Board, by Oct. 25.

An engineer with experience of steam and electrical plant is required for Park Prewett Asylum. Forms of application from the Clerk of the Hampshire Joint Asylums Visiting Committee, The Castle, Winchester. Applications by 10 a.m. Oct. 30.

Mr. C. W. Saddington has been appointed burgh electrical engineer of Oban in succession to Mr. D. McLennan, who has resigned.

Mr. Targett, of Llanrwst, is acting as electrical engineer at Bettws-y-Coed while Mr. W. Bangor Jones is serving with H.M. Forces.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—The opening meeting of the session 1916-17 will take place on Thursday, November 9, 1916, at 8 p.m., when the premiums awarded for Papers read or published during the past session will be presented, and the eighth Kelvin lecture, "Some Aspects of Lord Kelvin's Life and Work," will be delivered by Dr. Alexander Russell, vice-president.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 20th (to day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers. Paper on "Trials on a Diesel Engine, and Applications of Energy Diagrams to Obtain Heat Balance," by the late Lieut. Trevor Wilkins, M.Sc., to be presented by Prof. Burstall.

MONDAY, Oct. 23rd.

WESTERN LOCAL SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

5.10 p.m. At the Lesser Hall of the Merchant Venturers' Technical College. Addresses by the President, Mr. C. P. Sparks, and by the Chairman, Prof. D. Robertson.

INSTITUTION OF ELECTRICAL ENGINEERS, WESTERN LOCAL SECTION.

5.10 p.m. At the Merchant Venturers' Technical College, Bristol. An address will be delivered by Prof. D. Robertson.

TUESDAY, Oct. 24th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. The 24th "James Forrest" Lecture, entitled "The Development of Appliances for Handling Raw Materials and Merchandise at Ports and other Large Centres of Traffic," will be delivered by Sir John Purser Griffith.

FRIDAY, Oct. 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, South Kensington.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week.—Platoon Commander H. de. P. Birkett.
Next for Duty.—Platoon Commander N. E. Brown.

Monday, Oct. 23rd.—Technical for Platoon No. 9 at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Classes; Recruits' Drill 6.25-8.

Tuesday, Oct. 24th.—School of Arms, 6-7; Lecture 7.15: "The Meaning of and Necessity for Drill," by Company Commander Fleming; Range Practice.

Wednesday, Oct. 25th.—Instructional Class, 5.45; Platoon Drill, Platoon No. 3; Range Practice.

Thursday, Oct. 26th.—Platoon Drill, Platoon No. 7; Range Practice.

Friday, Oct. 27th.—Technical for Platoon No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.25-8.25.

Saturday, Oct. 28th.—General Parade 2.45, uniform, for Drill; Recruits' Drill 3.0.

Sunday, Oct. 29th.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway) Booking Office 8.15 a.m. Uniform, haversacks, water bottles, midday ration to be carried; railway vouchers will be provided.

Musketry.—For all Companies, see Notice and Tables A and B at Headquarters.

NOTE.—Unless otherwise indicated all drills, &c., will take place at Headquarters.

PRESIDENTIAL ADDRESS TO THE BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.*

BY R. A. CHATTOCK.

The present altered conditions of working will deeply affect the engineering industries after the termination of war. There may come a period of disorganisation, but this will probably not be of long duration, if the efforts of manufacturers are concentrated on developing the trade of the country, and organising their industries on scientific lines. Full advantage must be taken of economies suggested by scientific research.

Research work is very expensive work, and manufacturers often find it difficult to afford the cost of such work, unless they are working on a very large scale. In such cases industrial combinations of groups of manufacturers would be helpful. It would, however, be the wrong policy for a great number of research laboratories to be installed, leading to duplication of work.

Central research laboratories should be installed, each one dealing with some special branch of the manufacturing industry, where the best brains available for the purpose could be concentrated. These laboratories would probably have to be placed under Government control, but they should be maintained by the firms interested; possibly by some form of annual contribution proportionate to the turnover of such firms. Any special problems that required developing could then be referred to these laboratories for investigation. The whole question is one of great national importance, and Government control would be justified. But financial assistance from the Government is rather to be deprecated; those who benefit by the results should be asked to pay, and pay liberally, for what is done in their interests.

Another very important matter that will affect the engineering industry is the employment of labour. As a result of the present shortage of men, women have been employed to a large extent in engineering works. Whilst a certain number of these may remain, I do not think that this will be so to any very great extent. One hears of many young women who have entered works being very anxious to leave and go back to their own occupations, but owing to the rule in controlled undertakings that employees who leave without permission cannot enter other employment within a period of six weeks, they are prevented from doing so.

The high wages that now prevail in engineering works will probably continue to a large extent. There is no objection to this if the workmen will do good work for the money they receive. Unfortunately, in the past, many workmen have seemed to strive to do as little as they can for what they earn, and if this spirit is allowed to continue, effective competition with foreign countries, where such conditions do not obtain, will be almost impossible. Capital and labour cannot do without each other, and some scheme should be devised by which they can be of mutual assistance, instead of being, as at present, inclined to be antagonistic.

In order to compete successfully with foreign competition, the greater productive power of the workmen is not the only condition necessary. In addition, manufacturers must exercise greater economy in methods of production. Perhaps the most important economy that can be effected is in connection with the supply of power required to drive their works.

In a report of the Royal Commission on Coal Supplies in 1905, 5 lb. of coal per horse-power-hour was stated as the average consumption of industrial concerns in producing their own power. In the most modern electric power stations this figure could be reduced by about one-half.

An economy of 50 per cent. in the coal used for driving our factories would justify strong measures being taken to make it obligatory upon manufacturers not to waste coal by the present inefficient methods.

A committee of the British Association has been appointed to inquire into and report upon this question, with a view to coal economy and smoke prevention. The deliberations of this committee so far as they have gone, lead one to believe that the greatest economy in the use of coal can be obtained by gasifying it and recovering its valuable by-products. This must be done on an enormous scale to be really effective. Individual manufacturers could not do this nearly so economically as if the whole of the coal used in the country were treated at certain convenient centres. The number of processes involved is considerable, and the handling of each by-product would practically be a business in itself. The capital cost involved would be heavy, and could only be made remunerative by working the process on a very large scale. But if only for the proper conservation of the available coal supplies in the country, such a scheme should be developed.

The transformation of the energy in the coal into electrical energy is the one link that renders a scheme of this kind possible, because if all the coal consumed in the country is so treated at certain centres, the energy produced would have to be transmitted all over the country for use wherever it was required. The only way of doing this with a reasonable capital expenditure is electrically.

The plants would have to be installed as near to the great coal centres as possible, having due regard to a sufficient supply of water being available for condensing purposes. This is an important consideration, and may necessitate placing them within reach of the sea or on tidal rivers. If cooling towers are used roughly three-million gallons of water per day are evaporated per 100,000 kw. of plant installed, so that a station of 800,000 kw. would evaporate all the water that comes into Birmingham from Wales each day, if it could be made available. From this it is evident that an inexhaustible supply of water is a prime necessity.

A commencement in this direction has already been made. In Yorkshire, coal is being gasified at the pit; the gas is being used for firing steam boilers and producing electrical energy; sulphate of ammonia is being recovered, and coke is being produced. The Corporation of Brighton are now considering a somewhat similar scheme, although in this case the by-products are to be handled by a company, who are proposing to sell the gas to the Corporation for use in their generating station.

Energy in an electrical form can be economically transmitted at high pressure over very great distances by means of overhead trunk lines, and it can be conveniently transformed to a lower pressure and distributed wherever required. Electrical energy can now be efficiently applied to practically all purposes for which coal is now being used. Such purposes are:—

Power for driving manufactories.
Power for driving railways and tramways.
Heating of furnaces.
All domestic uses, such as heating, cooking and lighting.
Public utility services, such as lighting, pumping, &c.

Experience in the past has shown that large modern generating stations employing the most economical apparatus obtainable have been able to supply electrical energy at a figure considerably below what obtained 10 years ago, and one that is still being reduced from year to year as the stations continue to grow, and as the load factor of the stations is increased. The largest stations in this country have each approximately 100,000 kw. of plant installed. If stations were to be built to supply electrical energy for practically all purposes for which coal is now being used, they would require to be probably five times this size, or, say, 500,000-kw. capacity of plant installed. In stations of this size it would be quite possible to arrange for some of the boilers to be fired by means of gas, and for others to be fired by coke or other form of fuel that is produced from the distillation of the coal. At the same time, the valuable by-products in the coal could be recovered and disposed of, thus reducing the cost of the supply of electrical energy to the consumers.

A scheme of this kind would lend itself admirably to the utilisation of the poorer quality coals which in normal times it hardly pays to work.

In the Report of the Royal Commission on Coal Supplies it was estimated that this unworkable coal amounted to about 25 per cent. of the total coal raised from the pits.

Coal can be gasified in two ways—either by high temperature distillation or by low temperature distillation. High temperature distillation is used for the production of ordinary town gas, and certain by-products are obtained such as coke, coal tar, &c. A number of products are, however, destroyed in this process.

Low temperature distillation produces a form of smokeless fuel, different to coke, in that it will burn in an open fire grate. In addition to this, a number of other valuable by-products are produced. In order, however, to obtain the same amount of heat energy in the form of gas by this process something like six to eight times the weight of coal has to be handled to produce a fixed quantity of electrical energy as would have to be used if the coal were burned to destruction in the boiler fires.

A scheme of this kind will occupy an enormously greater area of ground than the ordinary electric generating station does at present.

Owing to the conservative nature of the average man, it is doubtful whether such a change could be brought about quickly enough to justify the erection of these larger super-stations.

The very slow development of the electric supply business in the past does not hold out much hope of any real progress being made by natural development, and some form of compulsion may be necessary to bring it about. Among the results to be obtained may be mentioned:—

1. By the proper conservation of the coal supply of the country.
2. By the elimination of smoke from our atmosphere.
3. By the possibility of giving a supply of power to manufac-

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* Abstract of an address delivered October 7th.

turers and other users at a figure so low that it would represent a saving in their cost of production and consequently a most valuable asset to the commercial prosperity of the country, and a weapon to fight foreign competition.

4. By relieving the congestion on the railways owing to the reduced traffic of coal which at present has to be delivered all over the country, and under this scheme would only have to be delivered by special lines to certain fixed centres.

Compulsion could be exercised directly by Government control of the coal supply of the country, or indirectly by putting a tax upon all users of coal who consume it in an uneconomical manner. Such a tax should be utilised for financing the scheme until it became self-supporting.

No doubt such a scheme would meet with serious opposition from many existing interests. It is obviously impossible to inaugurate such a change without interfering to perhaps a large extent with those interests, but if the great benefits to be derived from it are proved by searching inquiry to be obtainable, then the Government ought to deal with the matter in the national interests. Now is the [illegible] if we are to place British industries upon a basis firm enough to successfully meet all foreign competition.

GAS AUTHORITIES AS SUPPLIERS OF ELECTRICITY.*

BY J. W. NAPIER.

The object of the author in presenting this Paper is to create an [illegible] the supply of electricity as an agent in providing light, power and heat for public needs, and that the dual supply can most [illegible] be given by the existing authority for gas supply—company or [illegible]—having regard to the economics of the question from the point of view of both the supplier and the consumer. The [illegible] to discuss the merits of the illuminants as such, [illegible] gas and electricity as rivals—this is a fast disappearing conception, and happily so—and to disclaim any idea of [illegible] interests. It is not intended that this review of the subject should have reference to the larger towns or to areas already supplied by electricity authorities having Parliamentary powers.

Competition as a factor in serving the public interests most economically has been of great value, but it may be carried beyond the limits of sound judgment, and it is to be remembered that the supply of [illegible] in the hands of one party has [illegible] of Parliament. In Scotland [illegible] have for some time past been seriously considering the supply of electricity. There are several instances where Parliamentary power has been granted to gas companies for [illegible] the Tottenham District Light, Heat & Power Co. It is hoped, therefore, that this contribution describing the [illegible] will be timely.

[illegible] Undertaking.

The [illegible] Order was obtained in 1899, and the Town Council [illegible] with a company [illegible] period of 11 years. The arrangement was that the Corporation took delivery of [illegible] The arrangement for supply from [illegible]

[illegible]

was terminated by mutual agreement, the Corporation to pay an indemnity of £3,000 and this sum as it did not represent assets which could be termed capital expenditure, the gas profits were once more appealed to and payment of the sum in question was spread over a period of six years. The full sum has now been paid.

Site for Electricity Station.

It was now possible to decide upon the erection of a station. The question of site had first to be determined and the ideal site for an electric station is a point in the centre of, or so far as is practicable nearest to, the area of greatest demand for current in order to reduce cost of supply cables which otherwise would require to be larger and carried a considerable distance at greatly increased cost. The gas works site was ultimately decided upon and for the following reasons: (1) Spare ground available sufficient for future extension and at a low rate of feu duty; (2) being at the gas works a supply of fuel, either coke or coal gas was available; (3) the gas and electricity stations being under the same management supervision would be more convenient and the same offices and staff mutual to both; (4) extra labour and assistance from the gas works could be given when required; (5) the gas works site is situated in the industrial area where a large day demand for power was likely to arise; (6) private source of water supply available. As a result of experience now obtained the situation of the generating station at the gas works has proved most satisfactory and the convenience and advantages are real and considerable.

Type of Plant.

The type of plant to be erected received careful consideration, and in this regard the following points are to be noted:—

Steam Plant. The station being a comparatively small one the standby losses would be considerable and turbine plant is only economically possible for large units.

Oil Engines.—Price of oil would probably vary from time to time which would seriously interfere with works costs.

Producer Gas Plant and Gas Engines.—Gas works coke as fuel available in ample supply and price controlled by ourselves and not subject to railway dues, while the water supply available for the gas plant and cooling of engines would prove a distinct asset in practical working. Also a supply of coal-gas as a standby at low power rate.

Suction producer gas plant with gas engines was, therefore, decided upon as the most economical type of plant best suited to the local circumstances. The gas engine cannot be claimed to possess the high standard of reliability of the steam engine, but in our experience has proved satisfactory, when given proper attention. With engines specially built for driving generators, a steady voltage is obtained.

Description of Plant Installed.

In 1910 the plant first put down consisted of one 85 B.H.P. and one 140 B.H.P. gas engines with dynamos direct-coupled with one producer gas plant for use with gas coke. Storage battery (Tudor) of 221 cells and capacity to meet the demand after 11 p.m. and on Sundays. The battery is insured with the makers for a period of 10 years for an annual payment of £11, being 10 per cent. on the purchase price, they undertaking to keep it in good working condition, and at the end of 10 years to hand it over of full efficiency and equal to new. The capacity of the battery is relatively very small to the demand and its chief function is to permit of the engines being run at an efficient load, taking up the excess current generated, and meeting any slight extra demand when required. The usual switchboard is provided with the necessary panels for the separate machines, a balancer and automatic reversible booster for the charging and discharging of the battery. In 1911 the output of current had so increased that additional plant was required. A twin-cylinder horizontal type engine 250 B.H.P. with generator, with two separate sets of producer gas plant for use with coke was also installed. The cylinders of the engines are water cooled on the thermal tank system. The capacity of the water tanks was based upon 45 gallons of water per brake horse power, but experience has shown that this figure is much too low when gas engines of 100 H.P. and over are working 10 hours per day at three-quarter load. Mechanical water coolers, or cooling towers are necessary for efficient cooling of the cylinder jacket water. Otherwise trouble may arise from seized pistons due to faulty lubrication, caused undoubtedly by the viscosity and lubricating quality of the oil being reduced at an unduly high temperature.

In 1914, in view of the greatly increased demand, a much larger unit of plant was installed, namely, a vertical engine of 600 B.H.P. with eight cylinders and two sets of producer plant. For the cooling of the water required for the cylinders a cooling tower was erected with duplicate centrifugal pumps motor driven. With an arrangement of underground and overhead water tanks and pumps the water required for the producers is circulated through the scrubbers over and over again. The scrubbers, while fed with a constant supply of water, do duty chiefly in cooling the gas, there being no impurities to absorb except sulphur gases. When some qualities of anthracite are used in the producers or gas coke from horizontal retorts, very great care must be taken to clean the gas thoroughly from traces of tar. This tar, so called, is really a gummy substance which, if allowed to pass through to the engines, leads to trouble with sticking valves and deposits at the back of the pistons causing pre-ignition. One of the disadvantages of horizontal retort coke is the presence of volatile matter in excess, causing trouble in the working of the engines. This probably explains why gas works coke for producers has not met with general favour. The extraction of tar fog from suction producer gas is a difficult problem. Frictional contact with roughened surfaces in the form of wire grids, causing precipitation of the tar, has proved the most successful. With the use of vertical retort coke, however, all tar troubles immediately cease, the volatile matter in this coke being practically nil.

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* Paper read at [illegible]

The supply is on the three-wire system, 220 volts for lighting and 440 volts for power. Since 1914 the output of current has rapidly increased, and at the present time a 700 B.H.P. vertical engine and generator are in process of erection, this additional plant being on the same lines as that already described. The following statement shows the several sizes and year of installation of the generating plant :—

Generating Plant Installed.

Year.	Engines.	Generators.
1910	85 H.P. 140 H.P.	52 kw. 95 kw.
1911	250 H.P	162 kw.
1914	600 H.P.	410 kw.
1916	700 H.P.	485 kw.
Total	1,775 H.P.	1204 kw.

OUTPUT OF ELECTRICITY.

The increase in the output of energy is shown in the following statement :—

Consumption of Electricity.

Year.	Private lighting.	Power.	Public lighting.	Total.	Max load on feeders.
1910	55,460	13,922	28,938	98,320	85·0 kw.
1912	59,145	92,015	27,397	178,557	100·6 kw.
1914	88,037	247,060	24,845	360,942	229·0 kw.
1916	135,821	642,347	11,794	780,963	440·0 kw.

The greatest increase has been for power purposes. This has had a very important influence on the working results and success of the station. With an industrial day demand and therefore a long-hour load the plant is kept working when otherwise it would be largely standing idle and would be running only during the short period of peak load. The value to an electric station of a day load is further illustrated by the low rates of charge per unit for power, as compared with the corresponding charge for lighting.

COST OF PRODUCTION.

The following statement gives the working results for the past year, on the basis of cost per unit sold as ascertained from consumers meters. This includes all standby losses for fuel in producers, battery losses, current used in station, for lighting and power, and the transmission losses in distribution of energy :—

Working Costs per Unit Sold. Year ended May 15, 1916.

	Amount. £ s. d.	Pence per unit sold.
Fuel	767 0 2	0·23
Oil, waste, water, &c.	363 11 10	0·11
Wages of workmen	951 10 5	0·29
Repairs and maintenance	432 4 9	0·13
Rents, rates, taxes	114 8 9	0·04
Management office and legal expenses	159 6 8	0·05
Insurance of plant	187 11 1	0·05
Total	£2,975 13 8	0·90

The price charged for coke was 13s. per ton. The employés at the station are as follows: One station engineer in charge, three shift engineers, three switchboard lads, two men on gas producers, and one jointer for distribution work. A comparison with other stations of similar size and of stations having a much larger output is useful, as bearing out the low cost for fuel. The towns are represented by letters and are all in Scotland :—

Comparison of Fuel Costs with other Towns.

Town.	Annual sale in units.	Fuel only. Pence per unit sold.
A	89,000,000	0·23
B	18,000,000	0·34
C	15,000,000	0·22
D	10,000,000	0·27
E	4,000,000	0·41
F	3,000,000	0·25
G	1,600,000	0·57
Alloa	800,000	0·23

For stations of the size of Alloa gas engine driven generators and producer gas plant undoubtedly provide low works costs, and our experience has amply proved the wisdom of the choice of plant.

Prices to Consumers.

Lighting .... 4d. per unit

Power.

For all current consumed up to

,,	2,000 units per annum	2d.	per unit.
,,	4,000 ,, ,,	1¾d.	,,
,,	8,000 ,, ,,	1½d.	,,
,,	16,000 ,, ,,	1⅜d.	,,
,,	24,000 ,, ,,	1¼d.	,,
,,	65,000 ,, ,,	1⅛d.	,,
,,	100,000 ,, ,,	1d.	,,
,,	135,000 ,, ,,	0·9d.	,,
Units over	135,000 ,, ,,	0·8d.	,,

RATES FOR LIGHTING FOR LARGE POWER USERS.

When the consumption of electricity for power by any consumer is over 65,000 units per annum, and not exceeding 100,000 units per annum, the rate for all energy supplied for lighting to such consumer's premises will be 1½d. per unit; and when such consumption is over 100,000 units per annum the rate for lighting will be 1d. per unit.

In addition to the above rates an extra 15 per cent. on power and 5 per cent. on lighting will be charged until further notice.

JUSTIFICATION OF LOW POWER RATES.

In order to anticipate criticism in regard to the charge for power units of 0·8d. when works costs amount to 0·9d., and the impression that has obtained credence in certain quarters that electrical energy is frequently sold below cost, it is necessary to analyse the works costs of the several items: "Rents, rates and taxes," "management, office and legal expenses," and "insurance of plant," are standing charges, while "wages at works" will meet an expanding output without any sensible increase. The works charges concerned in the actual cost of each unit sold are fuel, oil waste, water, &c., and in part only wages of workmen and repairs and maintenance. Making the cost per unit 0·6d. there is sufficient margin left, and on a sale of, say, 100,000 units per annum, the surplus would be fully £80. A number of power consumers of the extent indicated when their consumption is aggregated together provide a large demand, and it is not possible to get large consumers of electricity unless low rates are offered, as competition from private plants has to be met.

Financial Results.

	1915-16.
Capital	£33,217
Revenue	
From private lighting	1,988
,, power and heating	2,832
,, public lighting	123
Rents, royalties &c.	13
Total	£4,956
Working costs	2,976
Gross profit	£1,980

	1915-16.
Gross Profits	
Before providing for interest, &c	£1,949
Per cent. to capital outlay	5·96
Interest	949
Sinking fund	987
Surplus	11

ECONOMICAL USE OF COAL.

In using coke as the fuel for the production of electricity, a product of the distillation of coal is being utilised. The raw coal has been consumed in the vertical retorts in a scientific manner, yielding a satisfactory heating gas for industrial and domestic needs, as well as a smokeless solid fuel, and the other valuable by-products, tar and ammonia. This aspect of the generation of electricity from gas engines with producer gas made from gas works coke as the fuel is of extraordinary importance from a national standpoint, having regard to the wasteful use of coal direct for electricity generation. The gas manufacturer distils coal-producing gas for domestic heating and lighting; for a great variety of uses in the industries for heat and power. Coke as a smokeless fuel; the production of tar with its multitude of uses and its value to the dye industry; the production of liquid fuel for internal-combustion engines and the basic material for the production of explosives; ammonia as the source of nitrogen as a food for plants. The use of coke for the generation of electricity prevents the wasteful use of coal—now an asset of great national value.

Attention may be called to the dictum of Prof. Armstrong in a Paper read at the annual meeting of the Society of Chemical Industry recently held in Edinburgh. "The gas works will be called upon to produce both gas and soft coke and to serve as the primary fuel supply in its district; moreover, it will almost necessarily be run in conjunction with the supply of electricity. Already the Brighton Corporation have made arrangements for the installation of a coking plant alongside their electrical works, the gas to be used in firing the boilers of the latter."

AMMONIA RECOVERY PLANT.

The producer plant in use at Alloa is of the suction type, and, therefore, the nitrogen value of the coke has not been recovered as [illegible]. The installation has been too small to warrant the capital expenditure for recovery plant, but in view of the increased power of [illegible] a scheme for producer gas plant on the Mond type with recovery plant has been determined upon. The conception of the scheme is as follows: Coke contains about 1 per cent. of nitrogen, and the results of experiment on the large scale have given a yield of 30–40 lb. sulphate per ton. Compared with a yield of [illegible] lb. sulphate from bituminous coal this amount is disappointing. The reason for this difference in yield between a fuel of the nature of coke and bituminous coal can be well explained, but need not be discussed at this time. The Mond plant will be erected on the gas works site and a supply of producer gas will be afforded to both works—to the gas works for heating the retorts and to the generating station for driving the gas engines. The gas works are already equipped with plant for the manufacture of sulphate and this plant will in part be available. The author lately inspected installations of Mond gas plant at a gas works where all the retorts were being heated by gas, and also a comparatively large electricity station where the Mond gas was in use for driving 3,000 H.P. of gas engines. At Alloa the circumstance of the gas and electricity works being on the same site should make the scheme an admirable one.

ADVANTAGES OF JOINT SUPPLY.

The [illegible] I can bring to prove that the electricity has a [illegible] place in public demand coincident with a large consumption of gas, and that competition does not enter in to destroy the [illegible] of either department is the example of the gas and electricity supply of Alloa. For many years Alloa has enjoyed a low [illegible] in pre-war times of 2s. [illegible] to 2s. [illegible] rate of 1s. [illegible] to 1s. 10d. for power. [illegible] to take advantage of the [illegible] since 1908, with the result that for a population [illegible] of 17,200 the gas manufactured [illegible]. The average annual consumption [illegible] cubic ft. per [illegible] consumer [illegible] 274,700 cubic ft. [illegible] the consumption of gas is considerably higher [illegible] in Scotland; indeed it may be stated to be [illegible].

As regards the consumption of electricity, it will be noted from the [illegible] that the annual output has increased from about [illegible] units in 1910 to [illegible] units in 1916. The [illegible]

The [illegible]

result would be a duplication of capital for additional plant without added profits. Such a view is dangerously wrong. Of no area of gas supply can it be said at the present time that the use of gas has reached the utmost limit, and an increase in consumption for domestic use, as well as for industrial needs, should lead to a rising output from year to year; certainly there should be no diminution of gas consumption if business methods are pursued. To embark on an electricity supply scheme would simply be pursuing the same line of business, but by a different avenue. It must be kept strictly in view that where electricity is available for lighting it will command a fair share for domestic use and for public buildings and shops is given preferment. The question of the relative cost of gas and electricity may not affect the decision. Further, the adaptability of the electric motor will tend to displace gas engines, and for larger units electricity will be installed.

The advantages and gain will thus be with the company supplying the two kinds of energy. Provided the area concerned is a suitable one, industrial to be preferred in order to obtain the highly valuable day load, the electrical side of the business can, in my opinion, be made remunerative if diligence is shown (1) in keeping down the capital account; (2) in selecting a type of plant, the working of which will be conjoint with the interests of the gas works; (3) in selecting the gas works as the site for the generating station; (4) in dissociating in practice any spirit of competition and in pushing the sale of electricity as a legitimate and remunerative business. From the point of view of the interests of the public it is not desirable that there should be a duplication of works supplying the one kind of commodity, though in two different forms, as the increased cost of production must fall on the consumer.

From the evidence now adduced it may be fairly claimed that the co-existence of gas and electricity supply under one control is at once a practical and commercial proposition. The fresh field of business will appeal chiefly in the case of towns where there is at present no electricity supply. It is my settled conviction that what is required of the gas industry of to-day is a broadening of the basis of its function as suppliers of the public need for energy—gas and electricity. There is small doubt but that gas companies, if they do not prepare the way, will be met in the near future with competition where there is no electricity supply at present. It is a true indication of strength and vitality when an industrial business can comprehend the issues that lie in front of it, and having done so, prepare accordingly.

DISCUSSION.

Mr. ALEXANDER MASTERTON (the President), of Edinburgh, said he thought the author had made out quite a good case for gas authorities taking over the supply of electricity. The strongest argument, to his mind, was the economy which would be effected in regard to the use of coal as a result of the combination. The author's experience and the data he had given ought to be of considerable service and assistance to municipal authorities who were considering the problem of the supply of light, heat and power. Placed under the jurisdiction of a capable engineer and manager—one without bias either towards gas or electricity—the joint management ought all to be in favour of economical working and the production of these two agents for the public at cheap rates. There was no reason why the two competitors should not work side by side promoting the interests of each other in the best possible way.

Mr. DAVID ROBERTSON (Dunoon) considered that there need be no rivalry between gas and electricity provided they were under the one control. He thought the author was proceeding on right lines when he suggested that gas companies or corporations ought to have the control of the electricity supply in any one district. If the electricity station was placed in the gas works there was absolutely no doubt but that economy would follow.

Mr. DAVID VOSS (Airdrie) asked if there was a tramway system connected with the undertaking in Alloa. That might have a bearing on the electrical question.

Mr. WILLIAM WILSON (Falkirk) said he felt that Mr. Napier was to be congratulated in finding himself in a position whereby he could hold the balance equally between two forms of energy.

Mr. CLARKE (Chesterfield) said he happened to be in the unique position of being chairman of a gas company manufacturing 220-million cubic ft. of gas and vice-chairman of an electrical company with plant up to 2,000 kw. These two interests were antagonistic and conflicting, and as chairman of the gas company he was suspected of having leanings towards electricity and *vice versa*. The great point he desired to make as the outcome of his experience was that the two undertakings were quite separate and distinct and a particular set of conditions appertained to each. He could see that the combination might be successful in small residential towns, but only there.

Mr. J. W. NAPIER, in reply, said he had been most careful to point out in his Paper that his conception of a joint scheme did not apply to towns of considerable size. In large centres he frankly admitted that separate management was not only desirable but necessary. Taking a broad view of things he was satisfied that for towns with a population up to about [illegible] an amalgamation of interests would prove beneficial.

METHODS FOR HANDLING BOILERS IN A 100,000 KW. STATION.*

The principal generating plant of the Edison Electric Illuminating Co. of Boston, Mass., known as the L Street Station at South Boston, supplies energy to a territory of more than 700 sq. miles. The rating of the generating equipment in the station is approximately 100,000 kw., and a large part of eastern Massachusetts is dependent upon this plant for electrical service.

Boiler Plant and Coal Storage.—The boiler-room equipment consists of 48 Babcock & Wilcox boilers, eight of which are provided with Roney automatic stokers, the remaining 40 being equipped with Murphy automatic furnaces. The Roney stokers are electrically driven, the Murphy installation being steam operated. The plant is located on Boston Harbour. Two steam unloading towers are used to take coal from barges. It is then carried by a belt conveyor to a storage field of 60,000 tons capacity directly adjacent to the plant. From the field the fuel is hoisted by two travelling cranes and delivered to bunkers in the boiler house by another belt conveyor.

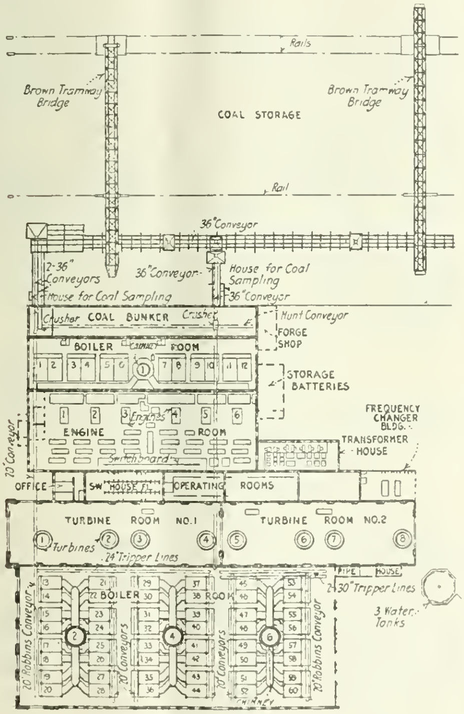

FIG. 1.—LAYOUT OF L STREET STATION.

On the way from the yard the coal passes over automatic scales registering the amount that is used, and then into a crusher. Samples for analysis are taken just before the coal is crushed. In this way the coal which is purchased on a specification basis is accurately checked up. The coal is fed from the bunkers directly into the furnaces by chutes arranged to permit weighing at each furnace. These scales, however, are not used except in boiler tests.

Feed-water Treatment.—Treatment of feed water for scale prevention is accomplished by the installation of a small cylinder upon the turbine pump, so that a small amount of Dearborn heated compound is introduced at each stroke. It is also necessary, however, to remove scale by washing out the boilers every 30 days.

Frequent inspection of the lower rows of boiler tubes enables the conditions of scale formation to be closely followed. If the scale has a tendency to become excessive, the tubes are calipered, since a mere observation will not give a sufficiently accurate check of the thickness of scale formation. Out of the entire 48 boilers only a few bagged tubes have resulted in several years. Every 30 days the drums are thoroughly washed and the water changed.

Boiler Tube Inspection.—A tube inspection is conducted every 60 days. This consists in opening up the lower rows of tubes as high up as the inspector finds scale. The lower row of tubes is generally found to be sufficient. The scale thickness is then estimated or calipered if aggravated. At the L Street Station it is seldom necessary to do more than look into the tubes on account of the thoroughness with which the removal of impurities is carried on.

The boilers annually receive an interior inspection by the insurance company. Before this inspection occurs the boilers are opened up and entirely overhauled by the engineer in charge of the boiler room. It is seldom that the insurance inspectors find any fault with the condition of the boilers. In preparing for an inspection connections are cleaned, tubes blown, front and back headers are blown and mud drum nipples are cleaned. The boiler is then tested by hydraulic pressure, so that any leaks may be repaired while the boiler is down. Red tags are placed on the valves to show that none is to be touched, all valves leading to and from the boiler being tagged. Scale is chipped off any headers that may not have been removed in blowing. The bottom rows of caps, front and back, and mud drum caps are removed. Rear manhole plates, and if necessary those in front, are removed. Besides removing the caps on the lower rows of tubes, one cap is removed on each row all the way up on the front and about halfway up on the back, but if necessary the removal is continued to the top in the back as well as in the front. A cap is also removed on each superheater header.

Cleaning of Tubes and Settings.—The cleaning of tubes and settings in this station is handled in the following manner. The evening before cleaning the engineer makes out a list of the men who are to take part in the work. After each man's name is listed the partner with whom he is to work, the tools he is to use, the boilers to be worked on and the order of their cleaning. The required tools are assigned to the men at the station tool room, and are numbered to correspond with the numbers on the assignment sheet. If any questions are necessary, so far as possible they are asked the night before. Thus, when the men come to the plant in the morning, they go directly to work without loss of time. If accidents happen to any of the tools, or if the lamps become broken, they are checked off against the party using that particular set of tools.

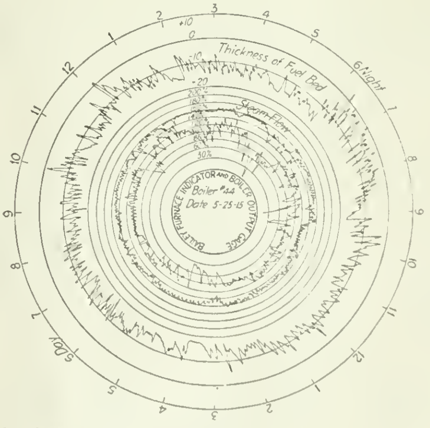

FIG. 2.—GRAPHIC RECORD, SHOWING FURNACE AND BOILER PERFORMANCE.

The cleaning of furnaces usually requires three sets of cleaners, two working together, and two sets of tube blowers, also working in pairs. The men who clean the furnaces clean off the grates and bridge walls, and see that the passages are in such shape that the coal will feed down properly, leaving the entire interior of the furnace in first-class condition as far as dirt goes. The bridge walls are usually covered with a hard clinker, which requires the use of a pick in dislodging it. Care is taken not to tear the wall in removing this material. If it is not thickly covered, it may be best to let it go until more accumulates, as the tendency is for the wall to wear away very quickly at best. A small amount of clinker is left in the V of the grates, so that the new coal will not fall through between the grates when the fire is built up again.

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* Abstract of an article in the "Electrical World."

The men blowing tubes are sent into the connections, and by means of a jet of steam and long hooks remove all the clinkers and soot from the tubes.

It is not sufficient merely to clean the tubes with steam when the boilers are off the line, for the passages between the tubes soon become blocked, and must be opened again if the boilers are to be operated efficiently. It is therefore necessary to blow these tubes while the boilers are in operation. This is done by a steam nozzle. When the boiler is off the line a thorough job is done, but when it is in service the pipe and nozzle are merely shoved through holes left in the setting and worked from side to side, taking care that the steam jet does not play directly upon the tube surfaces. Even with a system of tube blowing where each boiler is blown off every other day the soot and clinker collect after at least two weeks to such an extent that the passage of gases is materially impeded.

After the boilers are cleaned the engineer goes into them and makes a minute inspection of all defects, examining any particular features which, in case of failure, would necessitate the removal of the boiler from the line. This inspection enables the engineer to tell at any time the exact working condition of any boiler on or off the line, and to predict with close accuracy the results to be expected from a given number of boilers on duty.

As the boilers are very carefully inspected externally without [illegible] at frequent intervals, while an internal inspection is carried on after the company has had time to put the boilers in good condition. The external inspection gives a check upon the plant operation from day to day, and the latter insures a thorough yearly overhauling. Particular attention is always given to the tubes, so that any which have become bagged or otherwise defective can be removed promptly. Records of both the monthly and the yearly [illegible] are kept and used to check up the condition of the [illegible] from time to time. These are valuable in comparative studies [illegible]

[illegible] Flow Meters and Recorders.—Steam flow meters are [illegible] at the L Street Station and are considered accurate enough [illegible] of the different firemen, but are not sufficiently [illegible] dependable results of the amount of water

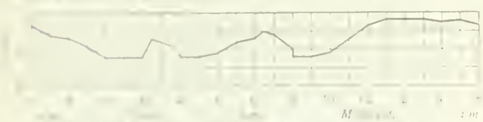

Fig. [illegible] CO₂ [illegible] 24-hour Period.

[illegible] It has been allowed to occur in the fuel [illegible] the man in charge of the firing aisle [illegible] responsible for the lag in the steam [illegible] of examining the fires through [illegible] This results in a more stable condition [illegible] Bailey recorders are also [illegible] the operation of the furnace. These meters show [illegible] the rate of air flow through the [illegible] These meters give results [illegible] A carbon dioxide recorder is [illegible]

[illegible] called for by the coal [illegible] reported to the [illegible] held [illegible] report to the [illegible] and [illegible] of the furnace [illegible] for the [illegible] the [illegible] of the [illegible] without [illegible]

[illegible]

ON AN UNBROKEN ALTERNATING CURRENT FOR CABLE TELEGRAPHY.

BY LOUIS COHEN.

In a very remarkable Paper under the above heading, presented by Col. G. O. Squier before the Physical Society of London,* a new system of cable telegraphy is proposed, the principal feature of which is the use of alternating currents. This, of course, is a very radical departure from the old method, and necessarily carries with it fundamental changes in the apparatus connected with the art. Col. Squier has himself very ingeniously worked out suitable apparatus, which are fully discussed in his Paper. The system proposed, however, offers so many new possibilities, and opens such a wide field for research and investigation, that engineers will probably occupy themselves for some time with problems arising in this new system of cable telegraphy. For one thing, the use of alternating current brings the problem of cable telegraphy in the realm of long-distance transmission, the phenomena of which have been carefully studied, and, allowing for some modifications, can be readily applied to problems in Col. Squier's system of cable telegraphy.

In discussing this subject with Col. Squier it occurred to the writer that the efficiency of transmission would be increased if the receiving apparatus is designed for complete absorption to avoid reflections and eliminate the losses caused by it. The problem is comparatively simple, and the general theory has been given in various places in connection with other problems in transmission. It was suggested, however, that it would be of interest to cable engineers to develop the problem in its particular application to cable telegraphy.

It is the object, then, of this Paper to give a brief discussion and some data on the electrical constants of receiving apparatus for the condition of complete absorption.

If we neglect the inductance and leakage conductance of a long electrical line we have the following two equations

$$\left.\begin{aligned} RI &= -dV/ds, \\ C\,dV/dt &= -dI/ds. \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

From the above two equations we get the equation of propagation,

$$d^2V/ds^2 = RCj\omega V = m^2V. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $m = (1+j)\sqrt{CR\omega/2}$.

The solution of equation (2) is

$$V = A\varepsilon^{ms} + B\varepsilon^{-ms}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From (3) and the first equation of (1) we get the expression for the current on the line

$$I = \frac{m}{R}\left(-A\varepsilon^{ms} + B\varepsilon^{-ms}\right). \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The constants A and B in equations (3) and (4) are to be determined from the terminal conditions. If we assume a sine E.M.F. of amplitude E impressed at the transmitting end, and the receiving end grounded through an impedance, $Z = r - jx$, we have

$$\left.\begin{aligned} V_{s=0} &= E, \\ V_{s=l} &= ZI_{s=l}. \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Substituting the values $s = o$ and $s = l$ in equations (3) and (4) we get

$$\left.\begin{aligned} A + B &= E \\ A\varepsilon^{ml} + B\varepsilon^{-ml} &= \frac{Zm}{R}\left\{-A\varepsilon^{ml} + B\varepsilon^{-ml}\right\} \end{aligned}\right\} \quad . \quad . \quad . \quad (6)$$

Solving the above equations for A and B, we get

$$\left.\begin{aligned} A &= \frac{E(Zm-R)\varepsilon^{-ml}}{(R+Zm)\varepsilon^{ml} + (Zm-R)\varepsilon^{-ml}} \\ B &= \frac{E(Zm+R)\varepsilon^{ml}}{(R+Zm)\varepsilon^{ml} + (Zm-R)\varepsilon^{-ml}} \end{aligned}\right\} \quad . \quad . \quad . \quad (7)$$

Now it is obvious that for the condition of no reflection the electrical constants at the receiving end must be so adjusted as to give the equivalent effect as that of an infinitely long continuation of the cable. That condition is realised when the constant A in equations (3) and (4) is zero. To make $A=0$ we must have by (7)

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* Proceedings of the Physical Society of London, Vol. XXVIII., pp. 540-561, August, 1916.

$$Zm-R=0,$$

and

$$Z=r+jx=\frac{R}{(1+j)\sqrt{CR\omega/2}}$$

$$=\frac{R(1-j)}{\sqrt{2CR\omega}}.$$

Hence

$$\left.\begin{aligned} r&=\frac{R}{\sqrt{2CR\omega}}\\ x&=\frac{-R}{\sqrt{2CR\omega}} \end{aligned}\right\}, \quad \dots \dots \quad (8)$$

and $Z=r-j/C'\omega$

where

$$\left.\begin{aligned} r&=\frac{R}{\sqrt{2CR\omega}}=\sqrt{\frac{R}{2C\omega}},\\ C'&=\sqrt{\frac{2C}{R\omega}} \end{aligned}\right\} \quad \dots \dots \quad (9)$$

The receiving apparatus must have a capacity and resistance in series whose values are given by (9).

The values of R and C for one of the best transatlantic cables is

$$R=2{\cdot}262 \text{ ohms per nautical mile},$$
$$C=0{\cdot}4224\times10^{-6} \text{ farads per nautical mile},$$

and for these values of R and C, the values of r and C' required for different frequencies are given in the table below.

n	r	C'	n	r	C'
3	377	140×10^{-6}	8	231	86×10^{-6}
4	326	122×10^{-6}	10	206	77×10^{-6}
5	292	109×10^{-6}	12	188	70×10^{-6}
6	266	99×10^{-6}	15	168	63×10^{-6}

As the frequency is increased the resistance and capacity required are diminished.

Other phases and modifications of the Squier system of cable signalling will be discussed by the writer in another Paper.

EDUCATION AND TECHNICAL TRAINING.*

BY A. P. TROTTER, B.A.

When the presidentship of an old-established engineering institution comes in due course to a member who has served for some years on its council, the presidential address is generally devoted to a survey of the particular branch of the profession with which that member has been identified.

When I turned over the interesting Papers which have been read before your association I found very few which dealt with my work, and only one which touched on a hobby. But the presidential address of Mr. A. H. Dykes, whom I have the honour to succeed, went to my heart (as an engineer, of course, for officials have no use for things of that sort), and I felt that to be allowed simply to continue Mr. Dykes' address on the Apprentice System for the Electrical Trade would be a valuable privilege.

Professional educationalists seem to be rather uncertain about the object of education. Technical education consists in the acquisition of useful knowledge, that is, knowledge which when applied practically will assist in producing material results. If the absorption of this knowledge develops a lad's intelligence, so much the better, but it is an accidental advantage. The value of education, on the other hand, has little or nothing to do with the knowledge gained, but in the intellectual processes of its acquisition.

Technical educationalists, in an attitude of defence, claim that the study of the action of levers, acids, lenses, magnets, and steam, offers exercise in mental agility no less than the Wars of the Roses, the rivers which run into the Black Sea, and Latin Grammar. The very expression, technical education, contains a contradiction. The object sought can only be appreciated and understood by a technical man. Let us, then, drop the word education altogether in this connection, and speak of technical training. Our universities and technical colleges now make provision for the training of engineers, and the student must have had a suitable grounding in elementary science, and particularly in mathematics, before he enters the course. No engineer can join the Institution of Civil Engineers, or the Institution of Mechanical Engineers, or the Institution of Electrical Engineers, unless he has attained a certain standard of theoretical knowledge. We are not concerned here with those high and wide ranges of training for the profession about which so much has been written, but with a certain section of electrical trade. At the foot of the ladder is the labourer who fetches and carries, and is not expected to know how to use a foot rule. It often happens that he has picked up the knowledge, and has acquired the skill of the expert workman, but owing to lack of ambition, or of pluck to break through the ties of caste, he does not rise. Opportunities occur where such men should be given a chance by shifting them. It is, however, with the training of a lad for the purpose of making him a skilled workman that we are concerned.

What is a Trade ?

A boy is apprenticed to a trade. What is a trade ? It originally meant a beaten path which we tread. Are these paths in the way of life wider or narrower than they were when the English nation was coming to its own in the days of Queen Elizabeth, when apprenticeship was made compulsory for all trades ? Quince, of "The Midsummer Night's Dream," was a carpenter, and Snug a joiner, and Snout was a tinker. If at all times in the world's history a first-rate craftsman had a complete knowledge and practical experience of his craft, it follows that with the development of the arts the range that any one man can master is a fraction with a continually increasing denominator. There must be a continual splitting up of trades, and in Shakespeare's time there was already a distinction between a carpenter and a joiner. Division of labour was introduced for economy of production, and it is realised at the expense of narrowness of experience. In those trades where very highly manipulative skill is required, it is impossible for one man to do more than one job thoroughly well, and he should be content and, indeed, proud to be a specialist.

The old way of learning a trade was to give a lad simple jobs at first, and let him gain experience in handicraft, and to acquire general knowledge by keeping his eyes and ears open. The old craftsman seldom realised that any general principles underlay the methods he used. Much was traditional and much was rule of thumb. Sheer experience told him which methods would produce good work, and which would lead to inferior results. In the absence of any knowledge of general principles and of intelligent reasoning from them, it is no wonder that the word mystery was used in connection with the arts and crafts, and great demands must have been made upon parrot-like memory, in faithfully carrying out work *secundum artem*, in accordance with the rules of the art.

With the development of science, which only means ordered or systematised knowledge, it was discovered that most of the methods of the craftsman could be explained in scientific terms. Snout, the tinker, made his own solder according to the mystery taught him when he was an apprentice. He knew that to solder brass or copper he must clean the surface and use a flux of some sort. He would have been a better tinker if he knew that resin would dissolve oxide of copper, for he would have been a more intelligent man.

Many modern businesses can hardly be called trades. How many people can make an electric glow lamp, can mix, melt and blow the glass for the bulb, prepare the filament and mount it, exhaust and finish it ? Then, again, in dynamo and motor building, what does a core stamper know about armature winding ? It is difficult to find a name for these trades within trades.

The essence of the contract of apprenticeship is that one person is bound to teach another a certain trade. What master would undertake to teach a lad how to make an electric lamp ? One of the causes of the break up of the old apprentice system was the introduction of machinery, and with it, sub-division of labour in the textile industry ; and this system is not readily applicable to some kinds of employment of the present day.

A change has taken place in the meaning of "a trade," but a greater alteration has occurred in the expression "master." We still speak in general terms of "employers and men," but we generally mean firms. It is true that the apprentice can work loyally for the "firm," in spite of the fact that it is a dim "they" ; but who is to undertake the important duty of teaching ? The works manager is about as likely to explain how to connect a motor to its starter, and to see that the apprentice does it properly, as to invite him when the job is done to lunch with the directors in the board room. In factory work, unless it is not only a recognised part of a foreman's job that he has to teach, and that he is able to teach and willing to teach, he cannot teach ; and as we go down the scale we get further still further from the master. In the case of house wiring, the firm, the vague "they," are remotely occupied in "the office," and are only represented by the flying visits of an inspector, while the foreman is obviously the man who represents the master, but in such a different degree that only a trace of the old relationship with the apprentice can remain. On a large job, with several gangs, the apprentice is at a still greater disadvantage, and for the fulfilment of the obligation to teach or cause to be taught, some special arrangements must be made. It is a matter for employers to consider whether it is worth their while to take such steps, both during the ordinary working hours of apprentices, and by allowing them to attend trade classes, to secure young men trained to do good and intelligent work in the style of the firm, and well versed with its special lines. Apprenticeship will secure these. The inevitable wasters will drift in, but a probationary period of not less than one month, but not more than six, will give them the opportunity of drifting out again.

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* Abstract of a Presidential Address to the Association of Supervising Electricians.

TRADE CLASSES.

Modern forms of indenture do not assume that the master will directly teach the apprentice, but he will "to the best of his knowledge and ability teach and instruct or cause to be taught and instructed the apprentice in the trade or business of .... and in all things incident or relating thereto. And that he, the master, will allow the apprentice such leave of absence as may be reasonable for the purpose of attending technical classes of instruction, and that the apprentice shall not suffer any diminution of wages on that account."

In primitive times, the apprentice worked alongside his master, and was taught by him, but as early as 1656, it was provided that "the said Master shall and will teach instruct informe and bringe up or cause to be taught instructed informed and brought up him the said Apprentice . . ."

Evening classes relating to the work on which a lad has been engaged all day are not desirable. They have their uses in certain cases. They require not only grit but a good physique. They are a valuable means of improving and widening the knowledge of those who have not had the benefit of a regular apprenticeship, or who have an ambition to rise higher in their trade, or to follow some other branches of their daily occupation.

The apprentice should be bound to attend, and the employer should see that he does attend, the chosen trade or handicraft day classes (without loss of wages), for periods of at least two or three hours per week, or two mornings or afternoons every week, thus making a minimum of six hours weekly instruction in the theory and practice of his trade. For technical classes to be successful, it is desirable that the teaching should be in close touch with the trade, and employers should be invited to take an active interest in the scope and content of the training. The instruction should not be a mere repetition of the daily work, carried on under the supervision of a teacher, but in the case of most trades it ought to consist of a study of general or scientific principles, illustrated or demonstrated by examples taken from the practice of the daily work.

In a science class a teacher avoids spoon feeding, because he is [illegible] for an educational purpose, and wishes his students to think out problems for themselves. He illustrates general principles and theorems which constitute any particular science, by experiment. In a trade class much of this is reversed. The experience, whether the making of a soldering iron or the charging of an accumulator, is the starting point, the main thing to be understood, and the principles and theories are brought in to explain it. In a science class the chemistry and transformations of energy in an accumulator [illegible] to explain the distinction between E.M.F. and difference of potential and some [illegible] of a philosophical nature were given on the [illegible] of E.M.F. [illegible] the first thing to be learned about an accumulator is that the peroxide plate is positive and [illegible] a [illegible] test. Then it [illegible] found in a text book. [illegible] mineral oil or vaseline [illegible] of a [illegible] contact. [illegible] interesting [illegible] work should be taught [illegible] sorting out [illegible] them all in a few [illegible] absolutely [illegible] and in the [illegible] But a thorough grasp [illegible] will often enable a [illegible]

[illegible] Ohm's law. The [illegible] $I=E/R$ [illegible] I is the current, or rent, E the E.M.F. or difference of potential, and R the resistance, and it obviously follows that $R=E/I$, and $E=IR$. He makes a mistake. It does not obviously follow, it mathematically follows; and that makes all the difference between a science class and an apprentice trade class. The expression E.M.F. should be suppressed as much as possible, and difference of potential should be very rarely mentioned. I stands for the number of amperes, E for the number of volts, and R for the number of ohms. For those who are not mathematically minded, do not write $I=E/R$, but

$$\begin{matrix} & E & \\ I & & R \end{matrix}$$

You want to know I. Put your finger over it and you get E/R, put your finger over R and you have E/I, and hiding E you have I/R.

In some cases boys are apprenticed while still at school, and the last part of their schooling is counted as part of their apprenticeship. To what extent school education should be specialised, with a trade in view is a difficult question. It certainly should not attempt to deal with technical details or handicraft. On the other hand, if time can be found in a normal curriculum for putting every boy through a course of elementary carpentering, perhaps one-half of them may be educationally benefited thereby.

The demand for trade classes in any special subject must precede the supply. The City Guilds have done a great deal for higher scientific teaching. It would be appropriate that help should come from this quarter to revive apprenticeship, which was originally instituted as the carefully guarded entrance to the Guilds, and that they should aid in the development of the guild spirit—a pride in craftsmanship of the highest quality.

Courses of instruction are already provided in London by the London County Council at day schools, to a greater extent than is generally known: and since these are by no means centralised but are widely distributed, they could be carried on in the same way, not only in other cities, but in the smaller towns.

The L.C.C. offer about 150 scholarships tenable at these schools.

Elementary and advanced evening classes for electrical wiremen are held at the Northampton Institute, St. John-street, Clerkenwell, and at the South Western Polytechnic, Manresa-road, Chelsea. Proposals for day classes would no doubt be considered.

The following notes on schemes of apprenticeship already at work may be useful as examples :—

The Pianoforte Manufacturers' Association, which is representative of the most important British firms, have carefully considered the question of securing thorough scientific training in connection with their trade, and have a definite scheme of apprenticeship. The boy spends 2½ days a week in the technical school during the first year, and not less than six hours weekly during the remaining four years. Boys of sound education, from 14 to 16 years, are invited to make application. The technical classes are organised by the London County Council.

The Gas Light & Coke Co. take lads as apprentices for a period of six years to learn the trade of a gasfitter. They have equipped a workshop in Horseferry road, and the London County Council provides special instruction at the L.C.C. Westminster Technical Institute, Vincent-square, S.W., on two or three afternoons a week in mechanical drawing, workshop arithmetic, composition and precis writing. After six months in the workshop the apprentices go out with the gas fitters, but they continue to attend the technical institute for two or three half-days per week. Although the company does not bind itself to provide employment for apprentices at the expiration of their articles of indenture, it is understood that they will probably become fitters' mates, and, later on, fitters. There are possibilities of further promotion to staff appointments.

Seeing that the London County Council are prepared to provide trade classes for apprentices and that they control or are in touch with a large number of polytechnics and technical institutes, and that there are two institutions having experience in arranging apprenticeships, no special organisation of the electrical trade seems necessary. It only remains for firms to put themselves in touch with the facilities which already exist.

APPRENTICESHIP.

Apprenticeship is a term of service during which the apprentice and the master agree for their reciprocal advantage to enter into a voluntary relationship, in which there is a careful balance of privileges and duties. The relation of master and apprentice is not that of employer and workman, and does not properly come within the law of master and servant. It has some of the features of a partnership, and this was at one time a very elaborate affair. The conditions now are much more simple and less picturesque than they were 300 years ago, when no person was allowed to exercise any trade or mystery without having served a seven years' apprenticeship. The master could administer moderate personal chastisement to an ill-behaved apprentice, and had to look after his morals, and might not give him salmon (then the commonest fish in the Thames) more than four times a week. But the apprentice could not be compelled to go outside his covenant and act in a menial capacity. The modern indenture ignores all these things, but some of them remain recognised in common law.

The main advantage to the electrical engineering industry in encouraging the apprenticeship system is that it secures good workmen thoroughly instructed in the craft. Apprenticeship, say, in the straw hat making trade, has its own value, but in the case of electrical contractors engaged in wiring, sound workmanship becomes a matter of public importance.

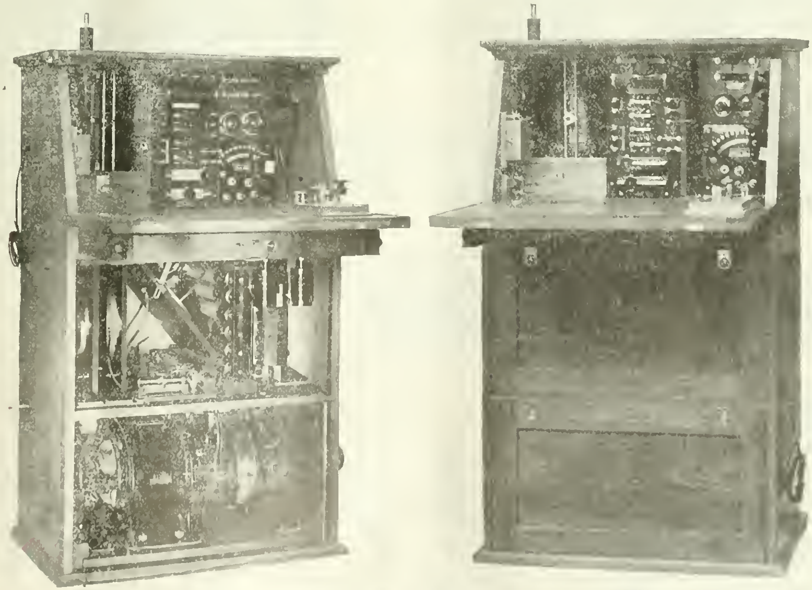
The old period of apprenticeship of seven years is too long in these days of competition and higher pressure. An apprentice who receives sound training in trade classes, and thus learns to understand his work intelligently, will master it sooner than a boy coming straight from an elementary school to pick up a trade by simply working at it. It is recommended that the period of modern apprenticeship should not exceed five years, and in some cases of simple, repetition work, may be reduced to three. In general, four years seems to be a suitable period for electrical contractors. If there is a variety of work, the apprentice may not have a chance of seeing it all during a period of less than four years.

When a consideration of a sum of money is paid to the master as a premium the wages during a certain period are sometimes assumed to be the return of this premium. In general, the payment of a premium tends to put the apprentice in a false position. He is tempted to feel that his master is to that extent indebted to him, and this may affect his inclination to work. In the absence of a premium, relations become simplified, a small wage is paid, and this places the master in his proper position.

I recommend those who wish to receive apprentices, or to obtain more information on the subject, to communicate with the Secretary of the National Institution of Apprenticeship, 28, York-place, Baker-street, London, W. That institution receives daily applications from parents for the apprenticeship of their children. It has arranged apprenticeships in 81 cases for electrical fittings makers, electrical fitters and turners, electrical instrument makers, electrical brass workers and armature and coil winders, and in 142 cases for general electrical engineers. The institution helps in negotiating terms, inquires into the teaching to be given, and sees that there is not an undue proportion of apprentices to skilled workmen. It provides forms of indenture; it has an arbitration committee to help to settle any differences which may arise between masters and apprentices; it has honorary counsel and solicitors expert in apprentice law. All applicants whose physical condition is considered doubtful are sent to the honorary consulting physician, or to the honorary consulting surgeon, or to the honorary consulting ophthalmic physician, for examination and advice as to their fitness for working at the trade chosen. There is another institution, the Apprenticeship and Skilled Employment Association, with an office at 53, Denison House, Vauxhall Bridge-road, London, S.W., with a considerable number of affiliated local committees.

A NEW MARCONI 0·25 KW. INSTALLATION.

The growth of the application of wireless telegraphy to vessels of small tonnage and the need of a moderate power installation for emergency uses on large vessels has caused the Marconi Company to put on the market a ¼ kw. installation containing many novel features.



Open.

Closed.

Fig. 1.—¼ kw. Cabinet Set.

The installation is capable of adjustment for the transmission of any wave-length between 300 and 600 metres, and the whole of the transmitting apparatus, including the motor alternator, is mounted compactly in a cabinet approximately 27 in. high, 26 in. wide and 17 in. deep when closed. It is divided into two portions, the larger portion (lead lined) containing the motor-alternator and disc discharger, the upper portion serving to hold the condenser battery, primary inductance, aerial tuning inductance, earth arrester terminal, wave shortening condenser and other details. To protect the apparatus and to prevent inexperienced persons from coming into contact with the high-tension circuits, the front of the cabinet is fitted with removable panels, which in general use are kept closed. This necessitates placing the manipulating key and the controlling switchgear outside the cabinet. From the storage battery, of which we shall speak later, continuous current is led through the switch gear to the motor-alternator, consisting of a continuous-current motor directly coupled to a 250-watt generator, which supplies alternating current at a pressure of 110 volts and a frequency of 300 cycles when running at a speed of 3,000 revs. per min. Attached to an extension of the framework of the motor-alternator is a containing chamber for the disc discharger. A suitable combined starter and regulator is furnished for the control of the set. The transformer is of the air-cooled closed magnetic circuit type, designed to raise the pressure from 110 volts to approximately 5,700 volts (the pressure required for charging the condenser bank). Special air-core protecting chokes safeguard the windings of the transformer from injurious induced effects from the high-frequency circuits.

Six tubular condensers are used in the condenser bank. These are constructed of glass tubes on which has been deposited a coating of copper, both inside and out. All of these tubes are calculated to have the same capacity, and in the event of a breakdown a new tube can be readily substituted. The condenser tubes are extremely strong from a mechanical point of view, and have an ample margin of safety for any electrical stresses to which they may be subjected.

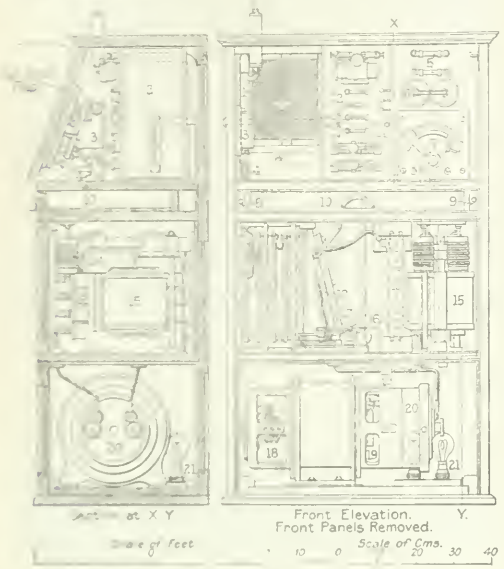


FIG. 2.—½ KW. CABINET SET WITH RECEIVER.

[illegible]	[illegible]	15 Transformer
[illegible]	9 [illegible]	16 Short-Wave Condenser.
[illegible]	[illegible]	17 Tune Lamp.
4 [illegible]	11 Jigger Secondary.	18. Motor
[illegible]	12 Jigger Primary	19 Alternator
[illegible]	[illegible]	20. Discharger
[illegible]	14 [illegible]	21 Guard Lamp.

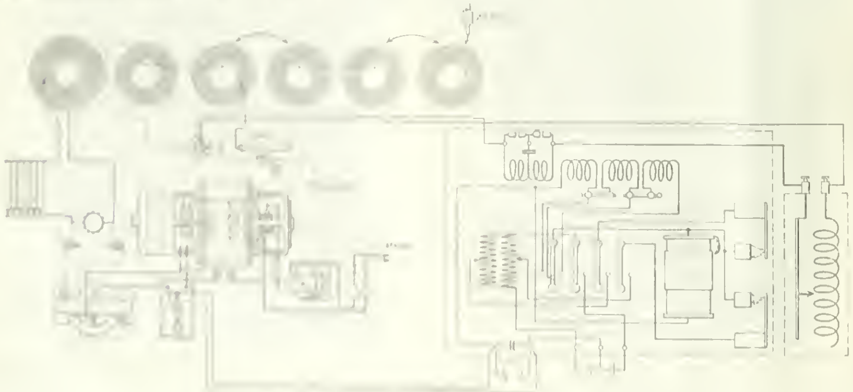


FIG. 3.—DIAGRAM OF CONNECTIONS OF ½ KW. SET.

[illegible] is [illegible] for the purpose of [illegible]

The disc [illegible] is of the [illegible] type, mounted on an extension of the alternator shaft, and carrying a number of studs bearing a direct relation to the number of alternator poles, thus ensuring correct synchronisation of the spark frequency to the periodicity of the alternating-current supply, and the consequent production of a spark of good quality and even tone. The spark frequency is 600 per second.

The disc, as mentioned above, is enclosed in a casing formed on the body of the machine, and carrying the suitably insulated stationary electrodes. Provision is made for the adjustment of these electrodes to meet normal wear and to enable the correct phase relationship with the alternating-current supply to be obtained.

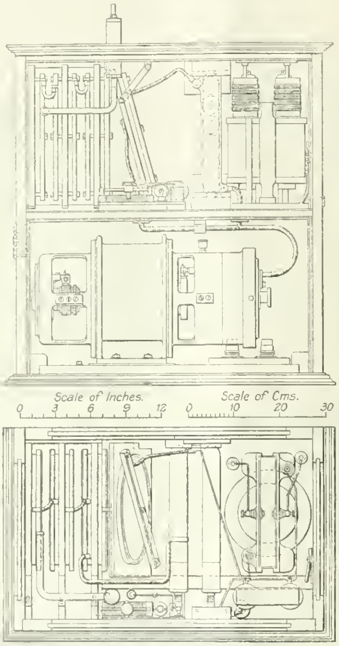


FIG. 4.—½ KW. MOTOR ALTERNATOR DISC CABINET SET.

The transmitting jigger is of the independent primary and secondary circuit type. The primary winding consists of a flat spiral of bare copper strip mounted on a suitable framework by means of ebonite insulating supports, connections being made at various points on the spiral by means of substantial clip connectors, thus enabling the amount of inductance included in the high-frequency primary circuit to be varied to suit the required wave-length.

The secondary inductance consists of a number of flat spiral units the various sections being connected up by means of flexible connectors stretching between one unit and another. A sufficient amount of aerial tuning inductance is provided to allow of the normal ship's aerial being tuned to the maximum wave-length without the need of external inductance.

The primary is hinged to the body of the cabinet and placed in front of the secondary winding, being fitted so as to swing outwards and allow of variation in the magnetic coupling between the primary and secondary circuits.

The manipulating key consists of a standard Marconi type wireless telegraph key, fitted with telephone short-circuiting contacts on the back stops, serving to protect the telephones from strong induced currents while transmitting, and rendering it possible for the operator to listen in for the communicating station between intervals of transmission.

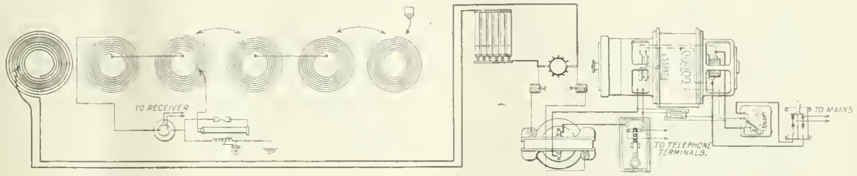


Fig. 5.—Diagram of Connections of ¼ kw. Motor Alternator Disc Cabinet Set.

The storage batteries are contained in a cupboard designed to accommodate 30 special ship type 80 ampere-hour cells. Care has been taken to ensure a free circulation of air through the cupboard. When the latter is placed in a sheltered position between the decks it is usual to fit a torpedo or other approved type of induced draught ventilator.

The electrical connection between the storage battery and the battery charging switchboard, situated in the operator's cabin, is made by means of insulated cable.

The several illustrations, Figs. 1 to 5, give a good idea of the general arrangement of the set, whilst the diagram of connections, Fig. 3, will sufficiently explain the wiring. When the ¼ kw. set is used on small vessels as the main installation, a receiver, of course, has to be fitted. This consists of one of the Marconi standard crystal receivers, having a range of reception covering all wave-lengths between the approximate limits of 200 and 2,500 metres.

THE ECONOMY OF ELECTRICITY IN SMALL HOUSEHOLDS.

BY W. B. SMITH.

Electric Lighting.—Nowadays, when metal lamps are comparatively cheap in first cost, electricity at, say, 3d. per unit is, light for light, more economical in running costs than the older methods, apart from the many other benefits it confers on the user. The chief difficulty is the initial outlay required to fit up lighting installations, and if electric lighting is to become the light for the smaller class of house already fitted with gas pipes, the cost of wiring will require to be considerably reduced. New and cheaper systems of wiring have already been placed on the market, but have not replaced the usual steel tubing and wood casing systems. Since the war commenced, prices of materials have advanced, and it is questionable if they will be much reduced for some years to come.

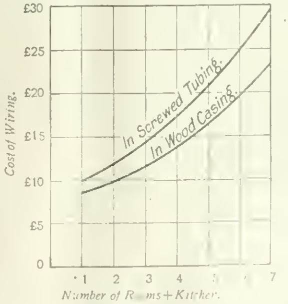


Fig. 1.—Approximate Cost of Wiring Houses for Electric Light, including Fittings and Lamps.

The curves in Fig. 1 show the approximate initial cost of lighting installations for houses of from two to eight apartments, wired in steel tubing and wood casing respectively. The figures given are for everything necessary to complete the installation with the best of materials, and allow for inexpensive fittings in the principal rooms. They do not include the provision of wall sockets for the use of standard lamps or heating appliances. The cost of wiring in screwed tubing rises in greater proportion than that of wood casing installations as the size of houses increases, due to the general practice of adopting more expensive fittings where the wiring is carried out of sight behind plaster and below floors.

The description of lamps and fittings adopted in a typical house of the semi-detached type, of, say, five rooms and kitchen might be as shown below. The cost of an installation of this size might be about £17 in wood casing and about £23 in screwed tubing, while the annual bill for lighting would vary from £2 to £3.

The actual cost of electricity for lighting in small houses naturally depends on the habits of the occupants, but the lighting bills of domestic consumers usually bear some relation to the size of the dwelling. The particulars in Fig. 2 have been compiled from the average lighting bills of domestic consumers in Greenock who are charged at present on a flat rate of 3d. per unit. The cost for each lamp per annum averages about 4s. In Fig. 3 the variation from month to month is shown, the amounts being calculated from actual meter readings. The cost of electric lighting per month varied from 5s. 7d. in January to 7d. for the month of July.

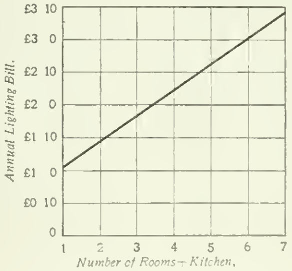


Fig. 2.—Annual Electric Lighting Bill for various sizes of Houses at 3d. per Unit.

Dwelling-House of Five Rooms and Kitchen.

Schedule of Lights and Fittings.

Position.	Lamps.			Fittings.
	No.	C.P.	Switches.	
Hall	1	50	1	One pendant (fancy shade).
Dining-room...	3	30	2	One three light dining table rise and fall pendant (silk flounce).
Drawing room or parlour...	4	30	2	Four small brackets or ceiling fixtures (fancy shades).
Kitchen.........	1	50	1	One rise and fall pendant (opal shade).
Scullery.........	1	16	1	One pendant (opal shade).
Stairway	1	16	2 two way	One pendant (fancy shade).
Bathroom	1	30	1	One pendant (opal shade).
3 bedrooms....	3	30	3	Three pendants (fancy shades).

The lighting of small houses has received a great deal of attention from station engineers. Prepayment meters are obviously suited to the very small consumer, but they are expensive and in many cases unreliable. The unlimited supply method is open to objection on the score of waste, to prevent which a great amount of inspection is necessary. In some towns, however, tenement houses and rows of cottages are supplied with electric light at a small sum per lamp each week, and the results from the consumer's, as well as the station engineer's, point of view have been quite satisfactory. The capital cost of the service is reduced by the value of the meter and cut-outs; no accounts are rendered, and only one weekly call at each house is necessary to collect the sums due. The advantage of this system in rows of tenements or cottages is evident, but it would hardly be suitable where houses are scattered over a large area. The weekly charge for energy is usually in the neighbourhood of 1d. per 30 c.p. lamp installed, which nearly equals the cost of 4s. per lamp per annum in the case of domestic consumers in Greenock.

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* Abstract of a Paper read before the Greenock Electrical Society

"Small-Current" Domestic Appliances.—Many "small-current" or "low-wattage" appliances are now in daily domestic use, the most popular in small houses being the electric iron, consuming one-third or one-half of a unit per hour. The electric kettle, with quick boiling heating element to boil 2 pints in less than 8 minutes, is, perhaps, the next most popular electric utensil.

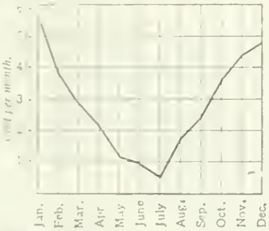

Fig. 3.—Electric Lighting in Small House at 3d. per Unit. Average 2s. 10d. per Month. Total for Year £1. 13s. 9d.

On the lighting rate of, say, 3d. per unit, the intermittent use of these "small-current" devices does not very materially increase the electricity bill. But if more frequent use is made of them the consumer should be advised to adopt the "fixed sum" system of charging, whereby an annual charge is made for the use of the supply and a small rate of, say, ¾d. per unit, for energy consumed and measured by meter. At this low rate for energy, the economy of applying electricity to all kinds of service in the home becomes at once apparent.

The greater the number of units supplied from a given generating plant the smaller the cost per unit becomes, or, in other words, the total cost per unit of supply depends on the load factor. If the load factor can be improved by the regular use of other apparatus, such as [illegible] heaters, hotplates, &c., the consumer should have the

Fig. 4.

[illegible]

[illegible]

[illegible]

[illegible]

consumer has the option of a low flat rate for the heating energy supplied by separate meter, the lighting being charged at the usual lighting rate.

Electric Heating.—The recent boom in electric heating is undoubtedly due to the advent of a reliable electric "fire" giving radiant as well as convected heat.

In actual heating value, electricity is seriously handicapped when placed alongside coal and gas. From each unit of electric energy only 3,410 British thermal units can be produced, so that at ¾d. per unit 1d. worth of electricity gives 4·550 B.Th.U. 1d. worth of gas at 2s. 11d. per 1,000 cubic ft. has a heat value of about four times this amount; while for coal at 25s. per ton the same cost would yield 105,000 heat units, or over 20 times the number of B.Th.U. But the excellent efficiency of electricity for heating enables it to compete in point of cost with gas at least, and although more costly than heating by coal fire, its other advantages would certainly recommend it in preference to the coal fire.

It is estimated that about 1·5 watts per cubit foot is necessary for the electric heating to raise the temperature by about 12°F. in one hour; but half of this expenditure of energy suffices to maintain that degree of heat. In a room of dimensions 14 ft. by 12 ft. by 10 ft., the capacity of the heater required would be 2½ kw., which could be reduced to about 1 kw. after the first few hours.

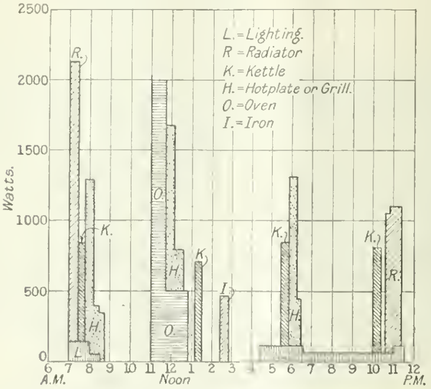

Fig. 5.—Daily Demand (during Winter) for Small Dwelling House. Lighting Consumption 0·6 unit per day at 3d. per unit= 1⅘d. per day. Heating and Cooking 4·5 units per day at ¾d. per unit=3⅜d. per day.

For the bathroom the electric fire is specially suitable, but certain rules should be enforced before placing an electrical appliance in a bathroom. The frame must be efficiently "earthed" to the water pipes, and to prevent further any danger from shock it would be advisable to insist on electric heaters or towel rails being securely fixed to the wall or floor of a bathroom, so that they cannot be moved to a position where they might be touched by a person who is already in contact with any of the bath fittings. Most electric fires are provided with an earth terminal, and where there is any possibility, however remote, of a person receiving an electric shock, it is imperative that the frame of the heater be efficiently connected to earth. Switches and wall sockets for heating supplies should also be of such a design that it is impossible to make or break the circuit by the insertion or withdrawal of the plug.

The automatic regulation of temperature in a room can be more satisfactorily performed with electric fires than with any other system of heating. By an arrangement of thermostat and circuit breaker in the heater circuit, it is possible to maintain an almost uniform temperature in any apartment.

Electric Cooking.—The progress of electric cooking in houses has not been so marked as the enterprise of manufacturers deserves. In England, where a large amount of roasting and baking is done in the household, the electric cooker is now extensively used; but in Scotland, where boiling, stewing, frying and grilling form the greater proportion of cooking operations, the adoption of the new method has been extremely slow. The reason for this is that although the electric oven has almost reached a state of perfection, the same cannot be said of the hotplates on most electric cookers.

Several makers have certainly improved the quick heating capacity of their hotplates, both of the open and the enclosed types.

Further improvement is to be expected with the open-element radiant-type of boiling ring, with which ordinary black pots and pans are most efficient, and where close contact between plate and utensil is not so important. The black hot plate has the disadvantage that the cast iron forming the surface has to be raised in temperature from cold before heat is conducted to the cooking utensil. Special flat-bottomed utensils are also necessary with the cast-iron hot plate, and the importance of good contact should be emphasised.

Neglecting the minor shortcomings of the electric cooker, it can be proved that cooking by electricity is economical. In roasting, meat only loses 10 per cent. in weight in an electric oven, as compared with about 30 per cent. for a gas oven. This fact in itself would be sufficient to support the adoption of electric cooking at reasonable rates for energy. But when regard is taken of the other advantages to be gained, its economy in the home is beyond question in so far as roasting and baking are concerned. With an electric oven it is only necessary to perform one cooking operation successfully to know that for subsequent cooking the same conditions will result in the same satisfaction, as the regulation of heat in the oven can be gauged to a nicety. In the selection of an oven, top heat should be insisted on as well as bottom heat, as it enables the food to be well browned on top, and a better variation of the heat distribution in the oven is possible. Side elements are not so serviceable in this respect. The full temperature of 300°F. or 400°F. should be attained in about 20 minutes after switching on, and the oven should be lagged so that about one-half of full-loading maintains this temperature.

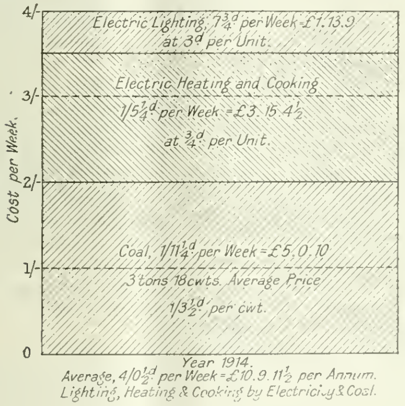

Fig. 6.

For the consumer who does not desire to instal a complete electric cooking outfit, but who wishes to make a trial of electric cooking, a small hotplate and grill, together with a self-contained quick-boiling kettle, make a very handy combination for preparing breakfast and tea. With these small appliances, a breakfast for three persons, consisting of porridge, ham and eggs, and tea, can be easily made in 20 minutes at a cost for electric energy of less than ½d. The electric grill is, perhaps, the most perfect part of the electric cooker. In a few minutes, ham, a steak, a chop, or a Welsh rarebit may be cooked with little trouble. The husband whose wife is at the coast or on a visit to relatives, and who has to prepare his own meals at home, will find the electric grill a decided boon. It is "on" for a few minutes only, so that the energy used is negligible.

From figures available, the energy used for cooking varies from 1 to 1½ units per day for each person, and the annual cost for a family of three or four persons should not be more than £4. 10s.

General.—In a small household of three persons where the cooking is done by electricity, and where electric heaters are used for occasional heating of rooms, the diagram in Fig. 5 would apply for a winter day. In the early morning the radiator is in use for heating in the bedroom. Later the kettle and hotplate are put on for the preparation of breakfast. During the forenoon the oven is in use for roasting and baking, the hotplate for boiling potatoes, &c., and later the kettle for boiling water for tea. The electric iron may be in use for a short period during the afternoon, and in addition to the lighting, the kettle and hotplate are again in commission for tea. Late in the evening the kettle is used for supper, and the radiator is put on in the bedroom before retiring. The lighting costs 1¾d., and the heating and cooking about 3½d., a total cost of 5¼d. per day in winter. For a day in summer the cost would obviously be much less.

In this case the daily load factor for lighting works out at 3 per cent., while with the cooking and supplementary heating, the load factor is raised to 10 per cent. for the same house. The average price paid for the whole supply works out at a little more than 1d. per unit.

The annual cost of cooking, heating and lighting by electricity and coal from actual results in such a house as shown in Fig. 6 was £10. 9s. 11½d., and it would seem that if electricity had been used exclusively for all these domestic purposes, the cost would not have exceeded £20 per annum.

Having taken up the various domestic uses separately, consider the case of a house of four or five apartments where no gas or coal is used, and where electricity supplies all the necessary light, heat and power. The following are the principal items of expenditure per annum under these heads:—

	Units.	Per unit.	Total.
Lighting	200	3d.	£2 10 0
Heating rooms	2,560	¾d.	8 0 0
Cooking	1,440	¾d.	4 10 0
Hot water supply	1,440	½d.	3 0 0
Other uses, say	480	¾d.	1 10 0
	6,120		£19 10 0

In Dumbreck, Glasgow, eight small villas of four, five and six apartments have been fitted with electrical appliances for lighting, heating, cooking, &c., and the cost of electricity per annum for the year ending May, 1915, was found to vary from £20 to £30 for each house.

For a small dwelling, where no maid-servant is kept, a total cost for electricity of £20 or even £30 per annum, cannot be said to be excessive, considering the dirt and labour saved, and the usefulness of the whole arrangement.

It might be argued that the effect of a large cooking and heating load would very materially raise the peak of a power station without much advantage in increasing the general load factor of the station. Such, however, is not the case. In a town where in large tenement houses the tenants use electricity for lighting, heating and cooking, although the total of the rated loads of 21 consumers in one block was 110 kw., the maximum load on the service cables supplying the block was only 13·5 kw. In the case of the Glasgow villas mentioned above, the maximum demand on the distributor supplying the houses was 17 kw., although the connected load totalled 80 kw., giving a diversity factor of about 5.

It has been shown in several towns that the domestic cooking and heating load comes on mainly at "off-peak" hours of the day, thereby tending to improve the load factor on the station, and assisting towards the cheaper cost of generation. The power load has already reduced the production costs, but the power load on a central station often depends on the state of trade in the district, whereas the domestic heating and cooking load, if properly developed, would provide an excellent day load almost independent of industrial fluctuations.

Influence of Foreign Ingredients on Steel. An important Paper by Dr. J. E. Stead read at the annual meeting of the Iron and Steel Institute on Sept. 21-22, discusses the effect of small quantities of phosphorous, sulphur, manganese, copper and tin on the qualities of steel. Attention is drawn to the need of greater precision in describing experiments on various steels. For example, in recording the results of tests of tensile strength, the dimensions of the test-pieces should be stated, and, in dealing with normalising and annealing, the temperature of heating and the time of cooling to below redness should be recorded. Speaking generally, the deleterious effects of impurities appear to have been exaggerated. Thus the effect of phosphorous within 0·1 per cent. is comparable with that of carbon and 0·13-0·20 per cent. is desirable to give good machining properties. Phosphorous alloyed with iron also makes the metal less liable to corrosion. While sulphur *per se* may cause "red-shortness" in small quantities, it is actually beneficial provided manganese is also present. Silicon up to 1·5-1·75 per cent. increases the limit of ductility and tensile strength, while copper, in quantities less than 0·5 per cent., has little or no influence on the mechanical properties. Tin, however, in any sensible quantity should be avoided, as it makes the steel difficult to roll and hard and stiff when heated.

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EFFICIENCY IN THE BOILER HOUSE.

It is now fairly recognised that the running of the boiler house efficiently is far more difficult than the running of the engine room, owing to the fact that the conditions under which the energy of coal is transferred into the energy of steam are more or less variable. For example, the conditions under which the combustion takes place do not remain constant. The external surface of the tubes which receive the heat varies as the deposit thickens, and the internal surface of the tubes where the heat is transferred from the metal to the water is liable to change through the formation of scale. Consequently, for efficient running it is essential that continuous attention should be paid to many matters of detail.

In our present issue we publish an interesting account of the methods adopted for this purpose in a generating station of 100,000 kw. at Boston. From this it will be seen that every 30 days the boiler drums are thoroughly washed out, and every 60 days inspection is made of the lower rows of boiler tubes, so that the formation of scale may be closely followed. The scale thickness can thus be estimated or calipered if necessary. The external cleaning of tubes along with settings is also carried out systematically. For this purpose the men use jets of steam and long hooks. Steam is also blown along the passages between the tubes while the boilers are in operation.

It is a little surprising to note that in this station use is made of boiler fluid. Engineers in this country have long since come to the conclusion that a boiler should not be converted into a water softener, and that water treatment should be carried out in a completely separate plant.

The account to which we have referred deals almost exclusively with the cleaning and inspection of the boilers, but there are many other operations which are equally important. There is, for example, the sampling of the fuel. The production of steam has become much more of a chemical operation than it was some years ago, and for the highest efficiency it has become necessary to trace the progress of the thermal units through the various operations, from the coal heap to the chimney shaft; hence, the desirability of examination of the coal on arrival and records of the flue gases, in order to see that the conditions under which combustion takes place are satisfactory.

Among the many problems with which the engineer is faced is the provision of sufficient boilers for peak load, and the banking of these boilers when no longer required. During times of peak some forcing of the boilers naturally takes place. It is questionable, however, whether anything is to be gained by the banking of boilers once the peak has passed. The efficiency of a boiler falls off rapidly if forcing is carried beyond a certain point, and the best results can only be obtained if the velocity of the gases is sufficiently low for the greater part of the heat to be taken from them by the boiler and economiser combined. On this account it is probably a better proposition to keep the full number of boilers in service during the times of light load rather than to bank a certain number, unless the difference between the peak load and the night load is very marked. It must also be remembered that the rate at which the fuel passes through the furnace depends upon the amount of steam required. Anything like complete combustion cannot be obtained if the speed is above a certain value. This point was brought out recently at the meeting of the Incorporated Municipal Electrical Association, when Mr. S. E. FEDDEN stated that the ash at Sheffield had been found to have a calorific value of 4,648 B.Th.U. and that this had been reduced to 3,152 by careful supervision. If we start with coal of, say, 12,000 B.Th.U. we, as engineers, cannot be proud of our methods of combustion if they leave over 3,000 B.Th.U. in the ash, or over 25 per cent., and we are forced to the conclusion that the best results can only be obtained by most careful supervision and by the most detailed investigation of all the losses in the boiler house.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

The Dynamical Theory of Gases. By J. H. JEANS. 2nd edition (Cambridge: University Press.) Pp. vi.+436. 16s. net.

When the first edition of this work was published in 1904, the Kinetic Theory of Gases was in many respects in a very uncertain state. Facts and hypotheses were very mixed and required to be disentangled, and the author, in reducing the whole subject to an ordered arrangement, rendered important services towards further research in a subject which many thought had become barren, and others were afraid to touch. The effect of this work has been manifest in many directions recently, and the development of the kinetic theory is now proceeding rapidly in the hands of several investigators.

The second edition now before us brings the more classical theory thoroughly up to date, and gives due prominence to even the most recent work of Chapman and others, pointing out, at the same time, certain important limitations, affecting the generality of many investigations, which are apt to be overlooked. The author's avowed aim is to develop the theory on an exact mathematical basis, but this aim has not been allowed to interfere with the value and completeness of the work for a non-mathematical reader. For there are both physical and mathematical chapters so arranged that all the essential successes and difficulties of the kinetic theory can be learned from the former by a reader who is content to dispense almost wholly with the latter—a remarkable fact, in view of the nature of the subject. The work could, if on this ground alone, be recommended to any reader, whether physicist, mathematician or engineer, who wishes to obtain a working knowledge of gas theory.

To say that this is the standard work on the subject is somewhat superfluous, in view of its authorship. The first edition had already earned that title. One very valuable feature is the frequent use of simple mechanical illustrations of difficult points, which, for the general reader, form a welcome and satisfactory substitute for a long mathematical investigation. After a short introductory chapter, the theory of a gas in a steady state is taken up, and followed by a descriptive chapter on the physical properties of gases in this state. Corresponding chapters follow, in which the gas is not in a steady state, and these naturally include full accounts of such phenomena as Viscosity, Conduction of Heat and Diffusion.

After a review of the evidence as to the size of molecules and allied subjects, the author proceeds to more particular problems, such as the theory of aerostatics and planetary atmospheres, the transfer of energy and propagation of sound, and the partition of energy in continuous media. The quantum theory has been confined to one chapter—the author has already, through the Physical Society, published separately a well-known report on this theory. In view of the present position of the quantum-theory, we must agree with the author that the proper procedure now is to indicate only the manner in which it appears to solve difficulties left from the classical treatment. The author anticipates, however, that it must necessarily appear to a much greater extent in any further edition. The present volume, in every respect worthy of the best traditions of the Cambridge University Press, already differs notably in size from its predecessor. J. W. N.

The Year-Book of Wireless Telegraphy and Telephony. (London: The Wireless Press, Ltd.) Pp. lxxx.+874. 3s. 6d. net.

The present volume contains a few more pages than its immediate predecessor. An addition has been made to the summarised laws and regulations laid down in the various countries, and reference is greatly facilitated by an excellent index. The dictionary in five languages and glossary of technical terms is supplemented by a report of the Committee on Standardisation. The volume includes a mass of technical information in addition to numerous tables.

Dr. Erskine Murray has revised and brought up to date the pages devoted to "Useful Formulæ and Equations." Mr. A. Hurd contributes an essay on "Intelligence in Naval Warfare," and "The Allies' Strategy in 1915," written by Col. Maude, forms interesting reading. Dr. Fleming also writes on "Photo-Electric Phenomena," and an article by Dr. Eccles on "Capacitance, Inductance and Wave-lengths of Antennæ" contains an original series of abacs of great utility for purposes of calculation. The Vice-President of the Institution of Radio Engineers, Mr. J. L. Hogan, jun., also contributes a Paper on the "Measurement of Signal Intensity." The volume is well illustrated, and contains biographical notes, together with much other interesting matter. The excellent reference section, in which are arranged in chronological order all the chief events in connection with wireless work, forms a valuable feature of the book. It is interesting to read that even in peace time Germany systematically endeavoured to elude the various regulations laid down by the Convention, although she played a predominant part in the debates leading up to their formation. The volume seems to us to be a *sine qua non* to anyone interested in radio-telegraphic or telephonic matters.

On the Relation of Imports to Exports. By J. TAYLOR PEDDIE. (London: Longmans, Green & Co.) (Second edition, Pp. xix.+148.) 5s. net.

The first edition of this book was reviewed in our columns a few months ago. The present edition includes an essay on "National Economics or Empiricism," which deals with the knotty question of tariffs, and other contentious questions. In the preface the author mentions that he was surprised to find that Adam Smith was not the originator of our present system of one-sided, or Free, Trade. We should have imagined that every writer on economics, or, indeed, any one who has taken the least interest in the now almost forgotten "Tariff Reform *v.* Free Trade" arguments, was aware that Adam Smith never suggested in any of his writings "one-sided" trade such as we have at present.

In this essay the author refers to Mr. McAdoo's Annual Report to Congress about the creation and adoption of the Federal Reserve Banking Systems, and deals very fully with Dr. Ewing Pratt's advice to the bankers in the United States about setting up an Exchange in New York. The position of the United States is now immensely stronger, and the author asks, "What are we doing" with regard to such matters. Germany has now totally lost all she has gained in years of peace, and according to the author America will be a most serious competitor for her in the days after the war. With his statement that "we should organise in war for peace" we entirely agree. The contrast (on p. 139) presented by Australia being prepared to spend £500,000 if necessary on scientific research when her population is only 4,000,000, whereas we find difficulty with a population of 46,000,000 in raising £30,000, is particularly opportune at the present moment. The book being written in a free and easy style is more readable than the ordinary text-book on economics, and may induce the "man in the street" to take some interest in these questions of such vital importance.

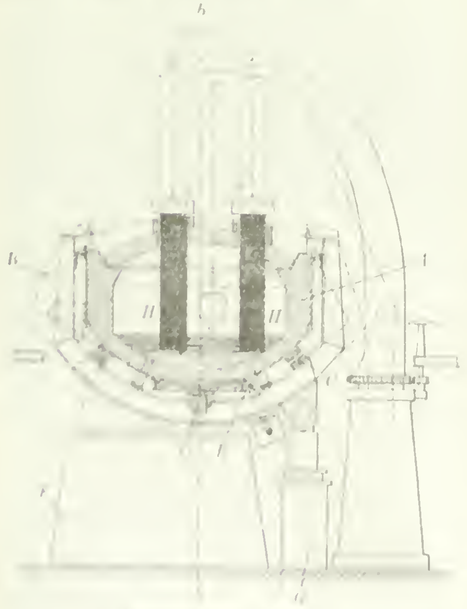
Wireless Transmission of Photographs. By M. J. Martin. (London: Wireless Press.) Pp. xi. 112. 2s. 6d. net.

The title of this little book is misleading in so far as the utilisation of wireless for the transmission of pictures receives no serious treatment at all. This is perhaps fortunate; for where the author has departed from the safe course indicated by the phrase "the usual wireless equipment having been omitted from the diagram to avoid confusion," the reader is [illegible] the wiser.

It is hard to see how any student could profit by the perusal of this book. Though professedly to a large extent an account of original work, it is characterised by a marked absence of any insight into the fundamental mechanical and electrical principles without which it is futile to tackle a task of this nature, nor is any literary ability to describe the work of others in evidence. The present writer confesses to a very meagre acquaintance with telephotography when he took up the book, but after as careful a perusal as its puerility would allow he is unable to report any advance. L. B. T.

ROTATABLE ELECTRIC FURNACE.

According to "Metallurgical and Chemical Engineering" an electric furnace which is rotatable horizontally about a vertical axis and which may also be tilted for pouring the charge has been patented by Mr. P. Evermann, of [illegible]. A sectional view of the furnace is shown in the accompanying illustration. The



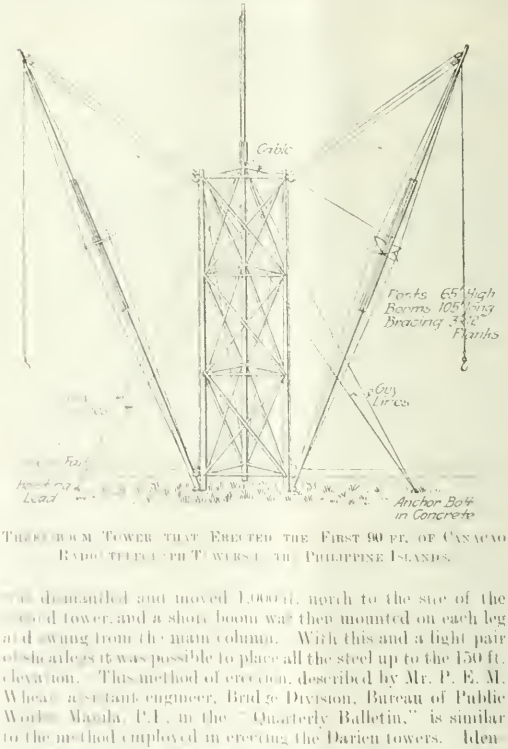
[illegible]

[illegible]

line *b b*, so that when the crucible is rotated on its axis, each of the electrodes describes a different path, thus subjecting the various parts of the metal to the action of the current. This feature is claimed to necessitate only a small number of electrodes.

ERECTING THE CANACAO RADIO TOWERS.

The first 90 ft. of the Canacao Radio Towers, recently erected in the Philippine Islands, was placed by three 105-ft. booms swung from a centrally located falsework tower shown in sketch. According to "Engineering News" these booms were operated by hoisting engines located on platforms directly behind three tower footings. The booms were rigged as shown. A 40 ft. length of 12 in. by 12 in. was butt-spliced to a 65 ft. Oregon pine pile with four 40 ft. 8 by 8's bolted across the joints. After one of the booms had broken in two, a ¾ in. cable truss was arranged. When the tower was 90 ft. high the falsework was dismantled and moved 1,000 ft. north to the site of the second tower, and a short boom was then mounted on each leg and swung from the main column. With this and a light pair of shearlegs it was possible to place all the steel up to the 150 ft. elevation. This method of erection, described by Mr. P. E. M. Wheat, assistant engineer, Bridge Division, Bureau of Public Works, Manila, P.I., in the "Quarterly Bulletin," is similar to the method employed in erecting the Darien towers. Identical stations are being erected at San Diego (Cal.), and at Pearl Harbour, Hawaii. The towers are 600 ft. high. The Canacao towers and station should be finished by Jan. 1, 1917.



Three-boom Tower that Erected the First 90 ft. of Canacao Radio-telegraph Towers in the Philippine Islands.

STEAM V. ELECTRIC WINDING.

In a Paper entitled "Application of Electric Power to Mining Work in the Witwatersrand Area, South Africa," read before the American Institute of Mining Engineers, Mr. J. Norman Bulkley gives some useful data.

It appears there are [illegible] hoisting equipments in this area, excluding winches. The average horse-power of these was 517, and the aggregate 74,000.

Careful comparison of the cost of working showed that the saving in the case of electric winding on some of the 4,000 ft. shafts was at least 0½d. per ton, and in addition there is a considerable decrease in the maintenance cost of shaft guides owing to the steadier turning movement of the electric winder. The advantage of greater safety and reliability is also with the electric equipment.

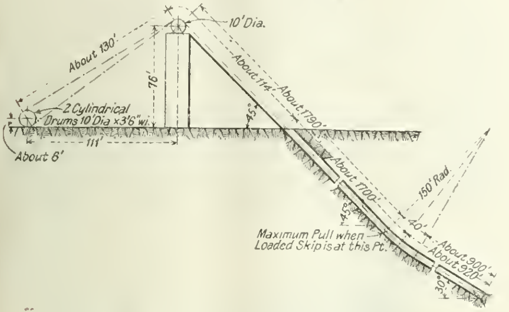


FIG. 1.—RHEOSTAT-CONTROLLED WINDER.

The figure above refers to the Van Rhyn Gold Mining Co., and it is equipped with a geared three-phase rheostatic winder handling 5 ton rock loads at 1,500 ft. per minute, with a monthly tonnage of about 22,000 tons.

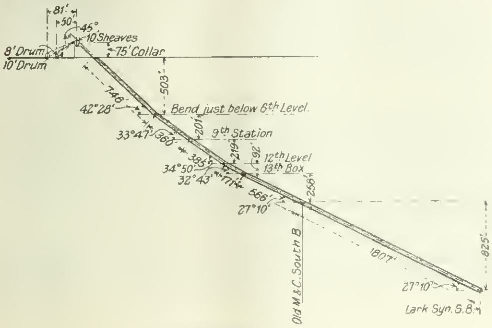


FIG. 2.—WARD-LEONARD WINDER.

The above figure relates to the Meyer & Charlton Gold Mining Co. and is a direct-coupled Ward-Leonard hoist operating at 2,500 ft. per minute, and a monthly tonnage of about 17,000.

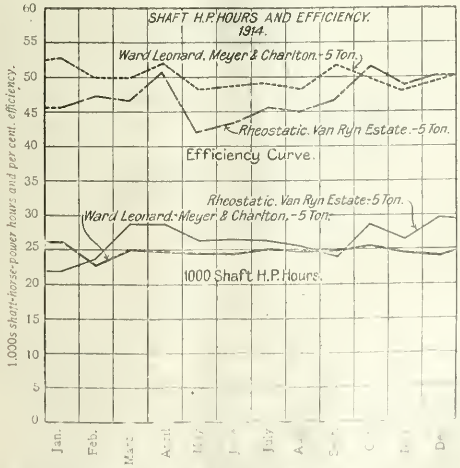


FIG. 3.—COMPARATIVE EFFICIENCY CURVE, WARD-LEONARD WINDER.

NOTES.—Meyer & Charlton Ward-Leonard 5-ton winder [illegible] only 6.30 a.m. to 10.30 p.m. No driver on night shift and motor generator set shut down.

Van Ryn Estate.—Three phase alternating 5-ton winder on three shifts.

Efficiency Curve.—Useful work in shaft-horse-power hours to [illegible] month as registered on switchboard watt-hour meter.

A comparison of a year's working is shown in the curves above, and it will be noticed that in steady working the efficiency of the Ward-Leonard set exceeds that of the rheostatic set by about 5 per cent.

In the case of another mine where the change from steam to electric drive was made the milling capacity was increased from 15,000 to 17,000 tons per month. The electric drive also saved £8,400 per annum, as compared with the steam costs of the two preceding years, no allowance being made for the increased tonnage treated by the electric driving.

CORRESPONDENCE.

THE AIR-GAP FIELD OF THE POLYPHASE INDUCTION MOTOR.

TO THE EDITORS OF THE ELECTRICIAN.

In the series of most interesting and instructive articles just concluded, Dr. Chapman has investigated the problem of the air-gap dispersion of polyphase induction motors by the method of harmonic analysis of the air-gap fields. As Dr. Chapman states in sec. 16, p. 730, it was one of the objects of his Paper to show that the only medium of action and reaction between stator and rotor, which need be considered in practice, was the fundamental field.

The arguments by which Dr. Chapman establishes this important fact are in the nature of general reasoning on the effects of the various multiple fields, rather than an exact mathematical proof that these effects are negligible. The substantial accuracy of this deduction is mathematically confirmed (on the assumption of negligible saturation effects) by the results obtained by the method I outlined in my articles on the dispersion coefficient of three-phase motors which appeared in THE ELECTRICIAN from October, 1915, to January, 1916. This consisted in applying to the calculation of the mutual induction between the stator and rotor winding exactly the same method as is used by Dr. Chapman (secs. 9-13) and was used by myself (for the case of three-phase windings) for the calculation of the total *self*-induction of the stator or rotor winding. This method gives the integrated effect of the fundamental and all the multiple fields. The calculation of the mutual induction by this method is not, however, as simple as that of the self-induction. A separate calculation was made for each case according to the numbers of stator and rotor slots per pole, and it was shown eventually that the maximum and minimum values (with respect to the relative positions of stator and rotor) of the mutual induction were given, in some cases accurately, in all cases approximately, by certain formulæ, from which a general formula for the air-gap dispersion (there termed the main dispersion) was deduced.

I give below a comparison of results so obtained with those arrived at by Dr. Chapman.

The comparison is a little complicated by the fact that Dr. Chapman defines his circle coefficient as the ratio $I_m/(I_s-I_m)$ instead of I_m/I_s as is more usual (I_m denoting magnetising current and I_s short-circuit current) and also because

$$(1+\lambda'_1)=\pi^2Q_1/4P_1K^2_{w1}$$

and not

$$\pi^2Q_1/4\sqrt{P_1P_2K_{w1}K_{w2}}.$$

If $(1+\lambda''_1)$ denote this latter quantity, then

$$(1+\lambda'_1)(1+\lambda'_2)=(1+\lambda''_1)(1+\lambda''_2).$$

$$\therefore\qquad \lambda'_1+\lambda'_2=\lambda''_1+\lambda''_2+(\lambda''_1\lambda''_2-\lambda'_1\lambda'_2).$$

and the quantity in brackets is quite negligible in view of the extreme smallness of the quantities λ'_1, λ'_2, λ''_1, λ''_2. Now Q_1, Q_2 are identical respectively with the coefficients p_1, p_2 used by me, while $4\sqrt{P_1P_2K_{w1}K_{w2}}/\pi^2$ corresponds to, but is not identical with, the mean value of my coefficient β (with sufficient approximation the mean of the maximum and minimum values may be used).

Stator slots per pole.	Rotor slots per pole.	$\lambda'_1+\lambda'_2 = \left(\frac{\pi^2Q_1}{4P_1K^2_{m1}}+\frac{\pi^2Q_2}{4P_2K^2_{m2}}\right)-2$	$\lambda'_1+\lambda'_2 = \left(\frac{\beta_s+\beta_r}{\beta_m}\right)-2$	Percentage mutual induction due to multiple fields.
3	6	0·1260	0·1219	0·19
6	9	0·0430	0·0409	0·13
9	12	0·0229	0·0222	0·035
9	15	0·0205	0·0198	0·035
9	18	0·0192	0·0177	0·065
12	15	0·0154	0·0148	0·03
12	18	0·0141	0·0134	0·035
12	21	0·0132	0·0128	0·02
15	18	0·0117	0·0113	0·02
15	21	0·0108	0·0104	0·02
18	21	0·0095	0·0092	0·015

They are not identical because β_m represents the mutual induction due to all the multiple fields, whilst $4\sqrt{P_1P_2}K_{m1}K_{m2}/\pi^2$ represents that due to the fundamental field only. In terms of the coefficients β_s, β_r, β_m we have

$$\lambda'_1+\lambda'_2=\lambda''_1+\lambda''_2=(\beta_s/\beta_m-1)+(\beta_r/\beta_m-1)=\{(\beta_s+\beta_r)/\beta_m-2\}.$$

In the table these values for $(\lambda'_1+\lambda'_2)$ are compared for a number of cases, with those obtained by using Dr. Chapman's Table XI., column A. It will be seen that the agreement is in every case very close, thus confirming Dr. Chapman's general conclusion that the *mutual* inductive effects of the multiple fields are negligible. Though negligible for all practical purposes they are, however, appreciable. The Table also allows of a quantitative determination of the magnitude of the mutual induction due to the multiple fields. Taking, for example, the case of three stator and six rotor slots per pole,

$$\left(\frac{\pi^2Q_1}{4P_1K_{m1}}+\frac{\pi^2Q_2}{4P_2K_{m2}}\right)=(\lambda'_1+\lambda'_2+2)=(\lambda''_1+\lambda''_2+2)=\frac{\pi^2(Q_1+Q_2)}{4\sqrt{P_1P_2K_{m1}K_{m2}}}=2\cdot1260,$$

whilst

$$(\beta_s+\beta_r)/\beta_m=2\cdot1219,$$

so that

$$\beta_m\div\frac{1}{\pi^2}4\sqrt{P_1P_2}K_{m1}K_{m2}=\frac{2\cdot1260}{2\cdot1219}=1\cdot0019.$$

That $4\sqrt{P_1P_2}K_{m1}K_{m2}/\pi^2$ must be increased by 0·19 per cent. in order [illegible], i.e., the total mutual inductive effect of all the multiple fields is only 0·19 per cent. of that of the fundamental field. The corresponding figures in the various cases are given in the last column of the Table.

One interesting result of Dr. Chapman's calculations is the [illegible] appreciable reduction of the air-gap dispersion to be expected with a squirrel cage rotor, even when the number of slots is [illegible].

Dr. Chapman has examined in considerable detail the effect of [illegible] on the air-gap dispersion and concludes that [illegible] reduced some 10 to 15 per cent. thereby, [illegible] in Tables XI. and XII. In my [illegible] from general considerations that the effect of [illegible] on the air-gap dispersion might be [illegible]. Dr. Chapman, however, does not state what degree of [illegible] columns "C" of Tables XI. and XII. [illegible]. True, the air-gap density is given for the [illegible], but this alone without data as [illegible]. It is, I think, [illegible] reduction of air-gap dispersion [illegible] ratio of total ampere [illegible] the greater will be [illegible] of the field from a rectangular form in [illegible].

The [illegible] Dr. Chapman considers [illegible] the air-gap dispersion, the reduction being entirely due to [illegible] of the field. It would add considerably to [illegible] if Dr. Chapman would say [illegible].

Bedford, Oct. [illegible] E. A. Biedermann.

THE TESTING OF ELECTRICAL PORCELAIN.*

BY E. E. F. CREIGHTON AND P. E. HOSEGOOD.

The high-frequency method is now being very widely utilised for the testing of porcelain insulators. The majority of failures of insulators on transmission lines have been due to two causes, namely, cracks and porosity. Failures occur most frequently in the summer time, when the potentials derived from lightning discharges reach their highest value. The cracked porcelain is due primarily to the unequal expansion of metal and porcelain. This trouble does not appear during the early months of use, because the Portland cement has not hardened sufficiently to transmit the strains. It is usually revealed at a later stage. Cracks may be caused by the placing of the metal cap directly on the porcelain skirt, or by filling the space above the iron pin completely with cement. Expansion of the cap or pin then causes a horizontal crack in the porcelain head. This defect is avoided by spacing the cap above the porcelain at the time the cement is set, and by leaving an open space both at the top of the cap and the top of the pin. Another improvement consists in doing away with the grooves in the porcelain and trusting to the grip of the roughened surface in one form or another. However, there is always some danger when materials having unequal coefficients of expansion are used.

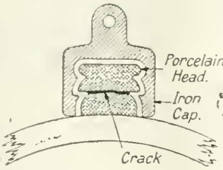


FIG. 1.—DIAGRAM SHOWING HOW A PORCELAIN HEAD MAY BE CRACKED BY THE LONGITUDINAL EXPANSION OF CAP OR PIN.

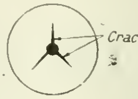


FIG. 2.—RADIAL CRACKS IN PORCELAIN CAUSED BY THE RADIAL EXPANSION OF PIN.

The other prolific cause of failure has been due to porous porcelain. Porosity in porcelain comes from lack of vitrification. Vitrification depends upon two conditions: First, the amount of feldspar (the flux) which is mixed with the clays; and, second, the temperature and time of firing. The less flux used the higher the temperature necessary to produce vitrification.

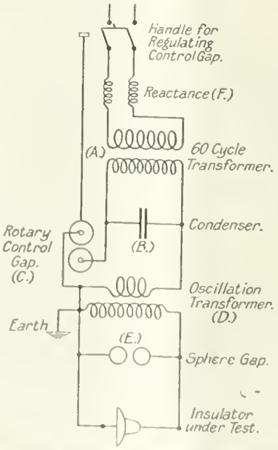


FIG. 3.—OSCILLATOR ARRANGEMENT FOR TESTING INSULATORS.

Porosity is an intrinsic fault in manufacture, and such faulty porcelain is used only because of inadequate methods of electrical test or lack of tests. When the porcelain is very porous it will not withstand the electric stress at flash-over voltage. Such porcelain will absorb water rapidly within a few hours and will give a low reading on the megger.

But in the case of lower degrees of porosity a 60-cycle test fails to cause a puncture. Absorption of water may take place very slowly, and diminished insulation only becomes evident after days or months. In practice moisture is commonly derived from the cement used between the hardware and the porcelain. The high-frequency test is of great value in detecting faults of this nature, and also weakness in the skirt of the insulator. The entire surface of the insulator is bathed in visible corona, and every weak point is searched out. The efficacy of the high-frequency oscillator is partly due to the fact that the stresses caused by lightning are of a similar high order of frequency.

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* Abstract of an article in the "General Electric Review," of America.

The fundamental theory of the oscillator is shown by the connection in Fig. 3. The essential process consists in charging up a suitable condenser to a voltage which will spark across a control gap. This discharge current flows through a few turns of an oscillation or coreless transformer. All the energy stored electrostatically in the condenser continues to oscillate until it is used up in the heat. The natural frequency of this circuit gives the frequency of oscillation, which is usually of the order of 200,000-400,000 cycles per second. This frequency, however, is only applied about twice every half cycle of the generator wave, and there is a relatively long interval between discharges.

As a rule the oscillator produces 120 wave trains per second. If each wave train has a natural frequency of 200,000 cycles per second, and lasts for 100 cycles, the potential would be applied for 0·0005 second, and the interval between this successive wave would be 0·0080 second. The period of no-application of potential might thus be 16 times as long as the period of application.

The 125-kv. oscillator covers most of the tests which practice usually demands. In addition, oscillators giving 250-kv. and 500-kv. are also made. A type of lighter weight for transportation along the line and a type capable of producing over a million volts are also being developed. Voltage is measured in terms of the sparking distance.

The oscillator is also particularly applicable to the testing of non-inflammable materials, such as porcelain, glass and certain impregnated articles. But the production of the corona may give rise to sufficient heat to burn inflammable materials, such as hard rubber. The applications of the oscillator to various classes of insulating material are now being studied, but the method of application varies in each case.

The oscillator is not well adapted for testing very wet porous porcelain, the explanation being that the discharge, being of brief duration, does not suffice to evaporate the water and produce a puncture.

HIGH-INTENSITY SEARCHLIGHT.*

According to tests by the United States Navy, the Beck searchlight was shown to be the highest-powered projecting lamp in the world. It employed small electrodes which were worked at a very high current density. For 150-ampere lamps the positive and negative electrodes were respectively 0·5 in. and $\frac{7}{16}$ in. in diameter. To maintain a small positive crater and thus confine the light-giving source to a small area the electrodes were cooled by alcohol vapour. The positive electrode was allowed to consume at the rate of about $7\frac{7}{8}$ in. to $9\frac{7}{8}$ in. per hour.

Experiments are now being conducted with a new high-intensity searchlight lamp which bids fair to eclipse the German lamp. About the same diameter electrodes are used, but the arc crater is more confined. The electrode holders are cooled by air, and the positive electrode is allowed to consume more rapidly than the Beck lamp.

Aside from its remarkable beam intensity, the search lamp has a number of novel constructional and operating features. Instead of producing the light with the positive crater of a pure carbon arc, impregnated carbon is used and worked at such a high temperature that a superheated vapour or gas is maintained in the crater, thus giving a much higher intrinsic brilliancy than is usually obtained. In order to develop the most light from the superheated vapour, a very deep and small diameter crater is maintained in the positive electrode and the vapour compressed in it by the flame from the negative electrode. With this arrangement, the crater is made to emit more than 500 c.p. per square millimeter, or 320,000 c.p. per square inch. This is 65 per cent. of the intrinsic brilliancy of the sun at 30 deg. elevation, and almost $3\frac{1}{2}$ times the brilliancy of a pure carbon arc crater.

Another great advantage of the lamp is that the area of the light-giving source or crater has been considerably reduced. By thus closely approaching a point source of light the reflector can be utilised to better advantage, and the rays projected more nearly parallel. For the 150-ampere lamps, the diameters of the positive and negative electrodes are respectively $\frac{5}{8}$ in. and $\frac{7}{16}$ in., about the same as for the German lamp. The positive and negative electrodes of the 200-ampere lamps are about 2 mm. and 1·5 mm. larger respectively.

On account of the small size of the negative electrode and its holder, very little shadow is cast on the mirror, thus increasing the beam intensity.

A rate of consumption of the positive electrodes is selected which favours the production of the correct amount of gas required in the positive crater to ensure the high intrinsic brilliancy. The positive carbons are made much longer, being 36 in. for a 150-ampere arc. From tests with this high-intensity arc it has been observed that the current, not the current density, is the controlling factor in producing the best results. The 60 in. lamp takes about 200 amperes at 70 volts and the 36 in. lamps require about 150 ampere. The rate of consumption of the positive electrode is in the neighbourhood of 13·5 in. per hour. The beam intensity of the 60 in. lamp at $\frac{1}{2}$ mile is estimated to be about 85 ft.-candles and that of the 36 in. lamp about 30 ft.-candles. Accurate data on this subject is not available, however, at present. The light source is so diminutive that the 60 in. lamp beam has only 1 deg. of dispersion according to measurements that have been made.

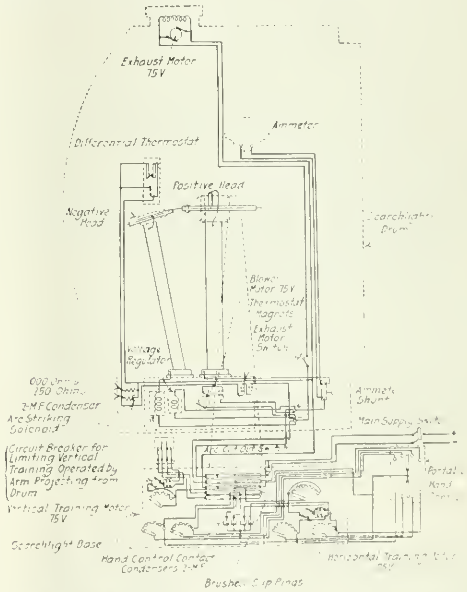

Fig. 1.—Circuits for Search Lamp Operating Mechanism.

Instead of cooling the electrodes, as is done with the Beck alcohol-cooled arc, and thereby naturally reducing the efficiency, every precaution is taken to maintain the highest possible temperature of the positive electrode tip and thin crater walls, since the illumination varies as a large exponential factor of the temperature. The electrode holders are cooled by intensive methods, however. This is performed by forcing air up through the electrode supports, which are hollow. The air supplied to the positive holder is discharged between head-radiating discs which surround the holder. This arrangement cools the mechanism feeding the electrode, and ensures its continuous operation. Air pressure is supplied by a motor-driven centrifugal blower in the base of the lamp.

With so small a source of light emanation as is employed in this lamp it is necessary that two operating conditions be assured: First is the maintenance of a perfectly symmetrical source. This is secured by continuously revolving the positive electrode. The blower motor is used for this purpose, being connected to the positive electrode holder by a shaft and gear trains. Second, this highly concentrated and localised light source must be maintained with a high degree of precision, at the exact focal point of the mirror. This is accomplished by means of a differential thermostat, which has been found by Government officers during a 10-hour run to maintain the arc within 1·5 mm. of its proper location in the exact focus limit.

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* From the "Electrical World," slightly abbreviated.

The differential thermostat is attached to one side of the searchlight drum diametrically opposite the focal point of the lamp reflector, and also opposite a small convex mirror on the other side of the drum. When the arc crater is in its proper position light is concentrated by the small mirror on the thermostat. As soon as the arc burns out of the normal position, however, the thermostat causes a solenoid to advance the electrode until the light is concentrated on the thermostat, when the crater is again at the focal point.

Connected with the motor driving the blower and feeding and rotating the positive electrode is the horizontal rod at the bottom of the lamp mechanism. This, in connection with the large solenoid connected directly across the arc, causes the negative electrode to be drawn back or fed forward, depending on the arc voltage. Another solenoid imparts to the negative electrode the striking motion required to establish an arc.

OPTICAL GLASS.*

BY WALTER ROSENHAIN, D.SC., F.R.S.

Since the outbreak of war the national importance of the optical glass industry has been illustrated in many directions. Optical glass is an important element in the construction of telescopes, binoculars, range-finders and other instruments essential to modern warfare. It is equally important in the laboratory and indirectly affects many industries dependent upon exact physical and chemical tests.

Dr. Rosenhain's series of three Cantor lectures, now available in pamphlet form, are therefore opportune. In the first lecture the chief qualities requisite in optical glass and the methods of testing them are explained. Transparency, freedom from bubbles, neutral coloration and absence of *stria* due to inequality of structure are all of importance and need to be studied with minute care. Another quality, very desirable in glassware for chemical and laboratory use, is ability to resist the action of the carbon dioxide in the atmosphere. Want of [illegible] in this respect, leading to "spotting" and imperfection in the optical surface, is caused mainly by the presence of alkali [illegible] oxide, boric acid and other constituents.

To these [illegible] qualifications must be added the more specifically optical characteristics, such as refractide index and coefficient of dispersion, with which the production of achromatic lenses is bound up.

The second and third lectures deal mainly with problems of manufacture. No fundamental departure has been made from the original methods initiated by Schott and Abbe at Jena, under a subsidy from the German Government. Apart from the early start thus secured, Germany has been fortunate in having available suitable materials within her own borders. At present, suitable white sand for the manufacture of optical glassware in this country has to be imported from Fontainebleau, near Paris. A systematic search in various parts of the British Empire might reveal other sources of supply.

A step of great importance has been the replacement of the coal-fired furnace by those of the regenerative gas-fired type, which, [illegible] to maintain, facilitate the production of [illegible]. The possibilities of electric furnaces of the [illegible] "induction" and "resistance" types also deserve further study, and it is possible that by experiment in this direction many of the difficulties [illegible] to gas and coal-fired furnaces might be avoided.

The making of the pots, in which the glass mixture is contained, is a long and tedious process. Here again it is suggested that by [illegible] substantial advances might be made, for example, in the production of highly refractory materials in the electric furnace.

[illegible] line of departure might be taken by [illegible] of transparent crystalline material of an entirely different [illegible]. The great [illegible] found in Nature [illegible] adequate [illegible] really [illegible].

[illegible] striking out is not very bright. What is, in my opinion, required is that we should strike out for ourselves in order to place the whole industry on a more rational and scientific basis. The existing process is in so many ways unsatisfactory and uneconomical that possibilities of radical improvement must exist in many directions. . . . If by a combination of expensive research conducted under the best conditions and with the aid of ample funds, with subsequent business enterprise and manufacturing skill, such a forward step can be achieved, then the leadership in this branch of industry may be restored to us, and we shall not need subsidies or tariffs to enable us to face the competition of those who are now our enemies."

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* [illegible]

TRADE PROBLEMS AFTER THE WAR.

At the meeting of the Manchester Association of Engineers on Saturday, the president (Mr. F. W. Reed), in the course of his address, reviewed some of the economic problems of the engineering industry.

Mr. REED said that scarcely would peace have been proclaimed than industrial war would be upon us, and it was for that organisation to be prepared. Already they had warnings that enemy countries were making strenuous preparations for capturing foreign trade after the war. In most of our establishments general work had been displaced by the making of machinery for the manufacture of munitions, while in others both the shops and machinery had had to be adapted to making war material. One of the problems which would come with peace would be the readjustment of those establishments to pre-war conditions.

There would also be the questions of restriction of output and the dilution of labour, which even now were deserving of serious consideration. For the war, trade unions had agreed with the Government to withdraw their rules bearing upon those vital questions, on the understanding that they would be reinstated on the return of peace conditions. If labour insisted that those rules should be restored the Government would have to comply; that was the present agreement, which could not be departed from without the consent of organised labour. Whether it would be to the ultimate interest of labour to insist on this restoration was a very important matter for consideration; both employer and labour must realise that the conditions of industry would be changed, and both would have to meet the situation in a new spirit. It was obvious that a nation did not prosper by curtailing its output of things. For if our competitors produced the same things at less cost per head the trade would go to them. Our future success would depend on getting the utmost production out of our industrial equipment. The idea of there only being a certain amount of work to do, and the less any individual did the more there would be for others, was economically bad, and to follow it up was to traverse the high road to unemployment. The great amount of capital outlay expended in equipping an engineering works formed an important proportion of the standing charges; therefore the obvious policy was to obtain the maximum output per machine, even to the extent of keeping the more important ones running night and day, and to encourage the workers' endeavours. A scheme of rewarding individual effort was advisable.

The capture of enemy trade was a question of output rather than of total employment, for in normal times we had only about 4 per cent. of unemployed, and if employment were found for those it could not be expected that we should be able to accomplish anything but a small fraction of the extra trade contemplated unless an understanding was come to between employers and employed to ensure greater individual output. It would be to the interest of the employer to discard out-of-date machinery and replace it with modern; more especially was this advisable with high wage rates. Then, again, it was not good economy to employ fully skilled men on work which could be equally well done by semi-skilled men or women. The important part women had taken in helping to carry out extra and unusual work which the war had brought about was an important industrial factor. They had adapted themselves to the novel conditions and had proved themselves capable of keeping pace with male labour on repetition work, even to the extent in some cases of giving better results. He referred to output rather than to production costs. Not only had they shown themselves capable of success in engineering works, but they had taken the places of other male labour. The skill which they had displayed afforded reason to believe that they could be qualified for more responsible work by a proper system of more prolonged training. The value of services rendered should not be measured by the time made, but by the work done. Good wages was a forward policy; it attracted the best labour and retained it, and, generally speaking, ensured the most economical production.

The Railway Clearing House. On the 15th inst. Mr. A. W. Gattie gave a demonstration of the plant at Battersea to a deputation of the Reading Branch of the National Union of Railwaymen, and explained how his scheme would facilitate the handling of goods and improve the position of the railways.

LEGAL INTELLIGENCE.

P.O. Tube Railway.

On Monday Mr. Alex. Ross sat as arbitrator to determine the difference between the Great Eastern Railway Co. and the Postmaster-General as to the use of compressed air in the construction of a portion of the P.O. tube railway. The railway will run under the G.E.R. hotel and part of the offices at Liverpool-street station. The company contended that compressed air was necessary as an additional safeguard, but on behalf of the Postmaster-General it was submitted that it was unnecessary.

Mr. G. M. Freeman, K.C., appeared for the Great Eastern Railway Co., while Mr. A. J. Walter, K.C., and Mr. Roland Burrows represented the Postmaster-General.

Mr. Freeman said the company desired the use of compressed air as an additional safeguard by reason of the peculiar nature and character of the property concerned. It was peculiar because of its enormous public importance and its physical construction. Enormous pressures were brought to bear upon the supporting columns, and at one end the whole was carried on one continuous girder, so that if anything happened the consequences might be disastrous.

Mr. Basil Mott, consulting engineer, said that in his opinion that was exactly one of the cases where compressed air ought to be used. If a movement began in one of the pillars it might be a very difficult matter to check. In cross-examination he said there were conditions under which he should construct tunnels without compressed air and he had done many stations without compressed air. It was exceedingly difficult for anybody, looking at clay, to say whether it was liable to give or not; the clay was not exceptionally good under Liverpool-street station; in fact, he thought it was of a bad character, and he had used compressed air there himself. He had carried out tunnels in close proximity to Liverpool-street and had had movement. Then he had put on compressed air, and the movement had ceased. He had come into "pockets" in the London clay at a depth of 40 ft. On the broad ground of the enormous risk run in that instance it would be wise to use compressed air so as to make it absolutely safe.

Mr. Horace Wilmer, chief engineer of the Great Eastern Railway, said the portion in regard to which the use of compressed air was desired was 462 ft.—about one-third of the whole interference with the company's property. The height of the hotel was about 100 ft. and the offices was about 95 ft. above rail level. If the tube did any damage the Postmaster-General was responsible, but in his opinion that was a case in which the railway company ought not to be exposed to any sort of risk. No compensation would pay them for the driving away of passengers and general dislocation of business. The buildings in question cost the company nearly half-a-million, and at one point in the area in question the weight was 4·3 tons per sq. foot. The Central London Railway under Liverpool-street station was carried out with compressed air.

Mr. C. L. Morgan, chief engineer of the London & Brighton Railway, also thought the tube under the area in question should be constructed with compressed air.

On behalf of the Postmaster-General, Mr. Dalrymple Hay, the engineer of the work, said the railway at present had reached a point between Blomfield street and New Broad street about 400 ft. from the southern face of the hotel. He produced samples of clay taken that morning on the Whitechapel side and the Finsbury side. Having had to do with some 45 to 46 miles of tube railways, he thought he could say those were very hard samples of clay. The clay was not uniformly hard in London, but it was uniformly hard from Finsbury towards Liverpool street and also from Whitechapel and without pockets. They were constructing tunnels varying from 7 ft. to 29 ft., and they had used compressed air on no part of the railway where the tunnels had been wholly in the London clay. They had used compressed air in the neighbourhood of Mount Pleasant, where they got into Woolwich and Reading beds, which ran up to a very much higher elevation in that part of London. The material at Mount Pleasant was the worst he had ever seen—what was called re-deposited clay, more or less separated clay. On the whole of the stations they had carried out a system of "breakup" chambers, and those they proposed to construct under Liverpool-street station were more elaborate. There was no real reason why the line should not be constructed under Liverpool-street station without compressed air. They had successfully gone under King Edward's Buildings, and the proposed work was child's play compared to that. It was shorter in length and the cover of clay was 30 ft. more.

In cross-examination Mr. Hay said a firm of contractors had estimated the cost of compressed air at £10,000 to £12,000; he did not see why the public should spend £12,000 when it was not necessary.

Evidence was also given by Mr. J. D. Middleton, Chairman and Managing Director of Messrs. Walter Scott & Middleton (Ltd.), and Mr. R. Elliott Cooper, C.E.

The Arbitrator, who has arranged to visit the station and workings, will announce his decision in due course.

Munitions Tribunal Case.

At Glasgow last week Sheriff Fyfe gave a reserved decision of the local munitions tribunal on two complaints, which were taken as test cases to rule 36 others, made by employés of the Glasgow Corporation tramways department. The complainers asked for clearance certificates as they were not paid time and a half for the four days of the usual holiday period at Glasgow Fair. The tribunal had found that they were entitled to obtain leaving certificates, but leave was granted to the tramways department to appeal.

In the course of his written decision the Sheriff said the complaints were primarily brought under the second part of sub-sec. 2 of sec. 5 of the 1916 Act. The situation under that subsection was that if a workman had for a period or more than two days been given no opportunity of earning wages he became quoad a leaving certificate in the same position as a workman who had been dismissed or discharged by his employer, and as regards such a workman the direction of the Statute was peremptory—"the employer shall forthwith give him a certificate as aforesaid." The employer had not any option. Neither, in his opinion, had the tribunal to which the workman might apply, failing his obtaining the certificate from his employer. The absolute right of a workman on that ground to receive a leaving certificate might be a very serious thing, for it might cause a munitions factory to be in a moment entirely depleted of workmen. The present case illustrated that, for it affected about 1,000 men at Coplawhill, where the manufacture and repair of cars and other work in connection with the upkeep of the tramway system was done, and if those 1,000 men walked out of the works the Glasgow tramway system would come to a standstill. He was afraid, however, that even if that dire result were to follow the tribunal would have no option for they must administer that section of the Munitions Act as they found it. He was happy to know, however, that the view which he was constrained to take of that sub-section would not lead to any such trouble, for the complaints were rather of the nature of a friendly litigation to settle an important question of principle. All that the workmen sought was to have affirmed their right to obtain clearance certificates in order that they might obtain what was a corollary of that right, namely, compensation for having been refused leaving certificates. That compensation the tribunal could only give "in addition to issuing or ordering the issue to him of such a certificate." The present complainants did not formally ask for that compensation. Dealing with the facts out of which the complaints arose, the Sheriff said that whilst the tramways department acted upon that part of a Government recommendation that work should continue during July they did not act upon the other part of the recommendation, which affected the employers, by paying them time and half. In consequence the workmen asked for leaving certificates, which were refused. The first intention of respondents was to close their works during the Fair Week, and they pleaded that sec. 5 (2) did not apply to them at all, because their men had themselves decided to postpone their Fair Holidays till August. If so, of course, the result to respondents was that they evaded altogether payment of the time and half which the Government had recommended, and so their plea must go the length that their workman, in the knowledge that this time-and-half recommendation had been made by the Government, nevertheless resolved to waive their claim to the time and half in July. Such an unlikely resolution for workmen to come to would require the most strong and exact proof, and all that was offered was some vague evidence that a deputation came from a men's meeting, and represented to the management that that was the men's resolution. But it was quite clear upon the evidence that it was nothing of the kind. There was no evidence to support respondents' plea that they were outside sec. 5 (2). On the question, Were these workmen "given no opportunity of earning wages" within the meaning of the section? the Sheriff said that respondents elected not to pay the time and half in the face of a clear warning given by the circular of July 7, and for more than two days the workmen were deprived of the wages to which they were reasonably entitled. That deprivation entitled them to ask for leaving certificates, which they did. The certificates having been refused, the workmen became entitled to bring those complaints before that tribunal, and in his opinion the tribunal was bound to grant them.

EDUCATIONAL.

Northampton Polytechnic Institute.—Classes for engineer salesmen and other technically trained men engaged in the commercial side of electrical engineering have been arranged for the session 1916-17.

The work of these classes will cover the syllabus of the City and Guilds of London Institute examination to be held in 1917 in the subject of electrical engineering quantities and estimates. The lecturer is Mr. J. W. Holliday, superintendent of construction of sub-stations to the County of London Electric Supply Co. The lectures are given on Fridays, from 7 to 8.30 p.m. Applications for admission must be sent to the Principal, Dr. R. Mullineux Walmsley, Northampton Polytechnic Institute, Clerkenwell, London, E.C.

Armstrong College (Newcastle-on-Tyne).—We have received a copy of the prospectus of the day classes at this College.

The buildings of Armstrong College have been in the occupation of the War Office since the beginning of the war; the various departments are temporarily housed in other premises. The departments of engineering, electrical engineering, metallurgy and architecture are at Dial House, Northumberland-street, and the departments of pure and applied mathematics, physics and chemistry at the College of Medicine. The prospectus gives full particulars of the courses of instruction, fees, examinations, &c. In engineering the courses cover a period of three years, and lead to the degree of B.Sc. (Dunelm.)

University of Bristol.—Merchant Venturers' Scholarships, tenable in the Engineering Faculty, have been awarded to the following students:—

Geo. Henry Farleigh (Queen Elizabeth Grammar School, [illegible]), Kenneth Allen Hayes (Merchant Venturers' Secondary School, Bristol), Herbert Douglas Kendall (Merchant Venturers' Secondary School, Bristol), Arthur Patrick Mitchell (Devizes Secondary School), Geoffrey Howard Leslie Smith (Bristol Grammar School).

SPECIFICATIONS PUBLISHED

The [illegible] abstract from some of the specifications recently published have been specially [illegible] by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72 Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

24,[illegible] [illegible] Etablissements L. Bleriot. Regulating means for electrical [illegible] (27 12 13.)

1915 Specifications.

[illegible] [illegible] generator for high-frequency currents with polyphase tuned [illegible] (12 [illegible] 14.)

[illegible] increase the number of discharges per second [illegible] lower frequencies, and to obviate the inconvenience [illegible]. The self-induction coefficients [illegible] low frequency and each condenser has a large [illegible] the duration of its short circuit.

[illegible] Dynamo-electric power transmission apparatus of the unipolar [illegible]

[illegible] systems.

[illegible] Electric heaters and electric heating apparatus.

[illegible] & Walls. Spooling machines specially [illegible] for electrical apparatus. (Cognate application, [illegible])

[illegible] apparatus.

[illegible]

[illegible] of vehicles.

[illegible] Electric incandescent lamps.

[illegible] filament made up of a plurality of parallel or [illegible] the same plane and spaced apart from [illegible] the diameter of the coils.

[illegible] Incandescent electric lamps.

[illegible] (29 9 14.)

[illegible] the speed of a direct-current series electric motor, [illegible] automatically maintaining the [illegible] and disconnecting successive [illegible] E.M.F. [illegible] the field of the motor, and also [illegible] E.M.F. to the field resistance so that the current [illegible] current taken from the main source of [illegible]

[illegible] with secondary storage [illegible]

[illegible] gear therefor.

[illegible] "conversion" [illegible] resistance of a test [illegible]

[illegible]

[illegible]

[illegible]

13,[illegible] [illegible] and Patent, Ltd. [illegible] [illegible] alternating current [illegible] a rotatable [illegible] an alternating current [illegible] said armature, a stator provided with a winding connected to stationary [illegible] engaging the commutator and a rotatable field member separate [illegible] from the stator and supplied with magnetising current, and arranged [illegible] relation to both the armature and stator windings, and means for [illegible] torque reaction between the fields of the field member and the stator, [illegible] armature will maintain synchronism with the field member and the speed of the field member may be adjusted.

13,587 Thordarson. Electric transformers.
13,561 & 13,652 Schroeder. Dynamo-electric machines of the commutator type.
15,057 Greville. X-ray apparatus. (Addition to 21,609/14.)
15,222 Day. Combined electric lamp holder and detachable shade support.
15,427 McIndoe. Combined electric switches and plug couplings. (Cognate application, 6,258/16.)
16,207 Graham. Telephonic transmitters.
16,469 Hefford. Portable electric lamps.
16,471 Bronsted & Hellesens, Enke & V. Ludviggsen (Firm of.) Method for producing durable primary galvanic battery cells with zinc anodes and alkaline electrolyte.
16,502 Mavor & Coulson & Lawrence. Electric switch appliances.
16,550 Alexander. Telegraph or telephone line insulator.
16,731 Vandervell. Portable battery lamps.
17,474 Burdon. (Siemens & Halske Akt. Ges.) Electromagnetic relays.
17,480 Markt. Construction of cord grip holder for use in connection with electrical apparatus.

1916 Specifications.

3,299 Midgley & Vandervell & Co. High-tension magnetos. (4/3/16.) 101,439.
4,190 Hasselt. Process for the electrolysis of alkali chlorides. (21/3/16.) 101,440.
5,526 Neuland. Dynamo-electric machines. (17/9/15.) (Divided application on 13,287/15.) 101,447.

Comprises a machine in which the two successive groups of alined and non-alined flux conductors on stator and rotor are formed by providing not only the rotor but also the stator with uniformly spaced conductors, the angular pitch of the latter conductors differing slightly from that of the rotor conductors, each closed flux-path section thus consisting of a plurality of consecutive fully and partly alined conductors, and each open flux-part section consisting of a plurality of consecutive fully and partly non-alined conductors, whereby uniform rotation of the rotor results in substantially uniform progression of a substantially uniform field.

100,017 Bosch, R. Switching devices for starting internal-combustion engines. (412.)
100,198 Western Electric Co. Machine switching telephone systems. (3,758.)
100,230 Heller, L. Electric heating devices. (Divided application on 14,405/15.) (4,901.)
100,394 Allmanna Svensaka Elektriska Aktiebolaget. Continuous-current dynamo-electric generators. (5,391.)

Consists in the combination with the generator, of means whereby a tension proportional to the rate of variation of the load circuit current is induced in the exciting circuit, said tension being directed oppositely to that induced in the exciting winding from the compound winding.

100,535 Western Electric Co. Call distributing telephone systems. (7,258.)
100,538 Clemens, J. C. Refillable electric fuse plugs. (7,291.)
100,894 Breslauer, M. Dynamo-electric power transmission apparatus of the unipolar type. (Divided application on 8,331/15.) (9,937.)
101,047 Relay Automatic Telephone Co., War[illegible], F. M., Bryant, G.M., & Inman, T. M. Automatic telephone systems. (Divided application on 11,600/15. Cognate application 1,868/16.) (1,821.)
101,321 Allegranza, A. Method of and means for assembling and uniting or connecting together accumulator plates. ([illegible])
101,362 Igranic Electric Co. (Cutler Hammer Mfg. Co.) Electric circuit controllers (1,246.)
101,372 Crockatt, J. E. Holder for [illegible] electric or other wires or cables. (3,059.)
101,387 Crockatt, W. C. & Bromell Patents, C[illegible] Electrically indicating the presence of saline, alkaline or acid impurities in [illegible] water used for steam generators and for other purposes. (5,163.)
101,329 Cardwell, A. D. Printing tele[illegible] systems. (Divided application on 8,451/15.) (8,211.)
101,330 San[illegible], R. W. Portable electric [illegible] for gas. (8,285.)

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 11, 1916.

12,824 British Westinghouse Electric & Mfg. Co. Electrical measuring instruments. (10/9/15, U.S.)
12,830 Smith. Signalling apparatus.
12,842 [illegible] Incandescent electric lamps.
12,850 Dyer. Portable electric lamps for [illegible] purposes.

September 12, 1916.

12,[illegible]74 Wilkinson. Automatic [illegible] electrically controlled sprinkler for fire, &c.
12,903 H[illegible] [illegible]

September 13, 1916.

12,[illegible] Green. Manufacture [illegible] hand-made link chains and cables.
12,971 Henkins & Relay Automatic Telephone Co. Automatic and semi-automatic telephone [illegible]
12,985 [illegible] Art [illegible]
12,986 Armstrong & [illegible] [illegible] (17/9/15, U.S.)
12,987 A[illegible] & [illegible] W[illegible] (1/10/15, U.S.)
12,9[illegible] A[illegible] & [illegible] T[illegible] signals. (10/2/15, U.S.)
[illegible]
[illegible] D[illegible] motors, &c.
[illegible]
[illegible] & Mayer. [illegible]
[illegible] Nar[illegible] M[illegible] (1/9/15, France.)
[illegible] & Nash & W[illegible] [illegible] et.

[illegible]

[illegible] N[illegible] D[illegible] telegraphy. (15/9/15, Holland.)
[illegible] W[illegible]

[illegible]

[illegible]
[illegible] engines.
[illegible]
[illegible]
[illegible]
[illegible]
[illegible] W. T. H[illegible], T[illegible] Electric terminals.

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COMMERCIAL TOPICS.

Dick, Kerr's Report.

From the annual report of Messrs. Dick, Kerr & Co. (Ltd.), which is abstracted in another column, it will be seen that the company has had a successful year's trading. We congratulate the company and its shareholders upon the resumption of the payment of a dividend on the ordinary shares. The announcement is also made that a controlling interest has been acquired in Messrs. Willans & Robinson (Ltd.).

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The Metal Industries After the War.

It is announced that the Iron and Steel Committee has submitted a detailed memorandum to Lord Balfour's Committee, which was set up in July last to advise the Government as to the best method of carrying out the resolutions of the Paris Economic Conference on Trade after the War.

The memorandum, which is not supported by three members of the Committee, has been prepared in answer to a request to the Iron and Steel Trades Committee for observations and suggestions. The Committee was invited to consider how the iron and steel industries of this country were to be restored to the position they had temporarily lost by reason of their conversion into instruments for the manufacture of munitions of war. The Committee recommends the prohibition of all imports of iron and steel manufactures from enemy countries during the period of reconstruction, and considers that the Government should urge the adoption of a similar policy in the Dominions and other parts of the Empire. All ores and minerals in their natural and unworked state should be admitted free. Raw materials, whenever produced in the Empire, should be prevented from entering enemy countries. It is further recommended that British ships shall be prevented from carrying raw materials or manufactured iron and steel from neutral ports to enemy countries or to neutral ports for ultimate despatch to these countries. The Committee suggests the setting up of a body representing the industries concerned, which should have power to issue licences in exceptional cases. The recommendations are to be operative only during the period of reconstruction after the war, and are without prejudice to any decisions that may be arrived at as to permanent fiscal policy.

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Labour Exchanges.

The Board of Trade announce that in future the Labour Exchanges under their control will be termed "Employment Exchanges," a title which corresponds more accurately to their present functions.

At the same time the scope of the employment department of the Board of Trade will be enlarged so as to include, in addition to employment exchanges and unemployment insurance, trade boards and certain other matters relating to labour. Mr. W. H. Beveridge, C.B., will continue to be the head of the enlarged employment department. Mr. C. F. Rey (hitherto general manager of labour exchanges) has been appointed director of employment exchanges, in succession to Mr. Beveridge, with the acting rank of assistant secretary.

The Board of Trade have been credited with an ambitious programme for expanding the scope and increasing the utility of labour exchanges, and although the alteration of the title of a department does not necessarily imply any change of policy or even an improvement in methods, it would appear that the Board are beginning to organise its employment department so as to make a bid for being the sole and universal medium for the employment of labour after the war. We are of opinion that such an eventuality would be a disaster to the country.

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The Trade Bank Scheme.

The Council of the Association of Chambers of Commerce, having considered the report of the Board of Trade Committee appointed to investigate the question of financial facilities for trade, and without committing themselves to the details of the scheme. They have passed a resolution urging the Government to take steps to promote the foundation of the new bank at the earliest possible moment.

On the other hand, the directors of the Manchester Chamber of Commerce, while welcoming the report, are of opinion that the scheme formulated is not sufficiently far-reaching, and does not adequately provide for the requirements of traders, since the capital and credit which under the Departmental Committee it is proposed to provide is insufficient adequately to replace enemy firms and organisations in neutral countries. They therefore suggest that the Government authority whom it concerns should consider the further development of the trade bank system.

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Russo-British Trade Relations.

A Russo-British Chamber of Commerce has been formed in order to promote, study and develop the home and foreign trade, commerce and manufactures of the British and Russian Empires and their mutual commercial relations, to collect, publish and disseminate statistics relating thereto ; to promote, study, extend and advance the special interests of Russian subjects carrying on any industry or business in or with the British Empire, and also the special interests of British subjects carrying on any industry or business in or with the Russian Empire, &c. The offices of the Chamber are at International Bldgs, Kingsway, W.C.

In connection with the development of trade with Russia, a recent report by H.M. Consul at Ekaterinburg (Mr. T. Preston), which is abstracted in this issue, should be read. It is stated that transport and other difficulties prevent much progress being made at present. Mr. Preston has been told by local British agents, who are overwhelmed with inquiries and orders from the Ural works, that they have been able to mark time, as it were, by selling goods bought in Russia by their Moscow and other buyers, in place of the goods they cannot get from the United Kingdom. "They state, however, that they cannot keep this up much longer; that, in fact, they are being ousted now by Swedes, Americans and Japanese, and are likely to lose entirely their good connections."

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Trade With Norway.

The Foreign Office notify persons interested in trade with Norway that (after Nov. 13) a new form of undertaking must be furnished in connection with applications for licences to export goods on the prohibited and restricted lists from the United Kingdom to Norway. The new form applies to all commodities on the prohibited and restricted lists with certain exceptions.

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Coal Output.

On the invitation of the Home Office a National Conference of the coal trade will be held in London on the 25th inst.

The Executive Committee of the Miners' Federation have accepted the invitation, and arrangements are being made for a representative to attend from each pit in Great Britain. The national meeting of representatives of colliery owners and workmen will be on similar lines to that held in London in July, 1915.

A joint meeting of the colliery owners represented by the Mining Association of Great Britain, and of the workmen represented by the Miners' Federation of Great Britain will be held on the 24th inst. to receive reports from the various mining districts as to wilful absenteeism on the part of workmen. It has been estimated that the complete elimination of absenteeism would increase the output of coal by another 30,000,000 tons per annum.

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Coal Economy.

At the recent meeting of the Newcastle-on-Tyne Chamber of Commerce, Mr. Gerald Stoney moved a resolution calling the attention of the Engineering Committee of the Advisory Council of the Privy Council for Scientific and Industrial Research to the importance of (among other investigations) a full and complete research into the methods by which the steam turbine could be improved in efficiency and reliability.

The resolution stated that, in view of the success of the steam turbine in the mercantile marine and its probable larger adoption in future, this was of the greatest importance to the shipping industry. The total expenditure on bunker coal in normal times consumed annually by English merchant ships was a very large sum, and a 5 per cent. saving would amount to a sum in comparison with which an expenditure on the proposed research of £10,000 or even £20,000 a year would be insignificant.

Mr. Stoney pointed out that the resolution was the outcome of a previous decision by the Chamber urging upon the Government the importance of industrial research. He had not been able to get the exact expenditure on coal used in merchant ships. He had received various estimates ranging from 20 to 40 million pounds a year as the value of the coal, and 5 per cent. of that would amount to from 1½ to 3 million pounds. The costs of fuel used on land amounted to about £70,000,000 a year, so that they would see that a saving of 5 per cent. effected there would amount to a very large sum annually. Research was greatly wanted in regard to oil engines, but he dealt only with turbines, which the Research Committee had been appointed to consider, and they were anxious to obtain the opinions of users. As an illustration of the value of such work, he mentioned that the National Physical Laboratory, at a cost of only £7,000 to £8,000 a year, had carried out investigations which had led to British supremacy in the air. The resolution was carried unanimously.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Oct. 7, 1916, *to* Oct. 13, 1916.

IMPORTS.

[illegible]

EXPORTS.

[illegible]

FOREIGN GOODS (duty paid and free).

[illegible]

IN TRANSIT.

[illegible]

[illegible] under the [illegible] what is described as [illegible]

BUSINESS NOTICES.

[illegible]

Plant for Sale. [illegible]

LIQUIDATIONS, &c.

A meeting to receive an account of the winding up of the Coke Ovens & By-Products Co. (Ltd.) will be held at 95, Gresham-street, London, E.C., on Nov. 17.

A meeting to receive an account of the winding up of Eades Hoist Co. (Ltd.) will be held at the offices of Messrs. Jeffery Parr, Hasell & Parr, 20, Temple-row, Birmingham, on Nov. 16.

A meeting to receive an account of the winding up of the Derby Electrical Co. (Ltd.) will be held at the company's offices, Woods-lane, Derby, on Nov. 18.

The Resisto Electrical Mfg. Co. (Ltd.) is being wound up voluntarily, and Mr. De Westley Layton, 167, Fenchurch-street, London, E.C., has been appointed liquidator. A meeting of creditors will take place at the offices of Messrs. Lowe, Bingham & Matthews, 167, Fenchurch-street, London, E.C., to-day (Oct. 20) at noon.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barnes.—The Urban Council have applied to the L.G. Board for permission to borrow £2,000 for house services on account of the £5,000 sanctioned in January, 1914.

Bury (Lancs).—The Council have applied to the L.G. Board for sanction to borrow £600 for laying mains to the Irwell Bridge Mill.

Hackney (London).—Sanction having been granted, a loan of £2,055 is to be taken up from the L.C.C. for mains, and £945 for switchgear, in order to link up the Poplar and Hackney electricity undertakings.

Interest on the loan is to be 5½ per cent.; £2,055 is to be repaid within 25 years, and the balance in 15 years.

The Electricity Committee has considered a proposal of the Borough Electrical Engineer and of the Engineer of the North Metropolitan Electric Supply Co. to link up the Council's e.h.t. system at Northwold-road with that of the company's at Edward's-lane, Stoke Newington. At present the demand for power for works in the company's area is putting too great a strain upon the company's available plant, and, on the other hand, the Council has spare plant. It is proposed that for the time being the Council should by means of their spare plant supply a portion of the company's network, and that upon the resumption of normal times the connecting link will be used for reciprocal supplies. The heads of the agreement are as follow: (1) Company to provide and lay necessary link between Northwold road and Edward's-lane at an estimated cost of £6,500; (2) on completion of the work, Council to pay company net cost of work, and the link to become the property of the Council; (3) company to pay to Council moiety of interest and repayment charges upon loan raised to defray cost; (4) upon extinction of loan half the link becomes the property of the company; (5) agreement to run for period of loan (say, 25 years), and the maintenance of the link to be at joint expenses of company and Council from completion of work; (6) the charges of supply from one party to the other to be of a reciprocal character.

With regard to the official tests of the 5,000 kw. turbo-alternator, it has been decided, in view of the high cost of fuel, and the difficulty of obtaining labour, that the test shall be carried out on the Town load instead of upon an artificial load. The contractors (Messrs. Willans & Robinson) are making a deduction of £120 for the test to be carried out in this manner.

Liverpool.—Owing to the erection of new and the extension of existing factories the demand for electrical energy is increasing, and the question of putting down additional plant at the electric generating station will shortly come before the City Council.

Runcorn.—The Mersey Power Co. proposes to lay a cable from the new station at Weston Point to the L. & N. W. Bridge via the towing path of the Runcorn and Weston Canal and Arnold Dock along Percival-lane.

Sunderland.—Last week the Corporation decided to apply to the L.G. Board and the Treasury for sanction to borrow £15,216 for extensions of electric generating plant and mains.

Swansea.—The chairman of the Electricity Committee and the Borough Electrical Engineer are, if necessary, to interview the L.G. Board in order to obtain sanction to expenditure for extensions of plant.

The agreement has been completed between the tramways company and the Corporation relative to the supply of electrical energy by the Corporation for the company's line.

The manager of the municipal markets is to confer with the borough electrical engineer as to the lighting of the stalls at present without lights.

Waterford.—The Corporation have received sanction to borrow £1,000 to meet the preliminary expenses for their electric supply scheme.

Wednesbury.—The Electricity Committee have applied to the L.G. Board for sanction to borrow £3,300 for mains and house services, &c.

GENERAL.

Birmingham.—At the meeting of the City Council on Tuesday, the chairman of the Electric Supply Committee (Ald. Jephcott) submitted the report of the committee on the recent failures of electricity supply.

In moving the adoption of the report, Ald. Jephcott referred to the difficulties encountered by the department. He said the interruption of the tramway services and the consequent inconvenience to the public was deplored by the committee, and as the circumstances which brought about those interruptions were not likely to be more favourable for some time the committee determined to give a full explanation of their difficulties. The report was printed before the interruptions of last week, but those which occurred earlier were usually of short duration. Those which occurred last week, and which unfortunately had not yet been got over, were due to a defect in a 5,000 kw. generator at Nechells, which had accentuated their difficulties. The growth of the demand for current in the last 12 months had been phenomenal. In September of last year the demand amounted to 25,000 kw., or a little over 31,000 H.P.; but this year it had risen to 38,000 kw., or about 48,000 H.P. The demand was heaviest between seven and eight o'clock in the morning and about two o'clock in the afternoon. It was usual for the load to fall off in the summer months, and that provided some relief, which was taken advantage of by the engineering staff to overhaul the machinery and plant in anticipation of the heavier demands that naturally arose in the winter; but owing to the pressure of the demand from the factories there had been no relief during the past summer, and the plant had been run right out. Where possible portions of it had been laid off for inspection, adjustment and repair, but the plant could not be altogether spared, and as the labour available was inadequate its proper upkeep had been seriously interfered with. Thus there had been a double effect; the plant was working far more than usual, and there had not been adequate opportunities to maintain it. The consequence was that its efficiency was naturally impaired. Efforts had been and were being made to provide additional plant to meet the difficulties, and it was hoped that a portion of it would be running by December, and the remainder in the spring of next year. With those additions the department hoped to be able to supply all consumers. At present, however, it was felt it would be dangerous to accept any further additions and the committee had ceased to accept applications.

Ald. JEPHCOTT explained that coal was delivered to Summer lane from barges and placed in buckets on an endless belt and carried into a dump. The amount of coal dealt with recently was very much larger than the conveyer was designed to carry. One side of the conveyer had been practically replaced, and the other half would be proceeded with as soon as possible. He also pointed out that by the erection of an additional chimney and economiser they would be able to improve the condition of the second boiler house and increase its steam-giving capacity. Unfortunately, there was such a shortage of labour, and the firms they were dealing with were so pressed, that there was likely to be delay in carrying out the work, but they were urging it forward as rapidly as possible. When completed it would be an insurance against interruption from breakdown. The difficulty in earlier breakdowns had been the maintenance of steam pressure. The three classes of supply given were (1) high-tension supply taken by factories, (2) low tension and power supply taken by firms, and (3) tramways supply. To get relief it was necessary to consider which of these three should be disconnected temporarily, and he thought he was correct in stating that the chairman of the Tramways Committee agreed there was only the tramways left to disconnect. He gave details of the coal difficulties, and said that during the last 12 months there had been numerous occasions when it had been "touch and go," the ingenuity of the engineers alone having carried them through crises. It had been through no fault of the engineers that the situation had become too much for them. Last week's interruptions were due to two additional causes. One was the trouble with the 5,000 kw. set at Nechells station and the other the defection of two boilers at Summer lane. They had not only to disconnect the trams, but also on one day a portion of the power consumers. The machine was now running again, loaded lightly. The committee were hopeful of getting over the difficulty and matters were now going better. It might be considered that the department had accepted more applications than the capacity of their plant justified. They had certainly been ready to accept applications which ran them nearer to the margin than was the case in peace time; but he pointed out the Ministry of Munitions would object to such a margin to-day. It had also been stated in a letter addressed to the press that it was general knowledge that the plant of the department was not equal to the demand made some years ago, and that the department were refusing applications in certain areas. That was not the fact. They did refuse a supply to persons in certain areas a few years ago, but the reason was that the return for the expenditure on mains was inadequate, and had nothing to do with capacity. It had also been stated that if they had maintained the Handsworth steam station there would have been no difficulty, but this also he denied, and contended that the transformation of the Handsworth station into a converter was justified. Claiming that the department had not shown any lack of foresight, he traced the development of the works, and pointed out that in a little more than 18 months they would have installed new plant of a capacity of 22,000 kw., which was the capacity for which Summer lane was designed to satisfy the requirements of Birmingham for a number of years. It must be obvious that the demands they had to face were unprecedented. They were passing through a critical period, and while everything possible would be done it must be remembered the demands on the department were dangerously near the present capacity; and if it became necessary to seek relief by disconnecting the trams he hoped the Council and the public would recognise the force of circumstances and bear patiently the inconvenience they might suffer.

The chairman of the Tramways Committee (Mr. HARRISON BARROW) charged the electric supply department with lack of foresight. The land for the Nechells works was purchased in 1911, and then delay followed in bringing a scheme before the Council because there was a difference of opinion as to whether steam power or gas should be used, with the result that the scheme was not brought forward until May, 1913. So far as he could ascertain no satisfactory explantaion had ever been given to the Council why the 10,000 kw. plant was not ready in the winter of 1915-16, as was promised in the report of the Electric Supply Committee in May, 1913. All they could ascertain was that it was found the state of the ground required a tremendous time to drive in the piles for the foundations. If the 10,000 kw. plant had been ready there would have been no necessity to start the temporary station. Further than that they might imagine that the other 5,000 kw. plant would have been ready by the winter of 1916-17, so that at present there was no more power available than the committee intended in May, 1913, should be ready. Then again they were told in January, 1915, that the permanent station would be ready for the winter of 1916; then a further report in 1916 that it would not be ready until 1917, so the new permanent station seemed to get farther and farther into the dim distance. That showed quite clearly there was nothing particularly abnormal in the demand upon the department. If they had only carried out the scheme of 1913 the difficulties would not have arisen. He could not understand Ald. Jephcott's statement that the department had no idea what coal was coming along. They knew what they had purchased, and could deal with the people who supplied it if it was not of the quality purchased. In any case, they ought to buy the best coal, for the question of price should not be considered in view of the terrible amount of inconvenience caused by breakdowns. Mr. Barrow recalled that on Oct. 12, 1915, the tram service was shut down for an hour between 5.30 and 6.30. The following morning, on making inquiries, he found the difficulty had been caused through a shortage of coal, which could not be got at because it was a little way off on the other side of the canal, but only required a few men to move it across. He immediately had men sent from the tramway department to move the coal. There again it was a lack of foresight, resulting in the trams being shut down and a consequent loss of hundreds of pounds and a great deal of inconvenience. On Sept. 27, 1916, having been told the previous day that unless men were sent down the electric supply department would have to shut off part of the tramways, 30 men were sent, and were told they were not wanted. Later in the day, however, the tramways department were told that unless 30 or 40 men were sent down immediately the trams would be shut off. One would have thought that when the men were sent down in the morning they would have been kept in anticipation of something happening. It was quite true that he agreed, taking everything into consideration, the tramways department was the first that should be shut down, but that did not make any less serious the loss they were suffering. He had looked up the figures for the three days on which stoppages occurred, and, comparing them with the preceding week (imagining both weeks as normal) he found the loss to be £2,060. That was not quite a net loss, but very largely so, because they had to keep the whole of the men on, and the only cost would have been the cost of current and a little wear and tear of rails and cars. In addition, there was the immense amount of inconvenience that would be passengers were put to, and, further than that, the fact that if passengers were continually finding the trams breaking down they would take railway season tickets and find other means of conveyance, so that the temporary loss would become a permanent one. After reminding the Council that the Tramways Committee were the most profitable customers of the electric supply department, Mr. Barrow suggested, as immediate remedies, that something might be done to overlap the dinner hour between one and two o'clock, when there was an immense fall of power, by some manufacturers reverting to summer time, and having the dinner interval an hour earlier. Another suggestion was that factories which had heavy work but not a large number of men might be induced to work at night. Altogether, however, he thought the electric supply department had not shown the foresight they might have done.

After discussion, Ald. JEPHCOTT replied, and pointed out that they were working the plant much longer than it was intended to be worked, and so repairs constantly had to be carried out. As to the emergency gang, he reminded the Council there was a special arrangement between each committee on that matter. Men who were willing to do the work were selected, but when the gang went to work what happened was that they commenced at three o'clock in the afternoon, and at five o'clock they said they would do no more unless they were given extra money, that had to be given. With regard to the suggestion that the power should be conserved, he explained that they were direct suppliers from generator to consumer. They had no batteries, and could not have a sufficient supply, even with an expenditure of from £40,000 to £80,000, which would last for more than an hour. They were trying to meet the demand of the working classes for a tramway service, but the people who were debarred from riding in view of the hours between which the stoppages occurred were largely those who were not usually considered as belonging to the working classes. They would endeavour, so far as they could control the demands made upon them, not to have more stoppages than were absolutely necessary, and if possible not to have any stoppages at all.

There was a further stoppage on Tuesday between 3.30 and 5.45 p.m.

Edinburgh.—The members of the Electric Lighting Committee, accompanied by the engineer (Mr. F. A. Newington), visited the stations of the undertaking on the 10th inst.

The first place visited was the new station at Portobello, where work has been stopped. The foundations have, however, all been laid for the first extension. The site extends to over 8 acres, and there is plenty of room for future extension. The foundations for two units have been laid, which is practically one-fifth of the ultimate capacity of the works. The Committee are impressed with the belief that a cheap, adequate and ready supply of electricity will do more almost than any other thing to encourage industries coming to the city. It is known that one very large firm has intimated an order for electric energy which of itself will go far to pay the interest on the outlay, and other orders are in prospect.

The M'Donald-road and Dewar-place stations were subsequently visited, after which, on the invitation of the convener (Mr. Bruce Lindsay), the company dined in the Caledonian Station Hotel.

In the course of his statement, the CONVENER said that the cost of the new works at Portobello would be about £216,000, and that they had paid £15,800 for the site. Though their work had been stopped by the war, they expected that when it ended it would not be very long till they got into working order. In the year ending May, 1916, they consumed for private lighting, power, street lighting and traction 17,373,558 units, a decrease of 5 per cent. on private lighting, 11 per cent. on power, 6½ on public lighting, and an increase of 1½ for traction. Owing to the increased restriction, the private lighting units sold in the first term of this year were about 13 per cent. below last year. The demand for power had increased most satisfactorily, and during the same period it was 27 per cent. above the corresponding period of last year. He was convinced that in the future the principal motive power would be electricity, and if they were able to give cheap electrical power it would be the first inducement to bring trade and industries to the city. They had every confidence in the future, and he thought the Corporation could congratulate itself on the fact that there was the prospect of a great extension. He was sure they would see a substantial profit whether it went to the relief of the rates or not.

Hackney (London).—Men employed by the electricity undertaking in receipt of wages of £2 and under per week are to be granted a bonus of 3s. per week, making a total war bonus of 5s. a week. Men receiving from £2 to £2. 5s. per week, are to be granted such part of the foregoing war bonus as will bring their total remuneration up to £2 5s. per week.

Horsham.—Offers are to be invited for the maintenance of the storage battery for 10 years from the expiration of the existing contract with the Tudor Accumulator Co.

Mr. J. E. Morgan has resigned his position as electrical engineer to the Council in order to become works manager to Messrs. H. & A. Lintott, of the Horsham Engineering Works, and applications are to be invited for a successor at a commencing salary of £220 per annum.

Marylebone (London).—The Electric Supply Committee stated in their report submitted to the Council yesterday (Thursday) the [illegible] turbines at the [illegible] works have recently been examined. No. 11 is in good condition and the low pressure wheel of No. 10 was slightly corroded. During the [illegible] years the machines have run [illegible] hours and have generated [illegible] per cent. of the total output. They have only cost £15 for repairs and [illegible].

Female Labour.—The Committee decided to recommend the Council to accede to the request of the London Society for Women's Suffrage that the Council's apprenticeship scheme be extended to include girls.

Increase of Wages.—The Committee recommended that the wages of [illegible] other than the clerical staff be increased by [illegible] in the case of employés whose wages do not exceed [illegible], to those whose wages [illegible] between 30s. and 42s., the [illegible] 42s. per week. [illegible]

Southend.—[illegible] of the electric supply undertaking for the [illegible].

The Council have been recommended to attend a meeting of the Joint Committee [illegible] of the Municipal Electrical Association and the Association of [illegible] to consider the [illegible].

Watford.—During July and August [illegible] consumers were connected [illegible] 2,298 connected [illegible] compared [illegible].

[illegible]

TRACTION NOTES.

Bacup-Rawtenstall Tramway Dispute.—Mr. J. W. [illegible], general manager of [illegible] Corporation Tramways, has been appointed arbitrator [illegible] Rawtenstall [illegible] the proposed [illegible] of tramway line.

Bradford.—The Tramways Committee reported to the Council last week that applications had been received from the traffic and clerical staffs for increased pay, and they had decided to report the whole of the questions involved to the Board of Trade, in accordance with the provisions of the Munitions of War Acts, 1915 and 1916.

Mr. PALIN, in moving as an amendment that the recommendation should be referred back, said that the minute was incorrect, because the resolution adopted by the Committee referred the question, not to the Board of Trade, but to the Committee on Production. The minute arose out of an application for a revision of the conditions of service of practically the whole of the employés of the tramways department, with the exception of the clerks and the skilled draughtsmen. He contended that there was no difference to arbitrate upon, and the questions should be negotiated between the parties interested.

The report was withdrawn.

Burnley.—The Tramway Committee recommends the Council to provide special free tickets for wounded soldiers.

Ealing.—A special committee of the Council recently met the managing director and other officials of the London United Tramways with reference to the condition of the tramway track.

The managing director, who detailed the various steps it was proposed to take to improve the condition of the track, stated that the expenditure would amount to some thousands of pounds, which, in the event of reconstruction would be entirely thrown away. He had asked that, if the repair work were proceeded with the Council would give some sort of guarantee that for, say, two years after the war, it would take no steps which would involve the sacrifice of this expenditure. The special committee recognising the difficulties of the company in regard to reconstruction at present, recommended the Council to pass a resolution that the company should not be pressed in regard to reconstruction immediately upon the conclusion of war, it being distinctly understood that the attention of the Council must be dependent upon the condition of the track at that time. The special committee's report was approved.

London County Council.—A supplementary estimate of £3,020 has been passed in respect of alterations and additions to the wiring of the Council's cars, so that the lights may not be more than sufficient to enable fares to be collected.

Application is to be made for a further extension by one year beyond Aug. 16, 1917, of the time in which the construction of the Horton Estate–Epsom Light Railway must be completed.

On Tuesday the Highways Committee reported that applications had been received from the charge engineers in the northern and southern sections of tramways sub-stations for war wages of 4s. a week, and from certain employés at the Greenwich generating station for an increase of wages of 2d. an hour. It was agreed to refer the requests to the Electrical Conciliation Board.

It was agreed to refer the requests to the Electrical Conciliation Board

During the 11 weeks ended Oct. 4 last the London County Council tramways carried 130,814,286 passengers, compared with 120,958,504 in the corresponding period last year, an increase of 9,855,782. The traffic receipts increased from £517,403 to £554,271.

The Minister of Munitions has issued a certificate that the supply of tramway facilities by the Council's tramway department is of importance for carrying on munitions work. The undertaking will, therefore, be subject to the provisions of Part I. of the Munitions of War Act, 1915, which prohibits strikes and lock-outs, and the provisions as to leaving certificates will apply to employés in the tramways department.

On the recommendation of the Highways Committee, the Council agreed to accept the resignation as from 31st inst. of Mr. W. L. Slattery, traffic assistant in the tramways department, who has been appointed general manager of the West Ham Corporation tramways.

Sheffield.—Interesting particulars of the work of the two electric vehicles used for refuse collection are given in the annual report of the cleansing and baths superintendent, Mr. J. A. Priestley.

The report states that the work carried out during the year could not have been accomplished without them. Each vehicle had displaced from five to six horses, and had enabled six men to do the work previously requiring nine men. On bin refuse collection, after making a liberal allowance for interest, depreciation and maintenance charges, the cost per ton averaged 10d. per ton less than that of horse labour on the same districts, and 2·7d. per ton less than the average for the whole city by horse labour, whilst on ashpit refuse the cost was 11·8d. per ton less than the average horse cost for the whole city. The electricity used was charged against the vehicles at 1d. per unit, although it was generated from steam raised by the refuse and involved no extra cost to the department. The refuse produced the motive power required to collect it. The first electric vehicle began work on Sept. 26, 1915, and the second on Jan. 17 last. A table is given showing the days worked, the refuse collected, mileage run, &c. Mr. Priestley also points out that by the use of the electric vehicles it has been found possible to discontinue the use of one of the local tips.

Southend.—The electrical engineer (Mr. R. Birkett) reports that considerable difficulty has been experienced in dealing with rail corrugation.

The removal of corrugation can only be effected when traffic is suspended, and the lighting restrictions prevent the use of the machine during darkness. Owing to the reduction in the car shed staff it has also become increasingly difficult to obtain the necessary skilled labour for repairing and overhauling the cars. The delivery of spare parts is also seriously affected by the war, and much difficulty is being experienced in obtaining the bare necessities required for the maintenance of the cars, by reason of the restrictions now placed on manufacturers engaged on war work. Alterations have been made to the trucks of certain cars, and in the event of these alterations not proving satisfactory the trucks will be removed, and prices obtained from the truck builders for three new trucks, to be delivered in time for next season's traffic.

TELEGRAPH AND TELEPHONE NOTES.

Russian Telegraphs.—The Imperial Russian Government have asked the Great Northern Telegraph Co. to recall all the Danish operators employed at the company's stations in Russia, including Petrograd, for the duration of the war, and replace them by Russians. No foreigners are to be employed in future in the Russian postal or telegraph service.

Blackburn Automatic Telephone Exchange.—The new automatic telephone exchange at Blackburn was inaugurated on Saturday.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says the North Illawarra (N.S.W.) Council has offers from the South Bulli and the Corrimal–Balgownie collieries to supply current for the electric lighting of the district. Corrimal, which is included in the district, is said to be impatient of the Council's delay in going on with the project.

The "Commonwealth Engineer" says the Queensland Government has approved of an irrigation scheme for Inkerman, near Bowen, to cost £131,000, of which £39,800 will be required for a power station and £38,400 for distributing network.

Tumut (N.S.W.) municipality has decided to install an electric supply plant and a gravitation water supply system.

Port Natal (S. Africa). Among the improvements at Port Natal are considerable extensions to the loading plant at the bunkering station on the Bluff, and electrically operated belt conveyors are now being installed.

FOREIGN NOTES.

Hydro-electric Works in Finland.—Some Swedish and Norwegian financiers are promoting a company for the utilisation of waterfalls in Finland and the erection of smelting works in that country. At present negotiations are in progress with the Russian Government.

Russia.—The British Consul at Ekaterinburg states that a great dearth of manufactured goods which formerly were imported largely from Germany is being experienced in his district.

Local firms who have been fortunate enough to obtain small parcels of such articles as steel instruments, tools, wire and electrical fittings, for which Ekaterinburg has always been a keen business centre, have been able to make sales at very high prices. New machinery from abroad (at any rate for private enterprise) being out of the question, a lively trade is being carried on in second-hand machinery, which is bought up all over the country and re-sold at large profits. Local tradesmen express regret that they are unable to do any business at present with the United Kingdom: the difficulty of exchange and cash payments would not stand in the way if only reasonable delivery could be guaranteed. British agents, who are overwhelmed with inquiries and orders from the Ural works, have only been able to mark time by selling goods bought in Russia in place of the goods they cannot get from the United Kingdom: but they cannot keep this up much longer, and are being ousted by Swedes, Americans and Japanese, and are likely to lose entirely their good connections.

MISCELLANEOUS NOTES.

British Firms in Belgium.—It is reported that General von Bissing, the German Governor-General of Belgium, has ordered the liquidation of all British owned or controlled firms in Belgium.

Exports to China and Siam.—A Supplement to the "London Gazette," dated Oct. 14, contains further lists of firms and persons in China and Siam to whom goods from the United Kingdom may be consigned.

Motor Trade Association Council Meeting.—In connection with the annual dinner of the Fellowship of Old Time Cyclists, which is to be held at Frascati's on the 25th inst., as this more or less clashes with a rather important Motor Trade Association Council Meeting and Divisional Committee's gathering at Cardiff on the following day (Oct. 26), those who are anxious to be present at both functions are reminded that it is possible to get down to Cardiff from London by a breakfast car train which leaves Paddington at 8.45 a.m. and arrives at Cardiff at 11.30, which would be in good time for the reception by the Lord Mayor, the luncheon at the City Hall, and the M.T.A. Council Meeting which follows.

Registration of Firms Bill.—A meeting convened by the Wholesale Traders' Association for the Hardware, Furnishing and Metal Industries, was held at Cannon-street Hotel, London, on Oct. 12, to discuss this Bill.

The notice convening the meeting stated that for many years the association had urged the importance of compulsory registration of firms and persons carrying on business under names other than their own. The Registration of Firms Bill had been passed through the House of Lords, and the directors of the association thought that steps should be taken to bring before the President of the Board of Trade the necessity for the Bill being dealt with by the House of Commons at the earliest possible moment.

Mr. H. J. GLANVILLE, M.P., who presided, said in the commercial warfare which would succeed the present war the nation wanted to be able to carry on business in such a way that British traders should not be handicapped by the methods of trade adopted in other parts of the world. There was no reason why an honest trader should hesitate to have his name made public. At the same time, the English nation welcomed trade competition, which developed the inventive faculties of mankind. Millions of money were lost every year through bankruptcies which sailed near the border line of fraud. They wanted to fix on the hidden trader the responsibility that was properly his, and they wanted him to register when he commenced and when he ceased trading.

Mr. G. G. POPPLETON (secretary of the association) then put before the meeting the suggestions made by himself and the directors. They did not wish to overload the Bill so as to retard it. It was proposed that a committee of 12 be appointed to confer with the five directors of the association, and that a memorial be prepared and presented to the President of the Board of Trade suggesting amendments in the Bill. The Bill provided that the names of firms and their agents should be registered, and that any person was to be at liberty to inspect the register. In default of registration the Board of Trade *may* call upon persons or firms to remedy the default under certain penalties, but the Bill did not compel a firm to register. It was only when they got notice from the Board of Trade that they were to register. It was suggested that that defect should be remedied. Even when a firm got notice it might discontinue under one name and take another name. The Bill was limited to persons in this country. A German firm could adopt an English title, send travellers here and carry on trade without disclosing it was an alien firm. The Bill ought to provide for the names of persons being exhibited on their premises, and there was no provision for information being supplied by post. Trustees and executors and receivers were excluded from the requirement to register, which was another weakness in the Bill. Registration might also prevent long firm frauds. Orders and stationery should bear the real names of the persons trading. The Bill ought to be amended to provide that where there was a change in the ownership or condition of a firm by the appointment of an executor or trustee this should be shown on orders, memoranda, &c. A receiver and manager appointed by the Courts was liable for debts, but a receiver and manager appointed by debenture holders could take goods and use them for satisfying the claims of the debenture holders. The receiver should be in the same position as if he were trading under some name other than his own. The Bill should provide for certificates of registration being displayed in the holders' premises. Information as to registrations should be obtainable in other towns besides London, Edinburgh and Dublin. Correspondence, price lists, &c., coming from abroad should have the names of the proprietors of the firms sending them printed upon them.

A representative of John Knox & Co. said he thought limited partnerships should be included in the provisions of the Bill, and that clause 3 (*d*) ought to provide not only for nationality being stated, but if it had been changed, what it had been changed from. Registration ought to be made compulsory within a specified time.

Mr. W. J. MCCORMACK said, according to clause 1 (*a*), where an addition to the business name indicates that the business is carried on under the name of a former owner, that addition shall not render registration necessary. It might be a German using an English name.

On the motion of the CHAIRMAN, who said he thought the Bill would pass the House of Commons without opposition, the following committee was appointed to act with the five directors of the association in drawing up amendments to be submitted to the Board of Trade:—

Mr. John F. Thornycroft (chairman of British Engineers' Association), Mr. A. J. Hobson (member of the Council of the Associated Chambers of Commerce), Sir Charles Shaw (Shaw & Sons), Mr. Geo. Addison, J.P. (Hull), Mr. Stafford Ransom (secretary of British Engineers' Association), Mr. W. J. McCormack, J.P. (member of Parliamentary Committee of Drapers' Chamber of Trade), Mr. Iliffe or other representative of Iliffe & Sons (publishers), Capt. Davidson (Morgan Crucible Co.), Mr. C. Sords Ellis (Interlock Metal Hose Co.), a representative of A. & F. Parkes, a representative of the London Chamber of Commerce, and a representative of the National Chamber of Trade.]

TENDERS INVITED.

Telephone and Telegraph Material, &c.

Tenders are invited up to Dec. 22 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept., State of Western Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 402. Specifications from the Commonwealth Offices London.

Tenders are invited (up to Nov. 15) by the Postmaster-General's Dept., State of South Australia, for the supply and erection at the telephone exchanges of Glenelg and Brighton, of Automatic Switchboards and all associated apparatus (as per schedule No. 426). Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are also required by 3 p.m. Nov. 8 for the supply of Accumulator Parts (100 positive and 24 negative plates) to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept., Perth (W.A.). (Schedule No. 527, W.A.) Specification, &c., from the Deputy Postmaster-General, Perth, Western Australia.

Coal Transporter Plant.

Tenders are invited for the supply, delivery and erection in Melbourne, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. [illegible] & Co. Pty. (Ltd.), Billiter-square buildings, London, E.C. Tenders by noon Dec. 11.

Carbons and Carbon Brushes.

Johannesburg Municipal Council require tenders by noon Nov. 27 for the supply of 12 gross of Carbon Brushes for Electric Motors (Contract No. 178). Specifications, &c., from the Controller of Stores, Municipal Offices, Johannesburg.

The VICTORIAN GOVERNMENT RAILWAYS DEPT. requires tenders by [illegible] Nov. 1 for the supply of 50,000 Yellow Flame Arc Carbons (Contract No. 30,105). Specification, &c., from the Victorian Railways Commissioners, Spencer-street, Melbourne.

Electrical Stores, Lamps, &c.

Tenders are required by 10 a.m. Oct. 24 for 12 months' supply of Electric Lamps and Fittings to the Glasgow Parish Council's [illegible]. Forms of tender, &c., from Mr. J. R. Motion, [illegible] George-street, Glasgow.

[illegible] County Council Asylums Committee want tenders by [illegible] for [illegible] Electric Lamps. Forms of tender from the [illegible] Committee, [illegible] W.C.

The Great Southern [illegible] Railway Co. [illegible] require tenders by 10 a.m. Nov. 2 for 12 months' supply of Electrical Stores, Lamps, Cable and Wire, [illegible] Motors, &c. [illegible] Dublin.

[illegible] 1917 of 71,778 [illegible] 19,711 [illegible] 5,112 Carbon Filament [illegible]

[illegible] Plant, Batteries, Booster Plant and Switchboards.

[illegible]

Tramway Material, &c.

JOHANNESBURG (Transvaal) Municipality require tenders by noon Nov. 6 for supply of 18 Grooved 12 ft. Points and 24 Grooved 9 ft. Points and six Ordinary Crossings (contract No. 171). Specifications from the Municipal Offices, Johannesburg.

MANCHESTER Tramways Committee require tenders by 10 a.m. Oct. 24 for supply of h.d. Copper Trolley Wire. Specifications, &c., from Mr. J. M. McElroy, 55, Piccadilly, Manchester.

The Direccion General de Obras Públicas, Ministerio de Fomento, MADRID, requires tenders by noon Nov. 24 for the Construction and Working for 60 years of an Electric Tramway in Saragossa. An option on the concession is held by the Sociedad Los Tranvias de Zaragoza.

Electric Light and Power Concession.

The Colonial Secretary, Grenada, British West Indies, will received tenders until Oct. 31 for generating and supplying Electricity for Lighting and Power in the town and suburbs of ST. GEORGE (Grenada). Particulars from the Colonial Secretary, Grenada.

Wiring.

Tenders are required by 10 a.m. Oct. 30 for Electric Light Wiring (about 400 points) at Messrs. Macfarlane & Robinson's new works at Bushbury, WOLVERHAMPTON. Specifications, &c., may be obtained at the firm's offices, Stafford-street, Wolverhampton.

TENDERS RECEIVED AND ACCEPTED.

CROYDON. The Corporation have placed an order with Callender's Cable & Construction Co. (at £1,425) for supplying and laying a h.t. feeder cable in Southbridge-road.

DERBY. The Corporation have accepted the following tenders:—

R. Wade & Sons, poles, £134; British Insulated & Helsby Cables, armoured cable, £2,990, copper cable £500, sundry materials £50; British Thomson-Houston Co., switchgear £253, extension of main station switchboard £262; British Electric Transformer Co., 375-kw. transformer £286, 150 kw. ditto £160.

MANCHESTER. The following tenders were recently accepted by the Corporation:

Grange Iron Co., ash hopper; Etchells, Congdon & Muir, hoist gear, &c.; Aiton & Co., steam and feed pipes, &c.; Callender's Cable & Construction Co., British Insulated & Helsby Cables, Pirelli General Cable Works, Western Electric Co., C. Macintosh & Co. and Johnson & Phillips, cables; British Westinghouse Electric & Mfg. Co., transformers; Chamberlain & Hookham and General Electric Co., meters; Ferranti Limited, [illegible] phase meters; British Westinghouse Co., a.c. polyphase motors; Veritys Limited and Ferranti Limited, motor starters; British Westinghouse Co. and Electromotors (Ltd.), motors; British Thomson-Houston Co., switchgear and switchboard; P. R. Jackson & Co., alterations to cranes; Mather & Platt, electrically-driven circulating water pumps; Ferranti Limited, extension switchgear, &c.; Stewarts & Lloyds, high pressure pipework.

WEDNESBURY.—The Council have accepted the tender of the British Westinghouse Co. for the supply of a rotary converter at £3,190.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

[illegible]

[illegible] figure has been justified, the [illegible] for the year being 13,9[illegible],136 units (increase 5,161,118), the [illegible] record. Full supply accounted for 3,157,521 units and [illegible] power and heating for 1,887,651. These branches of the supply [illegible] responsible for more than half the output. The lighting [illegible] public lighting and night supply for [illegible]. The total of these decreases was practically counterbalanced by the 269,197 additional units sold in connection with the supply to the tramways department.

The total income was £167,177 (increase £19,438). Increased expenditure for coal and other materials, wages, rates, &c., was £15,477, while additional charges of nearly £7,000 had to be borne for interest, sinking fund and income tax. Net profit was £15,988 (against £18,956) £7,500 has been taken in relief of rates, and contributions to capital outlay have absorbed £2,200, and £3,171 has been applied as depreciation in respect of obsolete plant, while £2,756 has been transferred to depreciation and renewals account. In February last it was reported to the Committee that it was necessary that further extensions should be made to the plant at the Valley-road works. It was decided to apply to the Ministry of Munitions for authority to expend £49,515 on additional boiler-house and cooling plant, and £49,450 on additional engine-room plant and switchgear. The Ministry approved the scheme of extension to the boiler-house and cooling plant, but did not authorise the installation of the additional engine-room plant and switchgear. A loan was obtained for £53,113 to cover the cost. The increasing demands for supplies for power purposes rendered it necessary for the Committee again to consider the advisability of installing additional engine-room plant and the extension of the e.h.t. transmission system. Application was made to the L.G. Board for a loan of £100,000 for the proposed works. The Board declined to entertain the application. The Committee has since interviewed the Members of Parliament for the City and explained the position with a view to obtaining their assistance in inducing the Board to reconsider the matter. The work in connection with the installation of the 5,000 kw. turbo-alternator was completed shortly after the publication of last year's report. The 1,500 kw. rotary converters Nos. 2 and 3 were also completed and put to work in Oct. last, while the original No. 1 rotary converter has been replaced by a 300 rev. machine similar to Nos. 2 and 3. The work on the extension of the boiler-house and cooling plant, in consequence of shortage of material and labour, is not making such headway as could have been wished, but although the extension will not be completed for at least another three months, there is every possibility of at least one boiler being put into service in time to assist in coping with the heavy loads which are expected during the coming winter. The maintenance of adequate stocks of coal during the year under review has occasioned anxiety, all qualities having been hard to procure. The quantity of coal required was in some weeks 50 per cent. over the amounts consumed during the corresponding periods of last year, and the carting of the coal to the works has only been accomplished as a result of strenuous efforts. The Committee resolved in May last to procure two 5-ton "G.V." electric tipping wagons from the Jowett Motor Mfg. Co. of Bradford, and it is expected that these will shortly be delivered. Due to the labour conditions obtaining at the collieries the quantity of ash contained in the coal has considerably increased. It was decided in June last to purchase from Wolseley Motors (Ltd.), of Birmingham, a 3½ ton "Baker" electric tipping wagon. This has been in regular use, and, in addition to relieving the position as regards the disposal of ash, has proved of considerable assistance in transporting materials. Users of commercial motor wagons have given greater attention to the question of the use of electric vehicles, and a local firm has taken up an agency in connection with vehicles of this type. Interest in the subject has no doubt been stimulated by "The Electric Vehicle" (produced by the I.M.E.A.). The Midland Railway Co. are now operating 76 electric wagons, of which one at least has been in daily use in Bradford, and excellent reports have been received as to its suitability to local conditions. There are not less than four electric wagons in operation or on order by firms in the city. The Committee are of opinion that a growing demand for electricity for charging such vehicles will be experienced soon. Ten additional transformer chambers have been equipped during the year, bringing the number up to 45, and additional switchgear and larger transformers have also been installed in a few existing chambers. Sixty-five three-phase static transformers, varying in size from 15 k.v.a. to 600 k.v.a., and having an aggregate capacity of 10,909 k.v.a., are in commission in the above chambers. Two additional e.h.t. 6,600-v. feeders, each in duplicate, have been laid from the Valley-road works, one to Thornton-road, and the other via Canal-road to Bolton-lane, and a new e.h.t. feeder, working at a pressure of 11,000 volts, has also been laid from the Thornbury sub-station to the city boundary in the Leeds and Bradford-road, for furnishing a supply of electricity to the Yorkshire Electric Power Co. The laying of this cable has resulted in the linking-up of the Corporation's supply system with that of the power company to the mutual advantage of the two undertakings. Arrangements were made in Feb. last for continuing the cable contract with British Insulated & Helsby Cables (Ltd.) Owing to the abnormal cost of material for armouring cables, it was decided to adopt the expedient of laying unarmoured cables direct in the ground, and this has effected a considerable saving. As far as the Committee are aware, e.h.t. cables have not previously been laid in this manner by any electricity supply undertaking in the country, and prior to coming to the decision the Board of Trade were consulted on the question and their approval of the proposal obtained. The Committee have authorised the sealing of seven new bulk supply agreements, the supplies covered by which aggregate 6,050 kw. and the renewal of three expiring agreements representing 801 kw., the total demand provided for under the 10 agreements in question thus being 6,851 kw. It is expected that during the remaining six months of the current year an equal or greater rate of increase of output will be maintained. Against the additional revenue, however, must be placed the higher charges for coal, wages, &c., and capital charges will also show an increase by reason of the extensions which have been carried out during the year.

Marylebone.—The accounts of the electric supply department for the quarter ended June last show that the quantity of current sold was 3,177,038 units (increase 109,363 over the corresponding quarter of last year). Lighting units decreased, owing to restrictions imposed by the authorities and to the operation of the Summer Time Act.

Revenue from sale of current and meter rentals was £31,948 (increase £1,605). Total costs, exclusive of capital charges, were £17,281 (increase £407)—1·305d. (1·318d.) per unit sold. The sales and publicity department shows a credit of £236 (compared with a debit of £217 for the corresponding quarter). The net improvement in the balance available for capital charges, &c., is £2,072.

COMPANIES' MEETINGS AND REPORTS.

BOGOTA TELEPHONE CO. (LTD.) The report for year ended June 30 states that there has been a considerable increase in the number of subscribers connected to the system during the past year. In order to meet the increasing demands for telephone service the premises at Bogotá have been extended so as to provide accommodation for a much larger switching equipment, which is now in course of manufacture.

DICK, KERR & CO. (LTD.)—The profits earned during the 12 months' trading to June 30, 1916, amount to £71,740. 5s. 5d., which added to sum brought forward (£18,346. 11s. 8d.) make a total of £90,086. 17s. 1d. Out of this sum the debenture interest and trustees' fees have been paid and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £10,790. 5s. 3d., leaving £79,296. 11s. 10d. available. It is proposed to pay a dividend of 6 per cent. per annum on the preference share capital (£18,300) and a dividend of 6 per cent. per annum on the ordinary share capital (£15,000), to supplement special reserve for contingencies by £25,000, and to carry forward £20,396. 11s. 10d. The directors feel that, though it is difficult to foresee the position of the business in the future, they are warranted by the results of the year under review in recommending the payment of a dividend on the ordinary shares. During the past year, in addition to extensions of contracts for the supply of war material, which kept their works fully occupied, the Government entrusted to the company the construction, equipment and management of one of the national factories, which is now approaching full output. During the year, control of Messrs. Willans & Robinson (Ltd.) has been acquired. The directors anticipate that this will be of considerable value in the future expansion of business.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

CELYNIN ELECTRIC LIGHT CO. (LTD.) (144,994.)—Reg. Oct. 4. capital £500 in £1 shares, to take over the business of producers and suppliers of electric light and power carried on by the Rev. D. T. Davies, M.A., H. Evans, R. F. Jones, J. Jones, R. Jones and W. Lloyd, all of Llwyngwril, Merioneth, as the Electric Supply Co. Private company. First directors are Rev. D. T. Davies, M.A., H. Evans, R. F. Jones, W. Lloyd, J. Jones and R. Jones (all permanent).

T. S. HARRISON & SONS (LTD.) (144,979.) Reg. Sept. 30, capital £10,000 in £1 shares (2,000 6 per cent. cumulative preference), to adopt an agreement with T. S. Harrison, sen., T. S. Harrison, jun., and J. H. Harrison, to carry on the business of engineers and machinists carried on at Liversedge, Yorks, as T. S. Harrison & Sons, and that of woodworking machinists, sawmill engineers, electrical engineers, suppliers of electricity, &c. Private company. First directors are T. S. Harrison, T. S. Harrison, jun. (chairman), and J. H. Harrison (all permanent, subject to holding 100 shares each). The two first named are managing directors. Sec., J. H. Harrison. Reg. office, Crystal Mills, Liversedge, Yorks.

MORTGAGES AND CHARGES.

LISCARD BATTERY CO. (LTD.) Memorandum of satisfaction to extent of £10 on Sept. 11, 1916, of debentures dated April 18, 1913, securing £2,000, has been filed.

RESISTO ELECTRICAL MFG. CO. (LTD.) Issue on Oct. 3, 1916, of £100 debentures, part of series of which particulars have already been filed.

WALTERS ELECTRICAL MFG. CO. (LTD.) Charge on 249 and 251, Kensal-road, Paddington, dated Sept. 29, 1916, to secure all moneys due or to become due from company to London County & Westminster Bank.

"Z" ELECTRIC LAMP MFG. CO. (LTD. Mortgage dated Sept. 18, 1916, to secure £10,000, charged on company's manufactured stock of lamps at factory and present and future stock of materials at Southfields, and company's other assets. Holders, H. F. Brown, A. Simson and W. H. Cheetham, trading as Kilburn, Brown & Co.

CITY NOTES.

MEMORANDA (Oct. 18).—**Bank rate 6 per cent.** (since July 13, 1916) **Consols** 56¼. Consols Pay Day, Nov. 2. **Stocks and Shares Ticket Days** Oct. 26 and Nov. 14. **Pay Days**, Oct. 27 and Nov. 15. Price of **silver, 32$\frac{5}{16}$.**

ANGLO-MEXICAN ELECTRIC CO. (LTD.)—The accounts for 1915 show a loss (after paying 2 per cent. on the debentures) of £3,327, which reduced the surplus brought forward to £22,981.

BRISBANE ELECTRIC TRAMWAYS & INVESTMENT CO. (LTD.)—A dividend at the rate of 8 per cent. per annum (4s. per share), tax free, has been declared on the ordinary shares for the past half-year.

CALCUTTA TRAMWAYS CO. (LTD.)—An interim dividend of 3 per cent. has been declared on the ordinary shares.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—An interim dividend of 5s. per share has been declared on the ordinary shares, being at the rate of 10 per cent. per annum (less tax), payable on Nov. 1.

DARTMOOR ELECTRIC SUPPLY CO. (LTD. AND REDUCED.)—A petition for confirming a resolution reducing the capital of this company from £4,000 to £2,000 will be heard at the County Court, Exeter, on Nov. 6.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment, by warrants, on Nov. 1, of interest for the half year ending 31st inst. on their 4 per cent. mortgage debenture stock. The transfer book of the [illegible] stock will be closed from Oct. 26 to 31 inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The transfer books of the 4 per cent. debenture stock will be closed from the 26th to the 31st inst., inclusive.

ELECTRICAL UTILITIES CORPN. (LTD.)—A dividend at rate of 6 per cent. per annum (less tax) has been declared on the preferred ordinary shares for the half year to Sept. 30.

LIMA LIGHT, POWER & TRAMWAYS CO.—A dividend of 1 per cent. has been declared.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—A dividend of 1[illegible] per cent. has been declared, payable Nov. 1.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—A dividend of 2[illegible] per cent. has been declared, payable Nov. 1.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—An interim dividend of [illegible]

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors have resolved to pay on Nov. 1 an interim dividend of 3 per cent. (3s. per share) on the ordinary [illegible] tax free for the half year to June 30.

METAL PRICES.

Messrs. [illegible] B. C[illegible] & Sons, 1[illegible] Upper Thames-street, London, E.C., quote under [illegible] the following prices:—

[illegible]			Per ton
[illegible]	[illegible]	E[illegible] Lead	£[illegible] 1[illegible] 0
[illegible]	[illegible]	Antimony	Nominal.
[illegible]	[illegible]	Old Metal	Per ton.
[illegible]	[illegible]	[illegible] Copper Scrap	£110 1[illegible] 0
[illegible]	[illegible]	[illegible] Brass Scrap	[illegible] 1[illegible] 0
[illegible]	[illegible]	Braziery Copper Scrap	[illegible] 1[illegible] 0
[illegible]	[illegible]	Old Lead	7 1[illegible] 0
[illegible]	[illegible]	[illegible]	4[illegible] 0 0
	Per ton.	H[illegible] Powder	3[illegible] 0 0
[illegible]	[illegible]	B[illegible] Powder	[illegible] 0 0
[illegible]	[illegible]	G[illegible] Metal	[illegible] 0 0

Messrs. A. J[illegible] [illegible] London, E. [illegible] quote [illegible] Scrap Metals:—

	[illegible]		Per ton.
[illegible]	£[illegible]	Old Lead	£[illegible] under English price
[illegible]	[illegible]	Old Zinc	4[illegible] 0
[illegible]	[illegible]	[illegible] Powder	[illegible] 0
[illegible]	[illegible]	[illegible] B[illegible] Powder	[illegible] 0 0

[illegible]

ELECTRICAL COMPANIES' SHARE LIST.

We give below the [illegible] which actual transactions took place on [illegible] Tuesday, Oct. 17.

Shrs.	Last Dividend	Name.	Price, Tues., Oct. 17	[illegible]	[illegible]
		Electricity Supply.			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price Tues., Oct. 17	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6 9/16	6 1 11	Feb, Aug
5	7%	Do. do. Pref.	5[illegible]	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72¼	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1⅛	6 14 8	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6⅜	5 5 11	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	83	6 4 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	79	7 11 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	68	5 17 8	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82¼	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	75¼	5 6 4	Jan, July
St.	4%	City & S. London Deb.	74¼	5 7 0	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1¼%	London Electric Ry. Ord.	2 3/16	5 15 4	Jan, July
St.	4%	Do. 4% Pref.	6[illegible]	6 3 6	Mar, Sept
St.	4%	Do. 4% Debs.	74½	5 7 5	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23 5/16	4 0 4	Feb, Aug
St.	3½%	Do. 3½% Pref.	60	5 16 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	58	6 0 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	63¾	5 9 10	Jan, July
St.	3½%	Do. 3½% Debs.	65	5 7 8	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16¾	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	71	6 6 9	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	70½	5 14 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	3	5 0 0	Apl, Oct
1	6%	Do. 6% Pref.	1[illegible]	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1 7/16	4 17 5	Mar
100	5%	Do. Prior Lien Debs.	93⅜	5 7 1	Jan, July
1	6%	Do. 6% Pref.	15/16	6 8 0	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12⅜	7 1 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 3/16	5 15 8	Jan, July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 7 5	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2 9/16	5 15 1	April
100	6%	Do. 6% Prior Lien Debs.	99¾	6 0 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12⅝	7 18 5	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Deb.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	[illegible]	6 8 0	Sept.
5	..	Edison & Swan U. Elec. Lt. A. £3 pd.	[illegible]	..	Feb, Aug
St.	4%	Do. 4% Deb.	61¼	6 10 7	Jun, Dec
1	7½%	Elec. Construction Ord.	[illegible]	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1[illegible]	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
1	6%	Do. 6% Pref.	9[illegible]	6 0 9	June, Dec
[illegible]	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16	6 5 0	Feb, Aug
[illegible]	2 3	Do. 4½% Cum. Pref.	4[illegible]	5 7 6	..
St.	4½%	Do. 4½% Db.	89	5 2 2	Jun, Dec
10	1[illegible]%	India Rubber, G.P. &c., Ord.	12 1/16	8 5 10	Feb, Aug
[illegible]	5%	Do. Pref.	7⅞	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38	6 6 4	Mar, July
10	4%	Do. 4% Debs.	95¼	4 4 1	Jan, July
1	12½%	Vickers Ord.	1⅞	6 13 4	May, Aug
1	[illegible]	Do. 5% Pref.	[illegible]	5 10 4	May, Aug
St.	4%	Do. 1st Deb.	75	5 6 8	June, Dec
[illegible]	4½%	Do. 4½% 2nd Deb.	99¼	4 10 8	June, Dec
St.	4½%	Willans & Robinson B. Cm. Pref.	41½	9 18 10	..
St.	4%	Do. 1st Mt. Deb. St.	55	7 5 5	..
		Telegraphs.			
St.	3/0	A[illegible]lo Am[illegible] 6% Pref. Ord.	[illegible]	6 2 5	Fb,My,Aug,N
[illegible]	1½%	Do. D[illegible]	[illegible]	7 0 2	Fb,My,Aug,N
[illegible]	4%	Com[illegible] 4% Deb[illegible]	71	5 12 8	Ja. Ap. Jly. O
[illegible]	[illegible]	Cu[illegible] S[illegible]	8	6 5 0	May, Nov
[illegible]	10%	Do. 10% Pref.	1[illegible]	6 11 2	..
[illegible]	[illegible]	Direct S[illegible]	7¾	6 13 4	..
1	4%	Direct U[illegible]	6[illegible]	6 2 6	Ja,Ap,Jly,O
[illegible]	[illegible]	Eastern Tel. Co. Ord.	1[illegible]	5 14 8	Ja,My,Jly,O
[illegible]	[illegible]	Do. [illegible]	[illegible]	5 7 8	Ja,My,Jly,O
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 1 3	May, Nov
[illegible]	4%	[illegible]	7[illegible]	5 3 7	Feb, Aug
[illegible]	[illegible]	Do. O[illegible]	14	5 14 3	Ja,Ap,Jly,O
1	[illegible]	[illegible] N[illegible] Tel. C[illegible] W[illegible]	[illegible]	[illegible] 14 3	Ja, My, Jly
[illegible]	[illegible]	[illegible]	11	[illegible] 6 1	May, Nov
[illegible]	[illegible]	[illegible] W[illegible] Tel. C[illegible]	[illegible]	3 1[illegible] 9	April
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 1[illegible] 9	July
[illegible]	[illegible]	W[illegible] Ord.	[illegible]	10 6 5	May, Nov
[illegible]	[illegible]	[illegible]	7[illegible]	6 11 9	May, Nov
[illegible]	[illegible]	W[illegible]	11[illegible]	5 10 4	Mr, Jly, O, Dec
[illegible]	[illegible]	Do. [illegible]	[illegible]	5 3 11	June, Dec
[illegible]	4[illegible]%	W[illegible]	99[illegible]	4 10 10	May, Nov
		Telephones.			
[illegible]	[illegible]	M[illegible] V[illegible] Teleph. Ord.	[illegible]	9 [illegible] 10	Nov
[illegible]	[illegible]	[illegible] Telephone [illegible]	[illegible]	4 6 6	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	5 1 3	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	5 8 5	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 17 5	Apl, Oct
[illegible]	[illegible]	[illegible]	4[illegible]	5 4 7	Jan, July
[illegible]	[illegible]	Do. Deb. [illegible]	[illegible]	[illegible] 5 3	Jan, July
		Financial and Investment.			
[illegible]	[illegible]	[illegible] & [illegible]	[illegible]	4 16 0	Sp,Dc,Mr,Jn
[illegible]	[illegible]	[illegible]	[illegible]	5 13 7	Sp,Dc,Mr,Jn
1	[illegible]	[illegible]	[illegible]	[illegible] 17 6	Ja,Apl,Jly,O
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 14 3	Ja,Apl,Jly,O
[illegible]	[illegible]	[illegible]	1[illegible]	4 13 5	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
[illegible]	[illegible]	[illegible]	[illegible]	6 1 6	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 10	Jun, Dec
[illegible]	[illegible]	[illegible]	10	[illegible] 1[illegible] 8	..
[illegible]	[illegible]	[illegible] Deb.	[illegible]	[illegible] 8 5	Jan, July
[illegible]	[illegible]	[illegible] C[illegible]	[illegible]	6 17 [illegible]	May, Nov.
[illegible]	[illegible]	[illegible]	4	5 1[illegible] 8	Mar, Sep

[illegible]

THE ELECTRICIAN:

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NOTES.

The "James Forrest" Lecture.

THE Council of the Institution of Civil Engineers is to be congratulated on the choice of subject for this year's "James Forrest" Lecture, as well as on the choice of a lecturer who, over a long period, has done much to promote the mechanical handling of materials. From the abstract given elsewhere it will be seen that the lecturer, Sir JOHN PURSER GRIFFITH, dealt with the objects aimed at by the development of mechanical handling appliances and with the economic advantages gained by their use. Striking examples were given as illustrations, and a plea for the extended use of modern machinery was made on the ground of the benefit such machinery is capable of conferring upon mankind. The subject selected, namely, "The Development of Appliances for Handling Raw Materials and Merchandise at Ports and Other Large Centres of Traffic," is in reality part of the bigger subject of mechanical handling of materials. Those who were fortunate enough to hear the lecture, and whose business necessitates the moving of material, will agree that Sir JOHN's remarks on the economic side of the subject are applicable to their own works and business. Take, for instance, the fitting-out of a vessel of large tonnage. It is the desire of every builder of such vessels to possess or to have access to a modern crane sufficiently large to place the heavy machinery in position with little unskilled labour. The existence in large numbers of fixed and floating cranes is sufficient proof that they are economical. Of certain of these cranes it is said that they pay for themselves in a very short time. The many special and costly cranes used in steelworks may be cited as another example of sound economy. If magnet cranes can be used in countries where unskilled labour costs 4d. per head per day, and where labour disputes are either unknown or easily settled, it is evident without argument that they may be used to very much better advantage in those countries in which it is within the power of unskilled labour to paralyse industry. A sense of the gravity of the issues involved led Sir JOHN to introduce social problems into the lecture. In the past the engineer has done much for the benefit of mankind, and we believe that the curse of unskilled labour and of casual labour will be removed by his efforts. We welcome the ventilation, in our engineering institutions, of ideas on these subjects, and it is as fitting as it is significant that the parent Institution should lead the way.

Municipal Dishonesty at Bahia.

MANY hard things have been said of municipalities, and although we are not enamoured of some of the methods of such bodies, we willingly admit that the search will be a long one before the inquirer discovers a Council having the limited sense of honesty possessed by the Municipality of Bahia. It was before 1914 that the Town Council of Bahia approached the Bahia Tramway, Light & Power Co. and the Compagnie d'Eclairage de Bahia, and submitted a scheme for purchasing these undertakings. In due course a contract was approved, and the undertakings were transferred for a provisional bond of £1,521,000 bearing interest at 6 per cent. from March 1, 1914, this bond being exchangeable later for definitive bonds. Trouble soon became apparent, for the Municipality failed to pay the interest on the first four months due on July 1, 1914, and then proceeded to default on the coupons due in August, 1914, on a loan issued in 1912. They also diverted taxes which were pledged as security for the 1914 loan. The Council then attempted to reduce the amount of the loan, in response to which the companies embargoed the municipal funds at the Banco do Brazil. In 1915 the suggestion was put forward that the loan was illegal, and that the companies should take back the undertakings. It was found, however, that the plant had been so neglected in the interval that an outlay of £110,000 would have been necessary to ensure their proper working, and there was no guarantee that a new concession would be respected by the Municipality to a greater extent than the old one.

◆

THE Town Clerk also put forward the plea that the contract had caused the Council heavy losses, and laid down the amusing proposition that, according to Brazilian law, contracts causing enormous injury to one of the parties could be cancelled! The next exploit of the Municipality was the dishonouring of promissory notes to the value of over £12,000. As will be seen by the account of the meeting of debenture holders, which we give elsewhere, the present position is that the companies have not only received none of the purchase price in the shape of definitive bonds, but there is also a sum due of about £150,000 on account of interest and sinking fund, nothing having been received on this account. Litigation in Brazil is said to be a hopeless remedy. Meanwhile the Municipality is in possession of the undertakings, receiving all the benefits, and the Councillors are, presumably, congratulating themselves upon being smart men of business. In private affairs such men would be termed mere swindlers, and would enjoy a well-merited seclusion for some years. But being a public body they can enjoy such a financial orgy with impunity. Even so, we do not doubt that the time will come when the Municipality of Bahia will desire to raise a loan for public works, and will find no financiers ready to trust them. Then it will become apparent to them that "Honesty is the best Policy," even for municipalities.

Electrical Apparatus for Cranes.

In their recent article on this subject, of which we give an abstract elsewhere, Messrs. R. H. McLain and J. A. Jackson direct attention to a point in connection with alternating-current equipments that is often disregarded. In order that an alternating-current crane may make as many trips per day as a direct current crane it may be necessary to gear the former for a higher full-load hoisting speed, because the motor can never run above its synchronous speed, and this means that the rating of the motor must be relatively greater. By means of an example it is shown that the induction motor may occasionally have to be 1·46 times as large as the direct current motor. Although in practice the ratio is seldom as high as this, an induction motor may have to be considerably larger than a direct-current motor for a given duty.

Brown, Boveri et Cie. Last Saturday this historic Swiss firm celebrated its 25th anniversary at Baden.

Germans Building Largest Generator in the World.—According to the "Electrical World," the Siemens-Schuckert-Werke of Berlin is now building a 60,000 k.v.a. generator wound for 6,600 volts and operating at 1,000 revs. per min. The generator is intended for the Rheinische Westphaelische Elektrizitäts Werke and will be delivered by April 1, 1917, which throws an interesting light on the conditions of the German electrical industry in spite of the war. The 6,600 volt energy will be stepped up to 110,000 volts for transmission in a [illegible] k.v.a. transformer.

Electricians for Royal Engineers Wireless Section. The Wireless Section R.E. has vacancies for a number of electricians and instrument repairers with good practical knowledge, to be engaged for the period of the war only. Applications [illegible] qualifications should be sent to the O.C., Wireless Training Centre, Worcester, from whom information regarding terms of service can be obtained. Men would be required to enlist as sappers in the Wireless Section of the Royal Engineers [illegible] prospects of promotion [illegible]

Excess Profits Decisions. The Board of Referees appointed [illegible] excess profits duty [illegible] 1915 have given decisions in [illegible]

[illegible]

[illegible]

[illegible]

The Board refused the application of the National Federation of [illegible] Paint, Colour and Varnish Manufacturers of the United Kingdom, through its president (Mr. H. W. Harding), for an increase of the statutory percentage as respects the business of manufacturing in the United Kingdom paint, colour and varnish, or any of them,

Co-operation between Engineering Institutions.—Attention has often been drawn to the excellent opportunity for co-operation afforded by the engineering societies' building in New York, in which the four leading American Institutions are represented. Sir Robert Hadfield, F.R.S., who was much impressed by the possibilities of mutual assistance in this direction when attending the opening ceremony in this building in 1907, has since been an advocate of similar co-operation in this country, and he has now made the suggestion that the Iron and Steel Institute, the Institute of Mining and Metallurgy, the Institute of Metals and the Institute of Mining Engineers should share in a central home, a common meeting place, and a joint library. A special committee has reported in favour of the project, and it is to be hoped that something practical will come of it.

OBITUARY.

Sir Joseph Beecham.—Sir Joseph Beecham, Bart., died suddenly on the 23rd inst. The deceased baronet was chairman of the Electricity and Tramways Committees of St. Helens Corporation, and he was also a director of the Lancashire Light Railways, the Lancashire United and the South Lancashire Tramways, and the West Cumberland Electric Tramways Companies.

Sir Henry Benbow.—The death of Sir Henry Benbow, K.C.B., D.S.O., took place on Friday at Eastbourne. He entered the Navy as assistant engineer in 1861, and became chief engineer in 1879. He became chief inspector in 1888, received the D.S.O. three years later, and was made a K.C.B. in 1902. He retired from the Navy in 1893. The deceased was a director of Davis and Timmins (Ltd.)

Rev. A. J. Shaw.—The death occurred on Aug. 26 of Father A. J. Shaw, of Melbourne, the inventor of the Shaw system of wireless telegraphy. Deceased was only 42 years of age.

John Skerritt.—On the 17th inst. the death took place at Addlestone of Mr. John Skerritt, A.M.I.E.E.

Killed in Action.—The following deaths in action or of wounds are reported :—

Lieut. and Adjutant H. Malcolmson (Royal Irish), who died of wounds on Sept. 16, was 26 years of age. He took first-class honours in the Cambridge mechanical science tripos, and was in the service of Scott's Shipbuilding & Engineering Co. when the war commenced.

Sec.-Lieut. R. B. Wood (Border Regt.), aged 23, who has been killed, was engaged at engineering works at Sandycroft, Chester, until the war broke out.

Sec.-Lieut. D. Mervyn Taylor (East Kent Regt.), who was killed on Oct. 4, was 26 years of age, and was formerly in the service of the Eastern Telegraph Co. at Penzance and Suez.

Sec.-Lieut. Douglas A. L. Derry (York and Lancaster Regt.), who was killed on Oct. 9, was 20 years of age. He was an engineering pupil in the works of Vickers Limited prior to the war.

We are informed that the following members of the staff of the Marylebone electric supply department have been killed in action : Pte. A. H. Bowen (24th County of London), Pte. C. F. Lewis (10th Gloucester), and Rfn. A. J. Scott (21st County of London). Pte. A. P. Grover (18th County of London) has also died on military service.

PERSONAL.

Sir Wm. Clark, K.C.S.I., C.M.G., has been appointed Comptroller-General of the reorganised department of Commercial Intelligence. Mr. Thomas Worthington, who has just retired from the post of Director of the Commercial Intelligence Branch under the age limit, has consented to assist the department in a consultative capacity as commercial adviser.

Adelaide (S. Australia) University recently awarded the Angas Engineering Scholarship (value £200 per annum and tenable for two years), to Mr. Cyril W. Goodman, B.E., a son of Mr. W. G. T. Goodman, engineer and manager for the Adelaide Municipal Tramway Trust. Mr. C. W. Goodman has enlisted for active service.

Mr. S. Williams, burgh electrical engineer at Wishaw, has resigned his position in order to join H.M. Naval Forces.

Royal Engineers (T.F.).—The following appointments have been made :—

Royal Engineers Signal Service: Sec. Lieut. T. H. Newlands to be temporary lieutenant and assistant instructor of power signals.

London Electrical Engineers: Sec. Lieut. (temp. lieut.) R. H. Smith (O.T.C. unattached list, T.F.) to be second lieutenant.

Tyne Electrical Engineers: Hy. S. Watson, Edwd. R. Brigham and Corp. Walter A. Gladwin (from A.S.C.) to be second lieutenants (on probation).

APPOINTMENTS VACANT AND FILLED.

An expert manager is required for a factory producing drawn-wire electric lamps. *See an advertisement.*

An electrical and mechanical engineer is wanted temporarily at the University of Bristol. Applications to the Registrar. *See advt.*

A professor and assistant are required for the department of physics of the South African School of Mines and Technology, Johannesburg. Salaries £800, rising to £1,000; and £350, rising to £450, respectively. Applications to Messrs. Chalmers, Guthrie & Co. (Ltd.), 9, Idol-lane, London, E.C., by Nov. 16.

Atherton Urban Council require a resident electrical engineer. Salary £200. Applications to the Clerk, by Oct. 31.

Horsham Urban Council is inviting applications for the position of resident electrical engineer. Commencing salary £220. Applications to the Clerk, by Oct. 31.

A lecturer in engineering (preferably electrical) is required for the Loughborough (Leics.) Technical Institute. Salary £150 to £175. Applications to the Principal by Nov. 1.

An engineer with experience of steam and electrical plant is required for Park Prewett Asylum. Forms of application from the Clerk of the Hampshire Joint Asylums Visiting Committee, The Castle, Winchester. Applications by 10 a.m. Oct. 30.

Mr. C. T. Asbury, of Atherton (Lancs), has been appointed burgh electrical engineer at Wishaw in succession to Mr. S. Williams who has resigned to take up a position in the Navy.

INSTITUTIONS AND SOCIETIES.

Institution of Engineers and Shipbuilders in Scotland.—At the opening meeting of the current session of the Institution of Engineers and Shipbuilders in Scotland, which was held on Tuesday of last week, Mr. W. W. Lackie, president, made some interesting remarks on engineering conditions after the war. Mr. Lackie said that during the past year they had witnessed the silent and rapid organisation of the whole engineering industry into a series of inter-related centres, each centre filled with gigantic workshops for the production of munitions of war. Mr. W. Weir, one of their members, had been called upon to fill the post of Director of Munitions in Scotland. They had seen the voice of party strife silenced in face of the growing national concentration on the prosecution of the war. Trade customs and policies had been scrapped, and so-called rights and privileges waived in the presence of the common menace of Prussian domination. There had also been the timely and complete collapse of that insularity of outlook which had been so largely responsible for their general unpreparedness at the outbreak of war. He reminded them of the campaign which had been carried on by the Australian Premier and of the prominent part taken by the Institution in the series of conferences which had subsequently been held in Glasgow as a result. He had no doubt that the outcome would be the formulation of a definite trade policy by all the various branches of the engineering industry. The widened outlook evolved during the past year had led science and industry to take a new view of each other's doings. The revival of interest in the practical possibilities of pure science was bound to have an entirely desirable influence on the attitude of scientific men to industrial processes. Knowing that the men in charge of their industries were now likely to welcome suggestions for improvements in industrial processes, the men of science would be the more likely to pursue their patient labours to a successful issue. He hoped that business men on their side would see that the labours of the men in the laboratory were appraised at something like their true value. In the immediate future the problem of adolescent education would demand increasing attention. There would continue to be labour problems after the war, but there was a feeling that such problems would have to be approached from a new point of view. Out of 26 States which composed the German Federation, 22 had day continuation schools for apprentices, the continuation schools of Munich, for instance, covering 56 trades. It was now recognised that the evening school was a slow and wasteful method of imparting elementary technical knowledge to the future artisan. He thought that in the atmosphere of the schoolroom something of the old spirit of discipline might be restored through the cultivation in the apprentice of a real interest in his work. Men to whom a more extended schooling had imparted some ability to weigh evidence would be less easily misled by the nostrums of those who promised easy and immediate remedies for all the real and imaginary ills of the body politic.

Institution of Civil Engineers.—In addition to the awards announced in April for Papers read at the meetings, the council of the Institution of Civil Engineers have made the following awards for Papers published in the "Proceedings" without discussion during the session 1915-1916: Telford premiums to Messrs. Hubert Mawson (Liverpool), T. W. Keele (Sydney), R. W. Holmes (Wellington, N.Z.), W. Fairley (London), J. M. Greathead (Johannesburg), T. C. Hood (Manmad, India) and J. B. Ball (London); the Manby premium to Mr. W. C. Cushing (Pittsburg, U.S.A.); and the Crampton prize to Major C. E. P. Sankey, D.S.O., R.E. (London). The Indian premium for 1916 has been awarded to Sir John Benton, K.C.I.E. (Eastbourne).

Metropolitan Association of Electric Tramways Managers.—At a meeting of the members at the Municipal and County Club (Whitehall) on the 20th inst. there were present the following:—

Messrs. Ullmann (East Ham), Schofield (Leyton), Harvey (Ilford), Williams (Erith), Hammond (Met. Electric), Mackinnon (L.U.T.), Mason (South Met.), Slattery (West Ham) and Goodyer (Croydon).

Mr. Ullmann was re-elected chairman, Mr. W. E. Hammond vice-chairman and Mr. T. B. Goodyer was also re-elected hon. secretary. Letters of inability to attend were received from Mr. Bruce (L.C.C.), Mr. Murray (Walthamstow) and Mr. Stokes (Bexley). Various matters of interest were discussed.

Greenock Electrical Society.—An inaugural meeting of this Society was held on the 19th inst., when the chair was taken by Mr. F. H. Whysall and a lecture was given by Mr. A. Norwell on the subject of "Steam Turbines." The lecturer dealt generally with the subject and the meeting concluded with an interesting discussion.

Institute of Radio Engineers.—A meeting of the Institute was held on October 4th, when Mr. Edwin H. Armstrong read a Paper on "The Heterodyne Theory of Amplification and its Relation to the Oscillating Audion."

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 27th (to-day).

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Papers on "The Determination of the Saturation Values for Magnetism of Ferromagnetic Metals, Compounds and Alloys by means of the Kerr Effect," by S. G. Barker, D.I.C., Ph.D.; "The Influence of the Time Element on the Resistance of a Solid Rectifying Contact," by D. Owen, B.A., B.Sc.; "On Diffusion in Liquids," by B. W. Clack, M.Sc.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (NEWCASTLE-ON-TYNE).

7.30 p.m. Annual General Meeting. A Paper on "Works Organisation": comprising "Manufacturing Organisation," by Mr. A. D. C. Parsons; "Financial Organisation," by Mr. E. L. Orde; and "Selling Organisation," by Mr. G. H. Tweddell.

TUESDAY, Oct. 31st.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7.15 p.m. At St. Bride Institute (Bride-lane, London, E.C.). A Paper on "Electric Cooking and Heating," by Mr. A. F. Berry.

WEDNESDAY, November 1st.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At the Royal Institution, Colquitt-street. The President, Mr. Thomas M. Newell, M.Inst.C.E., will deliver his Inaugural Address.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the week.

Officer for the Week.—Platoon Commander C. H. C. Bond.

Next for Duty.—Platoon Commander Hughes Hallett.

Appointments.—Corporals B. F. Bristow and D. R. Newlands to be section commanders (dated October 14th).

Monday, October 30th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits Drill, 6.25 to 8.

Tuesday, October 31st.—School of Arms, 6 to 7. Lecture, 7.15, "The Duties of the N.C.O.," by Company Commander Hynam. Range Practice.

Wednesday, November 1st.—Instructional Class, 6.15. Platoon Drill, Platoon No. 1. Range Practice.

Thursday, November 2nd.—Platoon Drill, Platoon Nos. 5 and 6. Range Practice. Lecture by Medical Officer, 6.0, "Marching and the Care of the Feet."

Friday, November 3rd.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits Drill, 6.25 to 8.25.

Saturday, November 4th.—N.C.O.'s Class, 2.30, Company Commander Fleming.

Sunday, November 5th.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway) Booking Office, 8.15 a.m. Uniform, haversacks, water bottles. Mid-day ration to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, *see* Notice and Tables A and B at Headquarters.

NOTE.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

SELECTION OF ELECTRICAL APPARATUS FOR CRANES.*

BY R. H. MCLAIN AND J. A. JACKSON.

In the selection of electrical apparatus for crane drives it is first necessary to consider the various classes of cranes. For reference later these classes are enumerated below :—

Class 1.—Stand-by or service cranes which are used in emergencies and at rare intervals. A typical example is the power house crane which is used during installation and thereafter only when repairs are made. The apparatus on such a crane should be simple and should be worked to the limit of its capacity. The control should be very accurate for placing large machines even when used by unskilled operators; as this kind of crane is so rarely used that there is no trained operator for it.

Class 2.—Machine shop and foundry cranes, which are always in service and moderately busy. The apparatus on them should be simple, but not worked so nearly to the limit of its capacity as in Class 1. There is always a regular operator in attendance, and, therefore, the control apparatus does not necessarily have to be so accurate as in Class 1. In this same class belong loading cranes which serve storage yards where infrequent movements of the stock occurs.

Class 3.—High-duty cranes such as are used for moving material in steel mills and for loading material into cars with magnets from storage yards where stock is frequently moved. On these cranes rugged apparatus is required, and complications are warranted to some extent in order to secure long life of the apparatus. All apparatus should be very conservatively rated.

Class 4.—Soaking-pit and stripper cranes. On these cranes fire-resisting insulation is required on motors, and apparatus should be designed to be rugged, conservative in size and exceptionally safe in operation.

Class 5.—Hot metal ladle cranes. These cranes should have fire-resisting insulation and should be extremely conservatively designed.

GENERAL SELECTION OF ELECTRICAL EQUIPMENT.

To assist in selecting the general type and arrangement of electrical equipment, Table I. has been compiled, in which all the various features to be considered are pointed out.

maximum horse-power to be delivered by the motor, and (*b*) the usual horse-power. The horse-power value obtained by adding the horse-power to hoist at full-speed to the horse-power to start should always be less than the five-minute rating of the motor if direct-current is used; and less than the maximum pull-out horse-power capacity under minimum line voltage of the motor if alternating-current is used. The horse-power delivered under usual operating conditions determines the ordinary rating of the motor, and it should be :—

For class 1 cranes the 15-minute rating of the motor.
For class 2 cranes the 15 or 30-minute rating of the motor.
For class 3 cranes the 60 or 90-minute rating of the motor.
For class 4 cranes the 60 or 90-minute rating of the motor.
For class 5 cranes the 30-minute rating of the motor.

On cranes coming under class 5 it is customary to have two hoist motors, each of which alone can hoist the total load without exceeding its 30-minute rating. This excess capacity is warranted on account of the great value of the metal and the necessity of hoisting the load even if one motor is broken down.

When direct-current is used the series-wound motor is most suitable. When alternating-current is used the wound rotor polyphase induction motor is most suitable, although for small (15 H.P. and less) cranes, which require no reduced speed control a high-resistance squirrel-cage rotor is suitable.

In order to make the same number of trips per day with an alternating-current crane as with a direct-current crane, it is frequently necessary to gear the alternating-current crane for a higher full-load hoisting speed, because the motor can never run above its synchronous speed, and this means that the rating of the alternating-current motor must be relatively greater than that of the direct-current motor. As an example the authors assume that a round trip consisting of hoisting full-load 20 ft., lowering it 20 ft., hoisting an empty hook 20 ft., and lowering it 20 ft., and show that the alternating-current motor would have to be 1·46 times as large as the direct-current motor. This ratio does not come as high as 1·46 for ordinary practical cases, but in order to meet the requirements of an occasional extremely high load, an induction motor may have to be considerably larger than a direct-current motor, because a direct-current motor can exert more overload torque.

Table I. *Key to Assist in the Selection of Electrical Equipment for Cranes.*

- [illegible]
  - Motors.
    - Enclosed or open insulation.
    - Mechanical strength and ruggedness.
      - Alternating current.
        - Wound rotor or squirrel cage.
        - Voltage.
        - Frequency.
        - No. of phases.
        - Heating basis.
          - 15-minute.
          - 30-minute.
          - 60 minute.
        - Max. torque.
      - Direct current.
        - Max. torque.
        - Series or Compound wound.
        - Voltage.
        - Heating basis.
          - 15-minute.
          - 30-minute.
          - 60-minute.
    - Rating.
    - Accessibility for repairs.
  - Controller.
    - Drum.
      - Straight reversible.
      - Dynamic braking.
        - No. of points.
        - Type of handle.
    - Magnetic.
      - Straight reversible.
      - Dynamic braking.
        - No. of hand control points.
        - No. of automatic control points.
        - Plugging point.
          - Hand controlled
          - Automatic.
        - Creeping speed point.
        - Space requirements.
        - Type of handle on master.
  - [illegible]
    - [illegible]
      - Heating.
      - [illegible] torque.
      - Plugging.
      - Creeping speed.
    - [illegible]
      - Series or shunt wound.
      - Torque requirements.
      - Ruggedness.
      - Wearing qualities.
  - [illegible]
    - Overload.
    - No voltage.
    - [illegible]
    - [illegible]
    - [illegible]
    - [illegible]

Selection of Hoist Motors.—[illegible] torque [illegible] lower the empty hook [illegible] per cent. [illegible] torque required to hoist the [illegible] load.

[illegible]

[illegible]

Example of Selection of Hoist Motors.—Take a crane which usually hoists 10,000 lb. at 20 ft. per minute, and which has a gear efficiency of 0·55. Assume the extreme load to be 15,000 lb. For direct-current the horse-power required to lift the load is 11, and to accelerate in two seconds the horse-power required is 2·75. When the motor has to hoist 15,000 lb. occasionally this will require approximately

15,000 × 11 ÷ 10,000 = 16·5 H.P.

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* Abstracted from the "General Electric Review" [illegible]

Therefore, the usual horse-power required will be 11 and on extreme loads 19·25. Choose a motor which will start at 19·25 H.P., and whose 15, 30, 60 or 90-minute rating, according to class of crane, is 11 H.P.

For alternating-current it is shown that a motor must be chosen having a 15, 30, 60 or 90-minute rating of 13·2, and which will start at 26·4 H.P. under minimum line voltage.

Selection of Bridge and Trolley Motors.—To select a proper bridge or trolley motor obtain the torque which corresponds to the horse-power values when maximum load is being handled. Add these torque values together and see that the motor chosen can exert this total torque for five minutes without damage. Then obtain the torque which corresponds to the horse-power values for usual load conditions. Add these torque values together and see that about 2·5 times this total corresponds to the 15-minute rating of the motor for class 1 cranes, the 15 or 30-minute rating for class 2, the 60 or 90-minute rating for class 3, 60 or 90-minute for class 4, and 30-minute for class 5 cranes.

Just as in hoist service, a series-wound direct-current motor or a wound-rotor polyphase induction motor is the most suitable type of motor to use.

A trolley with suspended maximum load usually weighs three times as much as a trolley without load. Hence, if, for example, 80 per cent. of the rated motor torque is required to propel a loaded trolley 26·6 per cent. of the rated torque will be required to propel it with no load. Now, on Fig. 1, 80 per cent. torque corresponds to 109 per cent. speed and 26·6 per cent. torque corresponds to 174 per cent. speed. The average of 109 and 174 is 141·5. An induction motor would have to be geared $\frac{141\cdot5}{109}$ (=1·30) higher than a series-wound direct-current motor in order to make an average round trip in the same length of time. Therefore, for this reason alone, the rating of the induction motor in such a case will have to be 1·30 times the direct-current motor rating. In some cases a still further increase must be made in the size of the induction motor in order to meet the five-minute test. An induction motor cannot take as much overload for a short period as a direct-current series-motor.

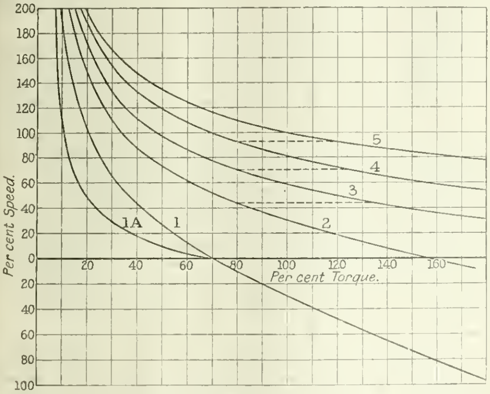

FIG. 1.—SPEED-TORQUE CURVES OF A D.C. SERIES MOTOR OPERATED BY A STRAIGHT REVERSIBLE CONTROLLER.

(Curve 1A shows effect of connecting resistance in parallel as well as in series with the motor.)

The weight of a loaded crane is about 1·5 times to twice the weight of a crane without load. By the same line of reasoning as used in the paragraph above, an induction motor for bridge service will have to be geared about 1·15 times as high as the direct-current motor. On bridge service the five-minute maximum load test is much more important than on trolley service, because a poor track or bad alignment of bridge is liable to cause the horse-power to be excessively high in certain parts of a building. For these two reasons it is frequently advisable to use an induction motor whose rating is 1·33 to 1·50 times the rating of a direct-current motor.

Example of Bridge Motor.—Take a bridge whose data are:—

Rated travelling speed = 300 ft. per minute.

Weight of fully-loaded crane = 100,000 lb.

Rolling friction factor = 0·015 for usual track, and 0·025 for one bad spot.

Efficiency = 0·90.

Time for accelerating = 5 seconds.

The authors show that 15·1 H.P. will be required to propel the usual load, and that 31·4 H.P. will be required at starting.

For alternating-current the motor must be able to stand 52·5 H.P. for five minutes, and its rating must be 15·1 × 2·5 or 37·8 H.P. or more.

For direct current the motor must be able to stand for five minutes a torque of 3·3 times the torque which the motor delivers at 15·1 H.P., and its rating will be about 2·5 times this torque. Such a motor would be found by reference to its speed torque curve to be rated about 28 H.P.

The extreme test which this motor must meet occurs when the crane must be started on a bad spot in the track. The propelling horse-power at this point is shown to be 25·2 H.P., and the torque required for acceleration will then be 3·95 times the torque which the motor delivers at 15·1 H.P. The motor must be able to do this occasionally without breaking down.

Direct-current Hoist Motor Control.—In the choice of control for hoist motors, the principal factors to be considered are whether to use manual or magnetic, straight reversible or dynamic braking, and the capacity and ohmic values of the rheostat.

The choice of manual or magnetic control depends primarily on the size of the motors and the severity of the service, although in many cases, magnetic control is used to prevent careless operators from abusing the equipment where, with a reasonably careful operator, manual control would be satisfactory. Reliability and reduced maintenance charges result from the use of magnetic control while the operator's work is lighter on account of the small weight and easy operation of the master controllers.

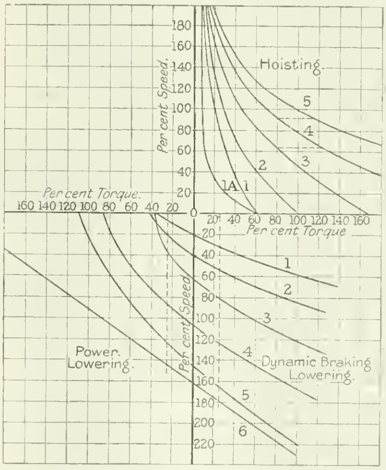

FIG. 2.—SPEED-TORQUE CURVES OF A D.C. SERIES MOTOR OPERATED BY A DYNAMIC BRAKING CONTROLLER.

(Curve 1A shows effect of connecting resistance in parallel as well as in series with the motor.)

A knowledge of the speed-torque curves of the motor when controlled by a straight reversible controller and by a dynamic braking controller is valuable in deciding which type to use.

The curves (Figs. 1 and 2) show the torque and corresponding speeds of a series motor when connected directly to the line and also when connected to the line through a controller with definite values of resistance in series. The dynamic braking curves (lower curves of Fig. 2), and curves 1A of Figs. 1 and 2 show the speed-torque relations with definite values of resistance both in series and in parallel with the motor.

It will be seen that, in the hoisting direction, both controllers give the same characteristics. The principal features to be obtained when hoisting are: (*a*) low torque on the first point; (*b*) slow speeds with light loads, and (*c*) current peaks which the motor will safely stand. The controllers shown on the curves give from 60 to 70 per cent. torque on the first point at standstill, and the horizontal dotted lines show the peaks obtained when accelerating a load requiring 80 per cent. torque.

In lowering with the straight reversible controller the same speed-torque curves are used as in hoisting, the speed and torque, of course, being reversed as the motor is working against the friction of the mechanical load brake. This friction is, at best, far from constant, and hence it is difficult to obtain definite slow speeds in the lowering direction.

With the dynamic braking controller the speed of lowering depends on the weight of the load and the electrical resistance, in the dynamic braking circuit. The load, in any one case, being constant, the speed can be controlled to a nicety by varying the resistance in the braking circuit. In the controller shown in the curves (Fig. 2) the circuits are so arranged that both power and braking are obtained on each lowering curve depending on which the load demands. For instance, on point 1 lowering, 35 per cent. torque tending to lower the hook is applied at standstill. Should the controller be left on this point and the load be heavy enough to overhaul the motor, it would accelerate on curve 1, until the power torque passes through zero and changes to dynamic braking torque. Acceleration continues until the braking torque equals that due to the pull of the load at which time acceleration ceases and the load travels down at the speed reached. For instance, if a load exerting a pull equivalent to 25 per cent. braking torque is being lowered, the speed will become constant at 31 per cent. on the first point, at 53 per cent. on the second point, and will reach a speed of 179 per cent. on the last point. If a light hook is being lowered it will not overhaul the motor and power torque, probably 25 per cent. will be required to lower it against the friction of the crane. The vertical dotted line through 25 per cent. power torque shows the speeds obtained on each point. From this it can be seen that for every torque value there is a fixed positive speed on each curve. With proper operation the solenoid brake is called upon to stop the load only from the speeds obtained on curve No. 1, thus making its duty light.

An additional refinement of control in the hoisting direction can be obtained by shunting the motor with a rheostat on the first point of either straight reversible or dynamic braking control. This changes the speed torque curve from No. 1 to No. 1A (*see* Figs. 1 and 2), which gives slower and more stable speeds than curve No. 1.

With straight reversible control a mechanical load brake and a one-half torque solenoid-operated brake are necessary for lowering, while with dynamic braking the mechanical load brake is omitted and a solenoid brake capable of retarding twice the actual full-load lowering torque is required.

An additional increase in the reliability of dynamic braking control can be obtained by using a double trolley in the dynamic braking circuit, and also by using two solenoid brakes, one on the motor shaft and one on the back shaft, each capable of holding from 1·25 to 1·5 times the actual full-load lowering torque.

On very important cranes such as hot metal cranes, a fly-ball governor can be added which will set the brakes if the speed becomes dangerous.

For convenience it has been found expedient to divide rheostats into two classes as regards heat dissipating capacity. One may be called a *standard duty rheostat*; the other a *heavy duty rheostat*, the latter being of twice the capacity of the former.

Summarising the above, we have the following types of control from which to select:—(*a*) Manual; (*b*) magnetic; (*c*) straight reversible with one mechanical load brake and one solenoid brake; (*d*) dynamic braking with one solenoid brake; (*e*) dynamic braking with two solenoid brakes; (*f*) dynamic braking with two solenoid brakes and fly-ball speed limit; (*g*) standard duty rheostats; (*h*) heavy duty rheostats; (*i*) creeping speed resistance in parallel with motor; and (*k*) no creeping speed resistance.

Table II shows the control which the writers believe is best adapted to the various classes of cranes given in the first part of this article.

Direct-current Bridge and Trolley Control.—As neither dynamic braking or solenoid brakes are used to any extent on the bridge and trolley motions, the control narrows down to straight reversible, either manual or magnetic. Refined speed control is not usually required, but as plugging is used for stopping the trolley and often the bridge as well, the rheostat must have sufficient resistance to limit the plugging torque to a safe value. An inspection of the curve Fig. 1, which is applicable to motors up to about 25 H.P. shows that if, when running at 100 per cent. speed on curve 5, the controller be plugged to curve 1, the torque will be about 184 per cent., tending to stop the motor. For larger motors the torque on the first point at standstill should be about 50 per cent.

For manual control on bridge and trolley motions, the current peaks which the motor will stand determine the minimum number of control points. The first point should provide a high resistance for plugging and is not considered an accelerating point.

For magnetic control, the number of automatic accelerating points is also determined by the current peaks which the motor will stand while the number of hand-controlled steps which should be used depend on—first, the condition of the track, whether wet, dry, dirty or oily; second, windage, on outside cranes; third, the delicacy of control required for the work; fourth, external loads to be dragged around, such as cars, &c.; fifth, variable grade on track and tight places; sixth, final free running speed.

It is difficult to make hard and fast recommendations for all of the above conditions, but as a kind of guide it can be stated that one step hand-control should not be used except where all of the above conditions are most favourable and where the final free running speed is not over 75 ft. per minute. Two steps of hand-control will cover the same conditions as one step of hand-control, except that a free running speed as high as 300 ft. per minute could be used.

Where all of the conditions are severe, it becomes necessary to use three or more hand-controlled steps; first hand-controlled step to give a light torque for moving the crane when unloaded; second hand-controlled step to give more torque, just barely sufficient to start the crane with the heaviest suspended load; third step of hand-control to give a torque just inside the slipping point of the wheels on a wet track; fourth step of hand control to give a torque just inside of that required to slip the wheels with a good dry track; fifth step of hand-control to accelerate it to full speed.

Unless the first point contains sufficient resistance to limit the current to a safe value when plugging from full speed, an additional point must be added to obtain this resistance. A foot brake is often used on the bridge motion and this removes to some extent the necessity for a plugging point. The capacity of the rheostats for bridge and trolley motors should be the same as that of the hoist motor.

Alternating-current Hoist Motor Control.—The ordinary practice at the present time is to use either a manual or a magnetic controller, a mechanical load brake and a solenoid brake, which is set to retard with 50 per cent. of the rated motor torque. Manual controllers are generally used for horse-powers up to 100 unless the service is so severe as to cause undue expense for maintenance, in which case it is advisable to use magnetic control above 50 H.P.

In order to obtain refined speed control with alternating current crane motors, it is necessary to work the motor not above 35 or 40 per cent. of its maximum breakdown torque. It is necessary to have a sufficient number of controller steps, so that the change in speed or torque from one step to another will not be too violent. It is necessary to have good smooth running gears on the crane, a smooth operating, reliable mechanical load brake, and a smooth setting, quick-operating solenoid brake. It is also necessary to provide sufficiently low torque on the first step of the controller, so as not to jerk a light load too violently.

Fig. 3 shows the speed-torque curves of an eight-point controller, which gives 50 per cent. starting torque. Fig. 4 shows similar curves for a 12 point controller, giving 25 per cent. starting torque. A careful examination of these curves will show that the controller in Fig. 4 will give far smoother results than that in Fig. 3, and for certain classes of duty the characteristics shown in Fig. 4 are necessary. It is possible to get as delicate control from that shown in Fig. 4 with a crane geared for 10 ft. per minute, as it is from Fig. 3 with a crane geared for 20 ft. per minute, and it is possible to handle a much lighter load by that shown in Fig. 4 than by Fig. 3 without undue shock at starting. Fig. 5 shows an eight-point controller which is used in connection with sufficient permanent external rotor resistance to give not over 85 per cent. full speed on full load torque. This controller is also laid out to give 25 per cent. torque at standstill. Fig. 5 will give about as refined speed control on a crane geared for 30 ft. per minute as will Fig. 4 on a crane geared for 10 ft. per minute.

If an induction motor is thrown directly on the line with its slip-rings short circuited by the controller it will exert only about 50

Table II.

Class of crane.	Hook speed in F.P.M.	Horse-power of motor.	Control to consist of
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] 150	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] or (*k*).
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

* [illegible]

[illegible]

[illegible]

to 75 per cent. of its maximum starting torque and will take about six times its full-load current from the line. Such a speed-torque curve is 8 of Fig. 3. If the proper resistance is in the rotor circuit when the motor is connected to the line, maximum starting torque will be exerted as in curve 8 of Fig. 5, and only about three times full-load current will be taken from the line. It is all right to turn the controller of Fig. 3 to step or curve 8 after the motor has attained 60 per cent. speed or more, but until that speed is reached the motor is working disadvantageously if on this curve.

The above explains the advantage of having a permanent rheostat in the rotor circuit so that the motor will always start efficiently no matter how quickly the controller is turned on. A careless, ignorant or hurried operator is quite liable to damage a motor and controller like that of Fig. 3 by operating it too rapidly. A careful operator, of course, need not damage the motor even when the permanent rheostat is not used.

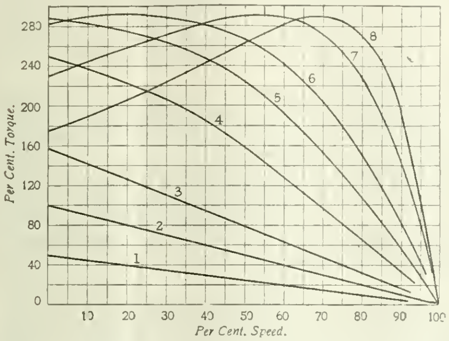

FIG. 3.—SPEED-TORQUE CURVES OF A WOUND-ROTOR INDUCTION MOTOR OPERATED BY AN 8-POINT CONTROLLER; 50 PER CENT. STARTING TORQUE ON FIRST POINT.

A further advantage of this expedient will be seen by examining Fig. 5, which, as above pointed out, enables an eight-point controller to compare more favourably, as to refinement of control, with the 12-point controller in Fig. 3 than would be the case if this permanent resistance were not used.

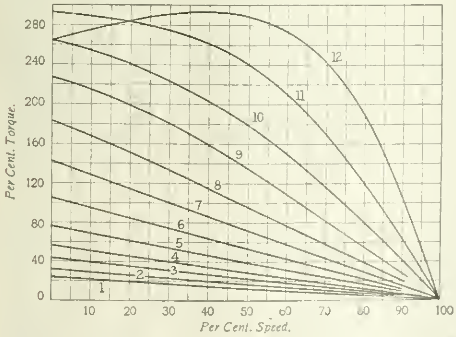

FIG. 4.—SPEED-TORQUE CURVES OF A WOUND-ROTOR INDUCTION MOTOR OPERATED BY A 12-POINT CONTROLLER; 25 PER CENT. STARTING TORQUE ON FIRST POINT.

A direct comparison between Fig. 3 and Fig. 6 will show two eight-point controllers, each of which gives 50 per cent. torque at starting. In Fig. 6 a permanent resistance is used, and it is never possible to get more than 85 per cent. of full-speed when full torque is being exerted, whereas in Fig. 3, 95 per cent. of full-speed could be obtained. However, there is practically no difference in speed when a 20 per cent. load is being hoisted. The speed control of Fig. 6 is somewhat more refined than Fig. 3, and the danger of too quick a start is entirely removed. The efficiency of starting by Fig. 6 is greater than the efficiency by Fig. 3 if the operator is prone to turn on power too rapidly. Therefore, if the controller is to be used principally for starting as in the case of trolley and bridge motion, and if the load is fairly light after the motor is up to speed, Fig. 6 is really more efficient than Fig. 3. On the other hand, if starting is a small part of the work of the motor and if heavy loads are to be hoisted more frequently than light loads, Fig. 3 will be more efficient than Fig. 6.

Cranes of classes 4 and 5 are very similar to classes 3 and 2 respectively.

Alternating-current Trolley and Bridge Motion Control.—Many of the problems in bridge and trolley motion control are similar to those in hoist motion control. However, as a rule the requirements for refined speed control are not stringent—50 per cent. torque on the first point of the controller is usually sufficiently low. An eight-point controller up to 30-H.P. and 11-point controller above 30-H.P. give sufficient refinement. It is on the trolley and bridge motion more than anywhere else that the most advantages and the least disadvantages of using a permanent rotor resistance appear. Rheostats, as a rule, should be as heavy on trolley and bridge service as they are on hoist service.

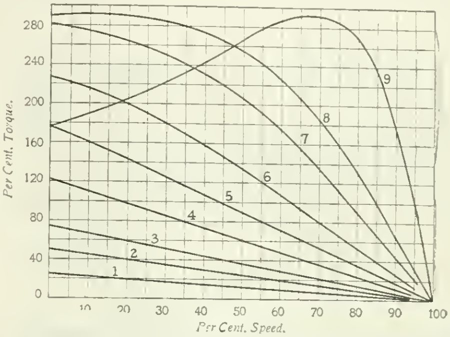

FIG. 5.—SPEED-TORQUE CURVES OF A WOUND-ROTOR INDUCTION MOTOR OPERATED BY AN 8-POINT CONTROLLER; 25 PER CENT. STARTING TORQUE ON FIRST POINT; PERMANENT EXTERNAL ROTOR RESISTANCE.

The trolley motion is stopped by means of plugging the motor, and the bridge motion is usually stopped by means of a foot brake or by plugging the motor. No solenoid brakes are required on this service unless they are used in connection with limit switches to stop the motion of the crane at each end of travel, or to stop the motion of the crane when power fails. The retarding torque of such solenoid brakes should be somewhere between 25 and 50 per cent. of the rated motor torque. If the solenoid brake exerts too powerful a torque, the shock of stopping by means of it will be objectionable.

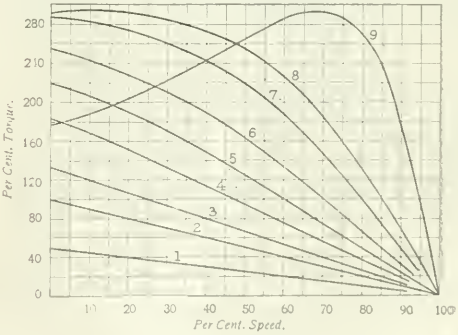

FIG. 6.—SPEED-TORQUE CURVES OF A WOUND-ROTOR INDUCTION MOTOR OPERATED BY AN 8-POINT CONTROLLER; 50 PER CENT. STARTING TORQUE ON FIRST POINT; PERMANENT EXTERNAL ROTOR RESISTANCE.

Protective Features.—Regardless of whether magnetic or drum control is used, the protective equipment should be concentrated in the operator's cab, and a double pole emergency switch for opening the main line circuit breaker should be mounted in a prominent place directly in front of the operator and within easy reach.

Complete overload protection should be afforded even though one line becomes accidentally grounded, and to accomplish this there must be a circuit-breaker contactor and an overload relay in each side of the incoming power supply.

No-voltage protection should be afforded which means that the circuit-breaker contactors should drop out on failure of power, but must not close on return of power until a button is pushed by the operator.

Fig. 7 shows a protective panel wiring diagram for a five-motor direct-current crane and Fig. 8 shows similar connections for an alternating-current crane. The line switch disconnects all electrical equipment on the crane from the source of power. It should be provided with a "lock-out clip," enabling it to be locked open with

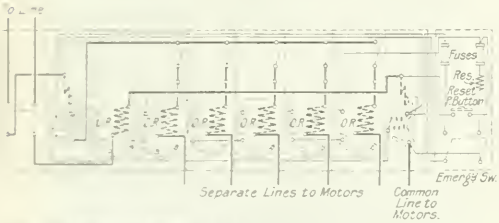

Fig. 7.—Wiring Diagram of a Complete D.C. Protective Panel for a Five-motor Crane.

several padlocks at one time. In this way several workmen can be assured of protection while making repairs. Two single-pole line contactor circuit breakers insure both sides of the line being open, as their operating coils are connected in multiple, and are then connected in series with all the overload relays. A common overload relay is placed in one side of the line while each motor has its own individual overload relay in the other side of the line. This arrangement gives full protection regardless of grounded circuits with a minimum number of relays. The relays are reset by gravity after an overload occurs. Their contacts are all connected in series and are wired to the operating coils of the circuit-breaker contactors. This control circuit is wired to the line side of one circuit-breaker contactor and to the motor side of the other contactor, hence when the contactors

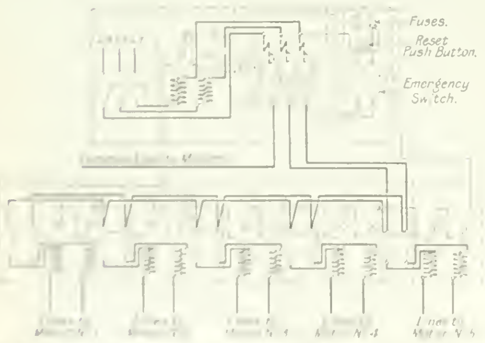

Fig. 8.—Wiring Diagram of a Complete A.C. Protective Panel for a Five-motor Crane.

[illegible] after the other [illegible] A reset push button [illegible] be pushed by the [illegible] of voltage. [illegible] can be [illegible] on the crane [illegible] facilitate the [illegible]

[illegible]

THE PROTECTION OF ELECTRICAL INSTALLATIONS AGAINST SURGES.*

I. Nature of Surges in Industrial Electrical Installations.

1. It is necessary to distinguish between veritable *surges* and *dangerous rises of voltage*.

2. Under the latter heading must be classed increases of voltage of relatively long duration.

3. *Dangerous rises of voltage* are generally caused by reciprocal actions between different parts of an installation when it is not in its normal condition, *e.g.*, unipolar connection or earth connection (*see* § 4). In such cases oscillatory circuits are formed that may be in resonance with harmonics of the fundamental frequency as low as the third and fifth and the oscillations will continue until the normal circuits are established.

4. Oscillations of far greater frequency may be occasioned by accidental earths (arcing grounds) and experience shows that the consequences of such accidents are more serious with underground cables than with aerial conductors

5. Oscillations arise on the opening and closing of circuits and particularly in circuits containing inductance or localised capacity, or a combination of both. These oscillations are generally of short duration owing to the presence of large damping, but nevertheless may damage parts of the installation on such occasions as the switching on of static transformers or the stators of asynchronous motors.

6. Such oscillations of very high frequency are also possible with the circuits in their normal running condition when they are affected by high-frequency atmospheric discharges or shock excitation, *e.g.*, by surges with steep wave-fronts, if protective condensers are used in combination with unshunted inductances. It is probable that the breakdown of the insulation of large high-tension transformers may be due to causes of this nature.

7. The condition classed as a veritable *surge* is of a transitory nature and the rise of voltage produced is of a very short duration, in the case of alternating-current circuits only a small fraction of a period of the supply frequency.

8. These surges are generated by sudden disturbances of the equilibrium of the circuit and may be (*a*) of internal origin caused by switching operations, short-circuits, earths or sudden changes of load, or (*b*) of external origin caused particularly by transitory atmospheric phenomena.

9. Analysis shows that this kind of surge has a time and a space variation and the space distribution at any given instant is known as the *form of the surge*.

10. The necessity of representing the propagation of this type of surge in a simple mathematical manner leads to the conception of travelling waves and of wave reflection, and the phenomena specified in § 8 may be interpreted as follows:—

(*a*) Surges of internal origin arise from sudden increase or decrease of the electromagnetic field of the circuits. They are accompanied by the simultaneous appearance of a charging wave and a discharging wave starting from the point where the disturbance was produced and travelling in opposite directions along the line according to the laws of free oscillations. These waves have a very steep wave front, *i.e.*, very large P.D. may exist between points on the line that are close to each other. The magnitude of the rise of voltage depends on the line voltage and cannot exceed twice the line voltage unless resonance phenomena occur.

(*b*) Surges of external origin arise from time- and space-variations in the P.D. existing in the terrestrial electric field. The charging waves have the character of travelling waves as described above, and are superposed upon the electric state of the supply system, travelling according to the laws of the free oscillation of the system composed of the supply system and earth. The magnitude of the rise in voltage produced and the energy of the wave motion depend solely on the character of the electric field and the position of the supply system in that field, and are independent of the supply voltage, and the rise of voltage may reach several times the value of the supply voltage.

Periodic variations in the P.D. existing in the earth's field will cause periodic charges and discharges of the supply system and high-frequency oscillations may result.

11. It is also possible that meteorological phenomena may induce static charges in aerial lines which may be dissipated slowly without oscillations. Although not partaking of the nature of a surge such

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* Abstract of a Report of a Committee appointed by the Schweizer. Elektrotechn. Verein und Verband Schweizer. Electrizitatswerke. The Report appears in the Bulletin (No. 6 of 1916) of the Schweizer Elektrotechn. Verein.

charges may, if the insulation of the line is good, produce differences of potential between the line and earth greater than the values under normal running conditions. By superposition of these P.D. on the normal state dangerous rises of voltage may ensue.

12. We will designate as *primary voltage rises* the dangerous voltages that arise directly from the disturbance of the original state of equilibrium of the energy in a line (*see* §§ 4, 5 and 8). These voltage rises may cause the appearance of *secondary voltage rises*, the amplitude of which is greater than that of the primary rise through reflection or the excitation of local oscillating circuits.

13. The actual voltage rises produced are often the result of a chain of disturbances originating in a primary voltage rise that may not have been noticed directly.

II. Protection Against Surges by the Design of the Installation and by the Use of Special Protective Devices.

14. The best practical protection against surges consists in taking the steps necessary to hinder the production of initial disturbances, and the installation of protective devices is only justifiable where this means has been found to fail.

15. Dangerous rises of voltage (§ 3) may be prevented if it is ensured that oscillating circuits (§§ 3, 4, 5 and 6) cannot be formed in any state of the supply circuit. This condition cannot be fulfilled for all parts of a heavy current system.

16. Oscillating circuits may be rendered harmless by the insertion of damping resistances. For example, by earthing the neutral point through a resistance in the case of § 4, or by introducing resistances in circuit with the switches in the case of § 5.

17. The magnitude of the surges produced by switching operations depends on the quantity of energy liberated thereby. The devices employed for the protection of switchgear (reduction of short-circuit power by reactances, resistances, relays or by affecting the exciting current of alterantors) may be considered to be at the same time protective devices against the production of surges.

18. When all measures have been taken (§§ 15, 16 and 17) to prevent disturbances of internal origin from arising there is still the possibility of the line being subjected to external disturbances, mainly of atmospheric origin. The primary surges due to such causes usually arise in and are propagated by overhead lines.

19. It is impossible to prevent such disturbances absolutely, but they may be modified by protective measures, such as the planting of trees.

20. There is no means of preventing the destructive effects to lines actually struck by lightning. It is advisable to install lightning conductors on the supports of lines particularly exposed to lightning, but this measure does not provide a certain protection to the intermediate sections of the line.

21. The dissipation of dangerous static charges (§ 11) may be effected by conducting them to earth through resistances or reactances with iron cores.

22. The effects of sudden variations in the earth's electric field (§ 10*b*) may be reduced by suspending an earthed wire above the transmission line. Theory shows that such a wire affords some protection in all cases and that it is practicable to reduce the voltages to which the line would be subjected in the absence of the earthed wire by 30 per cent. to 50 per cent. The screening effect of the earthed wire is qualified by the fact that the induced voltages in the line increase with the height of the poles supporting the overhead wires.

23. Surges travelling along a line do not necessarily constitute a danger to the line itself if the insulators are so designed as to permit discharges of the line without being punctured. Such discharges at the insulators diminish the oscillatory energy of the travelling wave and protect the plant connected to the line to a certain extent.

24. The essential problem is, therefore, to prevent surges from leaving aerial lines and reaching the apparatus or machines fed by them. This may be carried out by placing at the ends of the lines apparatus capable of reflecting the surges back on to the line or of dissipating the surge-energy by transforming it into heat (§ 28), by radiation or by discharges at the insulators.

25. Surges whether produced by internal causes (switching operations) or by external causes (atmospheric effects on aerial lines connected to the system) are more liable to be destructive to underground cables than to aerial lines connected thereto. Protection may be afforded by means of apparatus capable of absorbing as far as possible the energy called into play by a disturbance (§ 28).

26. The strain on the insulation of the system caused by surges depends on (*a*) the absolute magnitude of the surges, (*b*) the value of the P.D. at the point under consideration (steepness of wave-front), (*c*) the duration and frequency of the strains.

27. The absolute value of a surge travelling along a line is reduced when the wave passes from a conductor of a given "characteristic" (surge resistance) to a conductor of smaller "characteristic," *e.g.*, from an aerial line to a cable.*

28. The destructive power of a surge may be considered to be eliminated when its whole energy has been transformed into heat; the danger to any piece of apparatus fed by a line is therefore reduced according as the portion of the surge-energy transformed into heat in the line is increased. (Advantage of networks of cables and iron conductors feeding banks of transformers.)

29. The principle of reflecting surges away from plant at the end of aerial lines (§ 24) does not entirely harmonise with the principle of providing for the absorption of energy in protective devices (§ 25).

30. All devices with a valve action, such as spark-gaps, horn lightning-conductors, or Giles valves are suitable as a protection against surges that are dangerous on account of their amplitude.† These devices are provided with damping resistances for a two-fold object; firstly, to produce a damping effect by transforming the surge-energy into heat without reflection and, secondly, to limit the magnitude of the current in the arc so as to prevent the affected circuit from being automatically cut off. The use of this type of apparatus is limited in modern installations by the following considerations:—

(*a*) In high-tension systems (above 12,000 volts) the limitation of the arc current necessitates resistances of such a value that only a small portion of the surge-energy can be transformed into heat in them. If a reactive coil is used the greater part of this energy is reflected into the line.

(*b*) Spark-gaps, particularly if they are used in combination with reactances, may give rise to secondary surges. But as these conditions are not frequent in practice, the use of this class of apparatus is not greatly limited by this fact.

(*c*) Surges with steep wave-fronts do not suffer any flattening-out of their front if spark-gaps are used (unless damping resistances are present). On the other hand, choking coils placed in the leads to plant, that is to be protected, have a flattening effect on the wave-front (§ 31).

31. The insertion of a concentrated inductance between the aerial line and the apparatus to be protected or the connection of a condenser in parallel with the line at the same point has the effect of diverting surges from the apparatus to be protected and to flatten out their wave-front without the formation of a spark-discharge. If suitably designed these devices produce a less harmful form of wave. Combinations of choking-coils and condensers act in this manner, but more effectively. This mode of protection is independent of the supply voltage; it depends only on the character of the plant to be protected and of the protective devices themselves. The following circumstances tend to limit the effectiveness of such combinations of choking-coils and condensers:—

(*a*) An appreciable reduction of the value of the rise of voltage is only obtainable with this class of apparatus if the distance over which the surge is distributed does not exceed a definite value that depends on the constants of the apparatus to be protected and of the protective devices themselves.

(*b*) Choking-coils and condensers constitute points of reflection; their protective effect concerns only the transmitted wave and not the reflected wave, which is thrown back with increased voltage by the choking coils. After the statements in §§ 23 and 24 it will be seen that this circumstance is not of great importance in respect of waves reflected back on to aerial lines.

(*c*) Choking-coils and condensers absorb the energy of the surge only momentarily without any appreciable transformation into heat; there is no actual dissipation of the surge-energy.

(*d*) Combinations of choking-coils and condensers may constitute local oscillating circuits when acted on by periodic waves, and thus give rise to large resonance voltages. It is found that this is of rare occurrence, and so the use of this combination is hardly limited by this fact.

32. The drawbacks referred to under § 31 (*a*)-(*d*) may be avoided by shunting the choking coils with resistances and by inserting resistances in series with the condensers (Campos system).

33. The flattening out of steep wave-fronts and the protective effect indicated in § 31 may be assisted to any extent by connecting several choking-coils in series at not too small intervals.

34. Waves that have been rendered harmless by some protective device may again assume a dangerous character after reaching the apparatus to be protected if they are reflected by inductances, such as current-transformers, magnet-coils of circuit breakers, &c.,

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* The "characteristic" of a conductor is the expression $\sqrt{L/C}$, where L and C denote its inductance and capacity to earth per unit length.

† The resistances referred to under §21—*e.g.*, water jets—could also afford a protection in this case if their magnitude were chosen with this end in view. Their dimensions are, however, determined by other considerations (§ 11).

forming an integral part of such apparatus. The shunting of these inductances by spark-gaps or by resistances weakens such reflections to the extent of rendering them harmless.

35. The secondary surges produced by primary disturbances may be completely avoided if the free energy is entirely dissipated in the protective devices. This is of importance in the case of systems of cables (see §§ 25 and 28).

III. Practical Advice Concerning the Protection of Electric Installations against Surges.

36. The protection of electric installations should be carried out according to the principles laid down in Chapters I. and II., and on the four following lines:—

(a) Preventive measures with the object of eliminating as far as possible the disturbances and primary accidents that can occur.

(b) Arrangement of the protective devices so as to give the surges a form as harmless as possible.

(c) Measures with the object of prevehting the formation of surges as a result of primary disturbances or accidents.

(d) Arrangement of particularly exposed parts of the line so that they may be able to offer an effective resistance to the increased strains to which they are likely to be subjected by surges.

37. The insulators of aerial lines should be constructed so that their resistance to puncture is greater than their resistance to surface discharge with the insulators in a dry and clean condition. The discharge voltage when the surface of the insulators is damp should be at least twice the voltage that can exist between the earth and the lines when one of these is connected to earth. The strains to which the insulators may be exposed by repeated surface discharges can be moderated by the use of metallic protecting rings to conduct away the arc discharges.

38. The discharge voltage of the insulators of indoor lines should be greater than that of the dry and clean insulators of neighbouring outdoor lines (§§ 23 and 24).

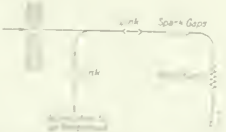

Fig. 1.—Use of Spark-gaps with Damping Resistance for Voltages up to about 5-10,000.

39. [illegible] guard wires may be suspended above aerial lines [illegible] magnitude of surges of atmospheric [illegible] (§ 12). Their effect becomes lessened as the height of the line [illegible], and with great heights of suspension [illegible] at a great distance from one another two [illegible] side by side. The limited effect [illegible] renders its use undesirable in installations [illegible] than 10 or 12 metres above the ground, [illegible] are frequent. The guard wires [illegible] steel of 35 to 50 sq. mm section; [illegible] wires may be used as guard wires. [illegible] earthed at every third or fourth [illegible] should be of copper of at least [illegible] at least 100 sq. mm section. Earth [illegible] unless the earth conditions permit [illegible], the earth plates should [illegible] of several bars of iron or gas- [illegible]

40. [illegible] protection to aerial [illegible] but they are useless when the [illegible] earthed and reach above [illegible] to be recommended when the [illegible] metal protective [illegible] of the line and [illegible] than the line to be protected [illegible]

41. [illegible] is advisable to [illegible] leakage of [illegible] been obtained [illegible]

[illegible] above 10,000 [illegible] and possess [illegible] They are cheaper [illegible]

As the conductivity of water is very variable, the construction of the water-jet must permit an easy regulation of the section of the liquid column and ensure the stability of its form. The design in the form of a freely falling jet leads to a small water consumption, but has the disadvantage that under the influence of the strong electric fields associated with high-tension systems the jet has a tendency to break up and start arcs; for this reason this type is not suitable for circuits of more than 10 to 15,000 volts. For higher voltages it is preferable to use jets of water under pressure, either ascending freely or constrained in insulating tubes. The latter construction has the inconvenience of the liability of the formation of deposits in the tubes. In countries exposed to severe storms it is desirable to be able to decrease the resistance of the jets momentarily by increasing the flow of water.

(b) Iron-cored choking-coils may be employed on circuits of the highest voltages; they enable static charges to leak away rapidly, and do not require particular attention. These coils must be of the single-phase type, and must not be constructed as polyphase coils with common magnetic circuits. They should be connected to the line between the protective devices and the apparatus to be protected. The coils should be connected to high-tension lines through damping resistances to prevent the formation of oscillations.

(c) No rules can be given for the determination of the number of static dischargers required in any given case, but long lines should be earthed by this class of apparatus at least at both ends.

42. For the protection of machines and apparatus connected to aerial lines it is necessary to install devices to transform or break the line-surges before they reach the apparatus. Among apparatus of this kind we may mention choking-coils, if necessary shunted by resistance, and instruments of the valve type, such as spark-gaps with or without horn-dischargers, multiple gaps and condensers (§§ 30 and 31).

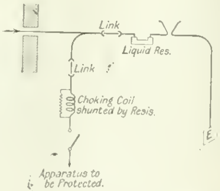

Fig. 2. Use of Horn-dischargers with Damping Resistance and Choking Coil for Voltages up to about 15,000 volts.

(a) With multiple gaps between cylinders the damping resistance should not be greater than is required for the necessary limitation of the current through the apparatus when it acts. The damping resistances may be made of *silite*, carborundum, &c. At any rate resistance material should be used that does not vary and that is found after prolonged tests not to alter under the influence of heat. In aerial lines of small extent and low voltage (below 5,000 volts), for which apparatus of this type is suitable, dangerous travelling waves are not generally to be feared, and on this account choking-coils need not be used.

(b) Horn dischargers with damping resistances and choking-coils can be used on direct-current and alternating-current systems for voltages up to 15,000 volts. With higher voltages experience shows that they are not to be recommended, as the limitation of current through the apparatus would require such large damping resistances that insufficient protection would be given, particularly in very extensive aerial systems (§ 30). The length of the gap between the horns of the discharger should be set by experiment on the supply to which it is to be connected, as this length depends among other things on the wave shape of the voltage. The discharger should be mounted under cover and well protected, as it is found that if exposed to the open air, the greater length of gap required renders the action of the discharger illusory. The energy of the surge is almost completely dissipated in damping resistances of a resistance equal to the surge-resistance of the transmission lines, or of about 500 to 700 ohms for each aerial wire. This value should be approached as nearly as the limitation of the current permits. Greater values of the resistance may be taken if the aerial wires are protected at their entry to the stations by choking coils shunted by resistances (§§ 30 (c) and 32; see Fig. 2). Contrary to general practice, the damping resistances should be placed between the line and the horn discharger, so that the resistances may perform their function if the arc strikes neighbouring metal parts.

This arrangement necessitates the use of well designed damping resistances constructed of homogeneous material of good heat [illegible] properties. Metal resistances are the best in this respect.

Liquid resistances in troughs and in other constructions in which the current causes evaporation should be fitted with a mixture of water, glycerine and gravel, and the electrodes should have the greatest possible surface.

(*c*) According to calculation the best protection is afforded for all voltages by combinations of condensers and choking-coils. These should be installed, where their high price permits, on all extensive systems in which particularly dangerous surges are to be expected and for high voltages above about 10,000 volts. The arrangement recommended is shown in Fig. 3. The dimensions should be chosen according to the principles of §§ 24 and 25, and the choking-coils should be shunted by suitable resistances (§ 32). The choking-coils should have such a size as to give the required flattening out of the wave-fronts of the surges to which the apparatus to be protected is subjected after the surges have passed the coils. A calculation has been made by considering the maximum potential gradient of the front of a wave of infinite length passing through the coil, on the supposition that the wave-front is rectangular before reaching the coil. It has been assumed that the potential gradient in the line shall not exceed 500 to 750 volts per meter, and that the discharge-voltage of the insulators, which limits the value of the surges that can occur on the line, is not greater than three to four times the supply voltage to earth. The result of this calculation gives the following figures for the values and dimensions of suitable choking coils.

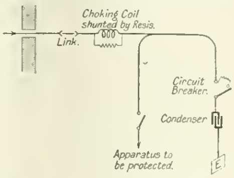

FIG. 3.—USE OF CONDENSERS WITH CHOKING COILS.

Cylindrical coils of the larger sizes in this table are very bulky; they may be mounted in the open air or space may be saved by the use of flat coils. The shunting resistances should be of 600 to 1,000 ohms, and need be provided only for the coil nearest to the installation to be protected, if several coil units are used in series; *silite* or carborundum are suitable materials for their construction.

The condenser should have a capacity of at least 0·025 mf. per phase. The protection afforded increases with the capacity, which is, however, limited by the bulk and cost of the larger sizes. Condensers of capacities as high as 0·05 mf. are often used in practice. It is a difficult but important matter to design the condensers so that sufficient reliability against breakdown is assured. Their terminals and the insulation of the terminals must be very carefully designed. The condensers should be composed of cells connected in parallel and with separate safety devices. The circuit-breaking devices of each cell should give a clear indication when they have operated. The battery of condensers of each phase should be assembled as a unit properly earthed according to the rules covering this point, and mounted on wheels so as to be easily removed for repairs. The circuit-breakers connecting them to the high-tension line should have a resistance step connected to a resistance of a solid material such as *silite* or carborundum of a magnitude of 500 to 1,000 ohms. The earthing wires should be as short and straight as possible and, when made of copper, should have a section of not less than 50 sq. mm. Iron is not suitable for this purpose. If the condensers are mounted in an upper storey and the earth wires are long, the section of these wires should be suitably increased.

43. (*a*) The transmission lines, protective devices and apparatus to be protected should be installed so that the protective devices are in line with the incoming mains, and the apparatus to be protected should be connected in shunt circuits that do not lie in the same direction as the incoming mains.

(*b*) In systems of over 20,000 volts changes in the direction of the lines should be very gradual, and sharp bends should be avoided.

(*c*) In systems of over 40,000 volts all sharp edges, angles and points should be avoided in all parts of the plant that are subjected to the high voltage.

44. Transformer stations connected to aerial lines should be protected according to the principles of §§ 42 and 43. Particularly good protection is found to be afforded by combinations of condensers and choking-coils placed in the stations situated in parts of the system that are particularly liable to exposure to atmospheric disturbances. In cramped positions it may be impossible to set up condensers, and in these cases several choking-coils in series should be used. Their total inductance should be not less than 0·5 millihenry. Some of the coils may be mounted in the open air—for instance, on the mast that is nearest to the station—and the coil nearest to the transformers should be shunted (§ 33). Horn-dischargers may be installed in addition (*see* Fig. 2) if there is room to place them inside the station. If the conditions of service permit, it may be useful to construct branch lines to transformer stations of iron (§ 28).

45. Underground mains may be protected according to the principles set out in §§ 25 and 28.

(*a*) Multiple spark-gaps with damping resistances afford sufficient protection for lines below 5,000-10,000 volts (*see* § 42 (*a*)).

(*b*) Above 5,000-10,000 volts spark-gaps should be avoided, and combinations of condensers and shunted choking-coils used instead. The shunting resistances should be of such a size as to absorb as much of the surge energy as possible; they range from 50 to 100 ohms in modern underground systems (§ 28). The condensers and other apparatus should be installed, as shown in Fig. 3. Smaller values of capacity are required than with aerial lines. It is generally sufficient to shunt modern condensers of capacities from 0·025 mfd. to 0·05 mfd. across the lines at the point where they join the cables (*see also* § 43). Oscillations between the conductors and earth may be prevented by connecting the cores of cables to earth through high resistances of solid material, such as carborundum for moderate voltages and of liquid (not flowing) for high voltages.

46. As the protective devices that are available cannot ensure absolute protection against all the surge-phenomena that are possible, it is advisable to make use of the following preventive measures:

47. The breakdown voltage of the insulation of the most vital parts, such as machines, transformers and cables, should be considerably higher than the discharge voltage of the insulators inside the station, and the insulation should be as perfect as economic considerations permit.

48. All reactive coils, current-transformers and windings of circuit-breakers should be shunted (§§ 32 and 35). Shunting by resistances is preferable to shunting by spark-gaps, so as to avoid the formation of local oscillating circuits. The shunts to current-transformers must be of such a size as not to interfere with the accuracy of the instrument readings.

49. The windings of transformers may be shielded from penetration by travelling waves of secondary origin by connecting shunted choking-coils directly to their terminals. These coils should have an inductance of not less than half the values indicated in § 42 (*c*).

50. The extra insulation of the outside turns of the high tension windings of transformers should be continued into at least 5 per cent. of the windings. Extra insulation is not required in the case of transformers built for 10,000 volts. Extra insulation is no protection against resonance effects that result from the arrangement of the windings and arise, for example, by shock-excitation (§ 6).

No. of coils per phase × number of turns for diameters of 30 cm. and 20 cm.
(Distance between turns, 15 mm.)

Diameter of wire (mm.)		8		10		12		15	
Permissible current in amperes	Copper	200		300		400		550	
	Iron	70		100		150		200	
Supply voltage (volts).	Required inductance per phase (millihenry).	30 cm.	20 cm.	30 cm.	20 cm.	30 cm.	20 cm.	30 cm.	20 cm.
10,000	0·15	2 × 24	4 × 25	2 × 26	4 × 26	3 × 20	5 × 24	3 × 21	6 × 21
20,000	0·20	3 × 22	5 × 26	3 × 24	6 × 26	3 × 24	7 × 24	4 × 24	8 × 21
35,000	0·30	4 × 24	8 × 26	4 × 26	9 × 26	6 × 20	10 × 24	6 × 21	...
45,000	0·40	5 × 25	10 × 26	6 × 24	...	6 × 24	...	...	...
60,000	0·50	6 × 26	...	7 × 25	...	...	...	...	...
80,000	0·65	8 × 26	...	...	...	...	...	...	...
100,000	0·80	10 × 25	...	...	...	...	...	...	...

51. The anchoring of the windings to prevent damage from short-circuits is necessary for small and large transformers, and the strains set up will damage the windings if this anchoring is not sufficiently well carried out.

52. In order to prevent secondary travelling waves from entering their windings generators should be connected to the 'bus bars by conductors of small "characteristic," if possible by cables (§§ 27 and 28).

53. Leading-in insulators may be subjected to abnormal strains through reflections of surges or the action of steep wave-fronts. It is therefore necessary to construct them so that their breakdown voltage is greater than their discharge voltage. Care should be taken that vapours cannot be formed inside their leading-in tubes.

54. The earthing of the neutral point of high-tension systems through a resistance is desirable as a precaution against surges (§§ 4, 10 and 16). The magnitude of these earthing resistances should be fixed by trial in each particular case. Water-jets with adjustable flow constructed according to the principles of § 41 (*a*)) have been found satisfactory in Switzerland.

55. The machines and transformers connected to the system should have voltage waves as nearly as possible sinusoidal to exclude higher harmonics from the system. If these are unavoidably present they may be damped [illegible] by means of shunted choking-coils, the magnitude of which should be determined by trial, so as to avoid resonance effects.

56. Experience has shown that the majority of the surge phenomena that can be set up by switching operations may be avoided by [illegible] and grouping of switches and circuit breakers. The following points should be noted in this connection:—

(*a*) High-tension circuit breakers cannot be recommended without reserve except in the case of the protection of outgoing lines that do not possess considerable capacity between one another or to earth, [illegible] "variable" earth connection. Lines ending in distant [illegible] should [illegible] be protected by automatic circuit breakers.

(*b*) The [illegible] caused by the switching of large high-tension transformers, [illegible] and extensive underground [illegible] by the use of circuit breakers provided with [illegible] (§§ [illegible] 16 and 17). These [illegible] should be of the order of [illegible] 1,000 ohms to prevent [illegible] for much [illegible]

(*c*) The precautions that can be taken to reduce the quantity of energy set free by short-circuits (insertion of choking-coils, subdivision of 'bus bars) afford at the same time a considerable measure of protection against surges. The special appliances indicated in § 17 act in the same sense.

Fig. 4.

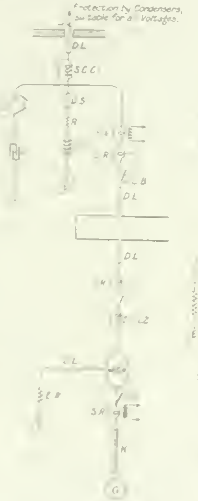

Fig. 5.

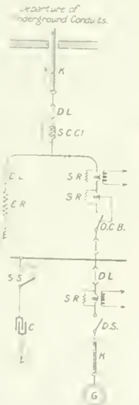

Fig. 6.

ARRANGEMENT OF PROTECTIVE DEVICES IN STATIONS.

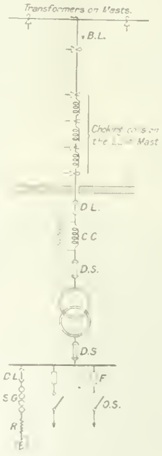

Fig. 7.

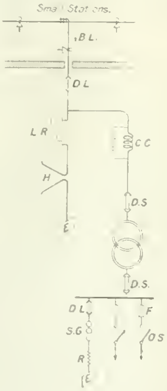

Fig. 8.

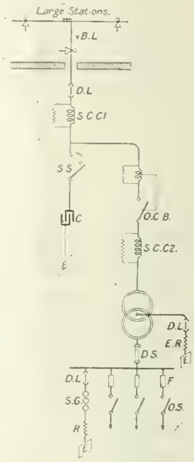

Fig. 9.

ARRANGEMENT OF PROTECTIVE DEVICES IN TRANSFORMER STATION.

[illegible] L.R. = L[illegible] resistance, [illegible] damping resistance for horn-discharger. C.C. = Choking coil shunted by resistance. [illegible] discharger. R. = Solid resistance to damp oscillations in the discharge circuit. D.S. = Dis[illegible] R [illegible] for the current transformers and high-tension switches to eliminate reflection of transmitted waves. E. = Earth. [illegible] D.L. = Disconnecting link. O.S. = Oil switch. O.C.B. = Automatic oil circuit-breaker with high-[illegible] waves surges with steep wave front). S.S. = Switch with resistance step to protect the condenser. [illegible] E.R. = Earthing resistance. S.C.C1. Shunted choking coil to divert surges due to switching or earthing. [illegible] wire.

THE TEMPERATURE COEFFICIENTS OF VOLTMETERS.

BY J. RENNIE.

In voltmeters, the changes in their indications due to temperature, depend very largely on the temperature changes in the resistance of the working coil, and in any additional resistance (the "added resistance").

Economy calls for limits to the current in the working coil, hence the added resistance. This usually consists of an alloy, having a small (compared with copper) temperature coefficient, and such high specific resistivity as is consistent with cost. The resistance in the circuit of the voltmeter is, therefore, a small part of it copper, and a relatively larger part of it of an alloy. The greater the resistance of the alloy portion in comparison with that of the copper the more nearly is obtained comparative immunity from errors in the voltmeter due to temperature changes.

To ascertain how this progress towards immunity might be obtained by changes in the ratio between the resistances of the copper and of the alloy, and by the use of alloys of different temperature coefficients, the following table has been calculated.

The column headed "Ratio" gives the ratio of the resistance of the copper part of the circuit to that of the alloy part at a common temperature. The columns headed "Alloy, $a = 20$ to $a = 250$," where the values for a, when multiplied by 10^{-6} are temperature coefficients per degree centigrade for alloys selected.

The ratios between "copper" and "alloy" are in chosen intervals between 1 to 1 and 1 to 100, the first figure being for "copper." The temperature coefficient for copper is taken as 0·00428 per degree centigrade. Various values for the alloy have been chosen, and the selection is probably sufficient to cover the alloys in practical use.

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* [illegible] Association [illegible] The Electrician [illegible] 1916.

Ratio.	Alloy.							
	a = 20.	30	40	50	100	150	200	250
1 : 1	2,150	2,155	2,160	2,165	2,190	2 215	2,240	2 265
1 : 2	1,440	1,447	1,453	1,460	1,493	1,527	1,560	1,593
1 : 3	1,085	1,092	1,100	1,108	1,145	1,182	1,220	1,257
1 : 4	872	880	888	896	936	976	1,016	1,056
1 : 5	730	738	746	755	796	838	880	922
1 : 6	629	637	645	654	697	740	783	826
1 : 7	552	561	570	579	622	666	710	754
1 : 8	493	502	511	520	564	609	653	698
1 : 9	446	455	464	473	518	563	608	653
1 : 10	407	416	425	434	480	525	571	616
1 : 15	286	296	305	314	361	408	455	502
1 : 18	244	254	263	273	320	367	415	462
1 : 19	233	242	252	261	309	356	404	451
1 : 29	162	172	181	191	239	288	336	384
1 : 39	126	136	146	156	205	253	302	351
1 : 49	105	115	125	135	184	233	282	331
1 : 59	91	101	111	120	169	219	268	317
1 : 69	81	91	101	110	159	209	258	308
1 : 99	63	72	82	92	142	191	241	290

The values found in the columns for any combination of ratio and alloy, when similarly multiplied by 10^{-6}, give the temperature coefficient per degree centigrade of the voltmeter circuit.

For the curves (Figs. 1 and 2) the ordinates are marked by figures representing the combined temperature coefficient. The abscissæ are marked by figures indicating the ratios; the figures being the number of times the resistance of the copper part is contained in the resistance of the alloy part of the circuit. As to the scale ordinates, these are temperature coefficients, and since this is the quality which determines the magnitude of the change produced upon the circuit by any change of temperature, it was thought desirable to indicate on the curves the number of degrees centigrade rise of temperature which would correspond to a particular height of ordinate. For example, if the circuit of a particular voltmeter were composed of copper, in a ratio of 1 to 10, with an alloy having a temperature coefficient of 150×10^{-6} per degree centigrade, such a voltmeter should be subject to a rise of about 19° C. before the indications were affected to the extent of 1 per cent.

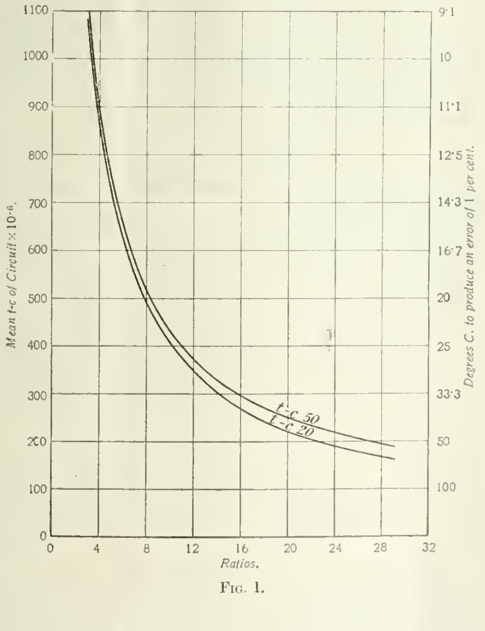

Fig. 1.

For convenience the curves are in two separate groups; Fig. 1 for the ratios 1 to 10 on a somewhat wider scale, and Fig. 2 for the ratios 1 to 100.

In the first group (Fig. 1) it was considered sufficient to draw curves for T.C. 20 and T.C. 50. In the second group (Fig. 2) the four curves are shown separately down to ratios of about 1 to 7; for ratios lower than 1 to 7 a mean curve is shown.

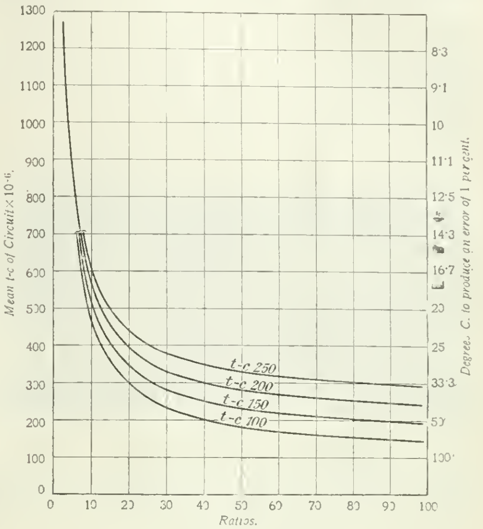

Fig. 2.

ENGINEERING AFTER THE WAR.*

BY FRANK BAILEY.

Your Council have requested me to continue in office as your President for still another year.

I had hoped that Sir Frederick Donaldson would have succeeded me as President of your Association, but as you know, we have to mourn his loss in one of the most tragic episodes of the war.

I propose to discuss the present position of the nation, and the steps that are being taken to enable this country not only to maintain its position but to improve it in the coming war of peace.

For the last 40 years the Germans have been continually improving their competitive energies and ability to secure foreign trade. This progress has been obtained by methods which deserve study; the whole energies of the British Empire must be concentrated on restoring our losses, maintaining our position, and recovering all lost trade and markets. The engineering facilities of this country are being organised, associations and committees are all doing their part, and the ultimate goal of a combined federation appears to be nearly accomplished. The call for munitions of war received a response which shows the value of co-operation and the ability of the nation to adapt itself to requirements. The rapid adaptation of tools and appliances, and the production of vast equipment of automatic and other machinery may have a beneficial influence on our future progress. Special tools have been made, at comparatively small cost, to secure rapid repetition of precision work, which compares favourably with that obtained from the most expensive automatic machines produced in this or any other country.

Highly Skilled Work.

The great question of labour in connection with the operation of such plant requires some consideration. In the case of automatic or semi-automatic plant, brains and skill are a part of the machine; the operator may watch this skill and admire it, but he cannot assume it. These machines, however, require an expert tool setter and other skilled workers to make and prepare the cutting tools.

The degree of skill acquired by the worker in any handicraft cannot depend solely on apprenticeship and training, but must have some connection with natural aptitude. The efforts of the inventor, the designer, and the mechanician have resulted in the production of machine tools, such as the profile miller, automatic machines for any ordinary practical operation, grinders of all kinds, and other labour-saving devices. These and similar machines have to a large extent limited the scope of skilled work in engineering establishments to the assembly or erecting shop, and the tool-room. Other factors have affected the responsibilities of the engineer-in-charge, for few works can now afford to generate their own power. The wise employer, however, should rejoice that the elimination of one source of expense and annoyance enables concentration of skilled effort to be devoted to the increase of economical production.

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* Abstract of a Presidential Address to the Association of Engineers-in-Charge, October, 1916.

Before leaving the question of skill as applied to labour, let us revive appreciation of the work of the old type of millwright, who, by aptitude, experience, skill, and caution, knew what to do and how to do it. Let us hope that this type of man is not extinct. No mention of labour can at the present time be complete without some reference to the magnificent response of the women of this country to the call for assistance. Their work in munition, explosive, and filling factories has shown great powers of adaptation to novel conditions by quickness of intelligence, deftness in manipulation, and a natural ability for using physical strength to the best advantage. Boys may be quicker in carrying out repetition work of dexterous manipulation, but they are less reliable, and possess less self-restraint.

The productive power of workshops is also influenced by improvements in mechanical design frequently due to the bold initiation of unfamiliar expedients in some new enterprise. The motor car, for instance, has furnished ideas for change speed gear, now annexed by many makers of lathes, and for driving other machinery. From the same source we frequently see strange forms of ball and socket joints, universal couplings, and oiling systems and pumps. The aeroplane and aircraft construction will doubtless also introduce innovations, which may be of benefit even to those who regard all new ideas as a heresy on acknowledged tradition.

TRADE OF THE WORLD.

The trade of the world as disclosed by returns of imports and exports may be summarised for general purposes as follows :—

Country.		Imports.	Exports.
United Kingdom	1913	£768,731,739	£634,820,326*
France	1912	318,034,240	265,454,160
Germany	1912–13	578,605,000	184,210,000*
Holland	1912	298,536,263	257,154,799
Belgium	1912	191,320,375	158,059,113
Russia	1912	123,881,411	160,558,518
Austria-Hungary	1912	146,093,312	118,199,993
Italy	1913	145,825,559	116,933,902
Portugal	1913	18,218,000	11,806,000
Spain	1911	42,580,000	38,691,000
Greece	1912	6,162,686	6,806,877
Norway	1913	20,690,755	21,161,783
Sweden	1911	38,538,800	36,863,600
Denmark	1913	47,522,000	40,072,000
United States	1913	372,706,199	506,653,824†
Canada	1912–13	142,188,697	80,799,682
India	1912–13	152,307,000	171,233,000‡
China	1913	67,462,557	403,305,546
Japan	1913	74,482,813	64,563,647
Australia	1913	79,749,053	78,523,769
Argentina	1913	84,270,000	96,701,000

* [illegible] included at £[illegible],727,262.
† [illegible] exports.
‡ [illegible].

Our [illegible] progress can be [illegible] from the following table :—

The Imports and Exports, United Kingdom, in Million Pounds Sterling (excluding [illegible] Metal).

Year.	Imports.	Exports.
[illegible]	374	[illegible]
[illegible]	411	286
[illegible]	420	328
[illegible]	523	354
[illegible]	565	407
[illegible]	[illegible]	[illegible]

The relation of imports to exports has been the subject of much [illegible] by repeating various [illegible] arguments. It seems clear that an excess of exports [illegible] condition of trade, but a [illegible] period by increased exports [illegible] and compels a nation to seriously [illegible].

A large portion of our imports takes the form of food.

Until engineers can reclaim the large areas of [illegible] land, and waste and tidal lands, and cultivate [illegible], and irrigate waste or [illegible] land in this country, and then hand it over to the farmer (and this is work for combined [illegible] power), it is clear that food must be imported or the population must be reduced by emigration, and our power as a producing nation would be irreparably injured.

If we have to import food from other countries, we must pay for it by producing something to sell, and ascertain the best means of selling it.

Before we can consider what goods to make, how to make them, and how to sell them, we must ascertain their selling value in the country which imports them. This value is assessed by the drastic ordeal of competition, the contest being one of suitability, durability, and price.

As an example of this competition, take the case of some imports into Russia in 1913 (quoted from Mr. J. R. Barrett, Editor of "The Financier"):—

	Total imported.	British proportion.	German proportion.
Chemicals	£2,490,000	225,300	£1,886,400
Machinery	16,372,700	2,142,300	11,754,200
Metals	5,273,500	932,200	2,496,100
Wrought iron and steel manufactures	1,946,400	233,800	1,532,900

These figures reveal a power of competition which we ought to investigate. The Parliamentary Returns (*see* paper No. 284, quoted by Mr. A. Ross, President Inst. C.E.) show that in the production of pig-iron the five principal countries stand thus :—

	1896.	1912.
United Kingdom	8,660,000	8,751,000
Germany	6,270,000	17,582,000
France	2,391,000	4,870,000
Belgium	944,000	2,264,000
U.S.A.	8,623,000	29,727,000

We must also note that the total production of steel by the Allies in 1915 was about 17,000,000 tons, and the Germanic Powers produced 15,944,200 tons; but during the first half of 1916 it is stated that the production was increased, so that Germany is now manufacturing as much raw material for guns and shells as the Allies.

As a producer of raw material, it is clear that Germany has developed fertile resources.

INDUSTRIAL BANKS.

The annual reports of the Disconto-Gesellschaft, the Dresdner Bank, and the Deutsche Bank, bear eloquent testimony to the enormous and rapid growth of German commerce.

The Deutsche Bank alone, in 1913, held £79,000,000 on current accounts and deposits, and advanced £32,000,000 on securities and £10,760,000 on overdrafts, the total turnover for the year being £6,460,035,811.

This Bank dominates and directs large manufacturing interests in various parts of Germany, and controls trades, governs prices, directs output, obtains raw material under the best conditions (frequently by owning monopolies), and then places goods on sale under a definite policy. A Kartell system is frequently employed, the term "Kartell" signifying an agreement between belligerents. It enables any particular industry to map out districts, or to arrange prices to crush competition; hence dumping in this country. Kartells are really forms of trusts, but not so comprehensive.

Many criticisms of our banking systems have been directed to the restricted sphere of their operations, and the consequent retardation of business enterprise, but it is sometimes forgotten that rigid adherence to a policy of reduction of risk has given the banking institutions of this country a financial stability of the greatest service to the State.

The origin of banks forms an interesting study. They were created by the needs of commerce, and although early Italian merchants, the Lombards, combined their work as goldsmiths with elementary banking in the street, to which they gave their name, the Bank of England was not constituted until 1694. Prior to this date, the possession of money seemed to give trouble, for as merchants became richer, they deposited surplus funds in the Tower of London. This was apparently a safe place, but in 1640, owing to an attack of impecuniosity, Charles I. annexed £200,000, left at the Tower by trusting citizens, and although this was shortly afterwards replaced, the security of the Tower of London for cash was distrusted. Cash was, therefore, deposited with the goldsmiths, who soon became influential and obliging, as they discounted bills and lent money—even to the King, but on the security of taxes. Depositors were given receipts known as Goldsmiths' notes, and as these were allowed to circulate, and were duly honoured, they were really the first bank notes issued in this country.

The proposed constitution of a British Trade Bank, under Royal Charter, has recently been published after careful consideration by a Committee composed of experts in banking and in commerce. This Bank will provide energetic initiative, and encourage and assist enterprise in opening up new sources of trade, and by making advances of capital for extension of plant, or for co-ordination of existing facilities, reduce the cost of production by increase of output under the best conditions.

SCIENTIFIC RESEARCH.

Much attention has recently been directed to the necessity for co-ordination and combined effort to be given to the thorough investigation of the fundamental basis of many of our processes and manufactures, and also the extraction from nature of further secrets still locked up or hidden from our view. The work carried out at the Royal Institution, at the National Physical Laboratory, and at many technical colleges, has left a record of achievement which does not appear to be generally appreciated. We can admire, even if we envy, some opportunities created by German prodigal outlay for the assistance of their manufacturers, but we need not forget that a large proportion of discoveries leading to useful inventions or to improved processes have been due to our scientists.

Trade associations and many writers have advocated the formation of a separate Department of State to deal with commercial matters, and they have done this with so much vigour and enthusiasm that it seems probable a Federation of Trade may itself carry out many reforms and institute new methods. Such self help should command the attention of any Government, and the expert knowledge of the highest authorities concentrated on all problems connected with commerce gives confidence in the ultimate result.

ATTITUDE OF LABOUR.

In referring to our workshops, trade, banking and community of manufacturing interests, my object is to enlist your sympathy in the concluding portion of my address.

You are in charge of other men, and you represent various trades, manufactures, and branches of engineering. There is work—serious work—to be done, and you can help to do it.

Engineers-in-charge will show the best loyalty to their employers by carefully considering all suggestions for the improvement of employeés. In this case it is possible to be both generous and just, for the best worker will generally respond to concession by increasing the value, and not merely the cost of his work.

In many cases it may be desirable to consult labour on the question of hours of work and arrangement of shifts; local conditions frequently materially affect the convenience of all concerned, and the nature of the work may cause special fatigue. No honest man can agree with the policy of a decadent section of labour advocates which encourages a limitation of output; no work is more irksome, or causes permanent fatigue more easily, than the effort to keep busy doing nothing. High wages do not necessarily mean high costs of production, though low wages are generally followed by inefficient service and low rate of production, but high costs.

Finally, let me express an earnest hope that you will use your influence with all skilled labour with which you may be associated, in an endeavour to avoid conflicts which may be more disastrous than war. Consider a request before it becomes a demand, as a request unsatisfied by reasonable answer or concession soon becomes a grievance which cannot be reasoned with, and which usually culminates in a conflict both injurious to the worker and disastrous to the nation.

THE POSSIBILITIES OF STAGE LIGHTING.*

BY BASSETT JONES.

Synopsis.—Stage lighting demands a diversity of colour and intensities not met with in any other class of illumination. This Paper deals with the requirements of certain specific examples, developing the colour schemes, indicating the relative intensities and positions of the illuminant with respect to the objects illuminated, and describing some novel units for the footlights, border lights and flood lights.

This Paper is to be taken as a sequel to "Mobile Colour and Stage Lighting" (an article commencing in the "Electrical World" for July 31, 1915).

The author believed some years ago that footlights, a seemingly unnatural and distorting source of illumination, could be dispensed with, but since he has become convinced of the importance of these units. They may sometimes be omitted from the lighting scheme, as in the first part of the fourth act of "Peter Pan," but even here only during the tableaux-like appearance of the pirate ship.

The trouble is not in the footlight *per se.* It is a case of *modus in rebus.* With purely overhead lighting the facial shadows are too pronounced, because they are not luminous. The footlights serve the purpose of relieving this contrast—not reversing the intensity. Furthermore, there may be little if any light coming through the proscenium arch to the stage, unless there be "front of the house" spots or floods.

Flexibility in the arrangement of footlights is essential. Usually there is a locus of action in the scene, where the maximum of illumination is required both from above and below. There is required, therefore, a sectional footlight controlled in sections and portable, so that it may be concentrated at one side or the other. A continuous foot trough is neither necessary nor advantageous. Rather the foots should be in the form of groups of two or three-light units, the groups so arranged that they can be moved longitudinally from below and the maximum intensity directed at will.

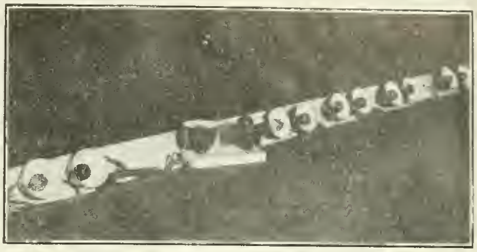

FIG. 1.—FOOTLIGHTS AT THE BAND BOX THEATRE, NEW YORK.

The chief defect to be avoided in connection with the proscenium arch is the production of a "black hole." This causes any object facing it normally to receive no light from this direction, and the stage may appear sharply silhouetted against the relatively brilliant background.

In one case a number of small spot lamps, mounted on the face of the balcony, were used with considerable success. In another the spots were set in the auditorium ceiling in such a position that they were obscured from the audience. Nernst glowers were the light source, thus somewhat closely approaching the ideal form of filament for projector work. The results were successful, but the apparatus was expensive in first cost and maintenance. It also required care in adjustment and structural facilities that were not always available when on the road.

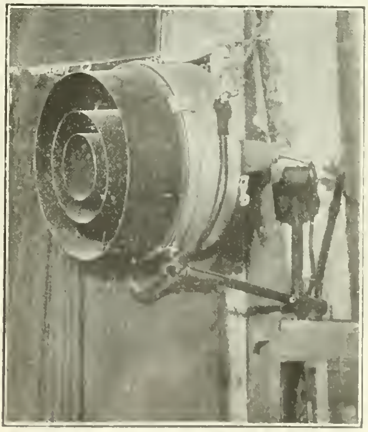

FIG. 2.—PARABOLIC SIDE FLOODS AT THE BAND BOX THEATRE, NEW YORK, WITH LOUVRES. COLOUR HOLDERS SLIP IN BETWEEN LOUVRES AND CASING.

In place of these there are now four 20 in. (50·8 cm.) parabolic reflector spots, employing concentrated filament type C lamps of special construction. The apertures of the reflectors are equipped with a system of concentric louvres to kill the direct "spill" light.

At the Band Box Theatre efforts were made to avoid the use of light in the front of the house by special arrangement of the foots and by using floods on each side of the proscenium arch. Later, front lights similar to those just referred to were installed, with the addition of diaphragms to confine the light to the desired region of the stage. The difficulty encountered in using such lights low down, as at this theatre, where there is no balcony, or on the balcony face, is that they light the scenery, whereas their only purpose is to light the performers down stage. To counteract the flattening effect of fronts and foots, and to illuminate shadows and lend them colour, light blue diffusing floods high up on each side of the proscenium arch have been employed.

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* An abstract of a lecture delivered at the mid-winter convention of the Illuminating Engineering Society, New York, February 10-11, 1916.

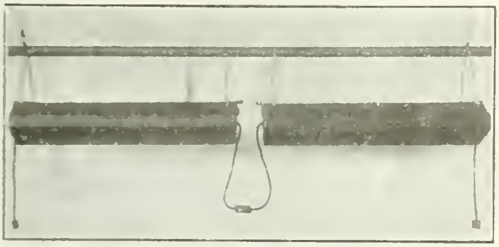

Fig. 3. Parabolic Strips used as Border.

There is nothing on the stage so unwieldy or so inefficient as the common trough border light. For this a line of white enamel or aluminium finish steel reflectors of various shapes has been substituted: these are usually of the 30-deg. aperture type, focussing at the main border just back of the proscenium, but the intensive type is also made use of.

The most successful arrangement has proved to be a main border as described and upstage borders of 20 in. (50·8 cm.) aperture reflectors using 400-watt special type "C" lamps and aluminium finish diffusing reflectors with different colours. Usually two borders of this type, each with two such floods, are enough. The disadvantage is the space required in the scenery loft, but if the

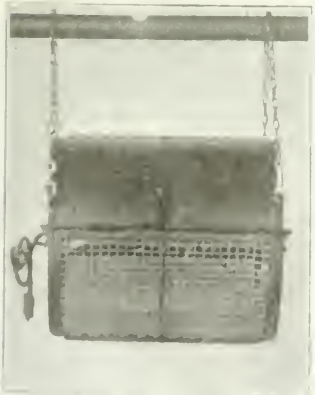

Fig. 4. [illegible] 1000-watt Lamp.

[illegible] can be spared the [illegible] is [illegible]. The [illegible] equipment had consisted of a [illegible] border of 16 100-watt white, two white floods and [illegible] units.

At the [illegible] there is such a border of three parabolic strips, each containing [illegible] lamps [illegible] used. There are also [illegible] at the [illegible] and two "basket" border units [illegible] of performers [illegible].

The border [illegible] on a long pipe, the border units hang from the pipe by [illegible] that they can be [illegible] on the pipe and the [illegible] directed in any direction. This gives great flexibility in the lighting arrangement.

These reflectors [illegible] for road work and a protecting [illegible] in spite of the space it occupies. Such steel reflectors at least give some sort of protection.

Furthermore, glass mirrors give a "hard" reflection and a corresponding glare, especially where high finish surfaces are required in the scenery and where grease is used in make-up. While the control of the distribution of brightness is not so perfect, with the more diffuse reflecting surfaces, such as baked enamel or etched aluminium, the quality of the light, in the author's opinion, is much better.

Recently successful experiments have been made in the lighting of back drops by a series of 20 in. (50·8 cm.) aperture parabolic reflector casings equipped with diffusing reflectors and 300-watt lamps set

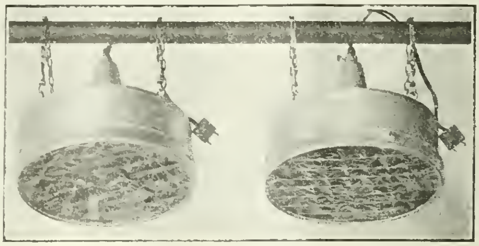

Fig. 5. Parabolic Floods used as Border.

on a stand along the bottom of the drop and facing upwards. These take the place of the parabolic strips and are easier to handle in road work. They require greater spacing between drops, however.

The wiring for a system such as this and the switching arrangement required are, of course, quite different from anything found in the usual theatre, therefore on tour portable wiring, even to the front of the house lights, must be carried. A switchboard and dimmer bank of eight plates—a very much simpler switchboard than one usually finds—is used.

By using a transfer switching system the number of dimmer plates can be materially reduced. The author recently designed and installed a permanent board of this type working much after the manner of a jack type telephone switchboard.

The system of stage lighting described is peculiarly flexible, and represents, in effect, the various brushes and pigments that experience has proved essential to the stage artist. And, as the painter makes shift to obtain wonderful and complex tonal quality with a few colours, so an enormous variety of results can be produced by a few pieces of properly designed stage lighting equipment.

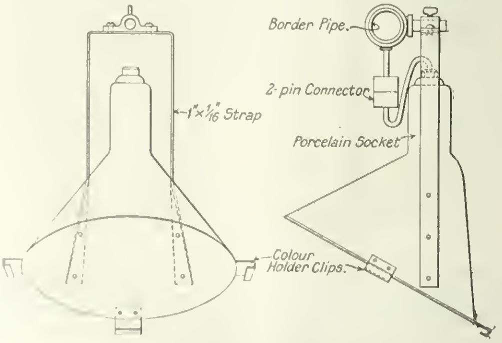

Fig. 6.—Border Unit.

The author is opposed to "effect" on the stage to the "spot," which has been relegated to the burlesque and musical "show"; to mechanical lighting "stunts" of all kinds which tend to reduce the stage to what may be termed "a mechanic's universe."

Nor is it enough to merely flood the stage with light. The direction, quantity and quality of the light count for much. By direction is meant the effect of the light in giving perspective and shadow; this is of great moment in the picture. The best scene can be killed by distortion. Accenting the wrong high lights is like bad pronunciation in speaking—it jars.

Possibly there has never been a case where asymmetric lighting of the stage was not advantageous. Sometimes a silhouette is quite as interesting—even more so—than a full face effect. The sole object is to paint into the scene just the atmosphere that will best serve to accent the acting situation whether that be farcical or tragic, or merely the presentation of an exquisite picture, dancing, music, &c. In earlier lectures before this Society running as far back as 1910 there was shown, by the aid of a colour and shadow booth, how extraordinary was the distortion of form produced by unnatural direction of intensities or excessive diffusion. How, then, is it possible for the observer to gather the finer nuances of feeling or emotion from a scene when the sensory material upon which the physiological side of the emotion is built come to him all out of form and proportion? He is so busy unconsciously sorting out and correcting impressions that his mind simply passes over all of the finer elements, which merely slip through the sieve of memory and are lost.

Excess of light is a great mistake. Chromatic value cannot be obtained at high intensity. The use of high intensity tends towards garish and crude colour arrangements, for the colour must fight for its life. Nothing fine can be done under such conditions; and the poor actor is inevitably hampered by the effect of glare.

The production of a hard or soft atmosphere is largely a matter of distribution and diffusion. Shadows must be luminous and free from sharp edges. There must be no marked focussing—nothing metallic about the light.

These three requirements are apart from colour, which requires special treatment. Saturated colours should be avoided, and a judicious proportion of white or black should be mixed with the pure hue. The requirements of stage lighting might be briefly summarised as follows: The least possible amount of light in conformity with the detail required; diffused and soft illumination, but with a distinct general direction; quiet and harmonious effects in the general colour scheme.

NOTES ON SOME SMALL POINTS RELATING TO DUPLEX BALANCES ON LONG SUBMARINE CABLES.*

BY WALTER JUDD.

The following notes are the result of observations made by Mr. W. Gaye in the laboratory of the Eastern Telegraph Co., and are communicated as being of interest to others charged with the maintenance of duplex balances on long submarine cables.

Various phenomena lead to the deduction that even the relatively small capacity of the connecting wires concerned in a cable duplex system—such wires being generally of considerable length—enters into the problem of duplex balancing to an appreciable extent. Manifestations of these phenomena are:—

1. A balance which has been observed to be good on one siphon recorder is often found to need more or less small readjustment when the circuit is transferred to another recorder or to a relay, the only difference being that another pair of connecting wires is used for the second piece of apparatus.

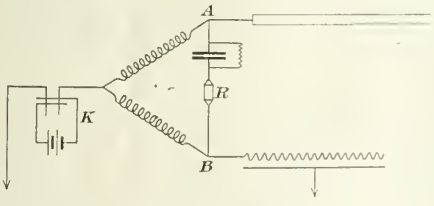

Fig. 1.

2. If both the cable and artificial line are disconnected from the system a small balance disturbance is invariably shown.

3. On what are known as oscillatory curb connections, such as those shown in Fig. 1, if large changes are made in the capacity of the condenser or the resistance of the shunt over it, a previously existing good balance may be somewhat upset.

4. When the entire cross circuit is short-circuited by connecting a wire of negligible resistance between the points A and B (Fig. 1), a disturbance of a good balance may be produced.

These curious effects are likely to be attributed to defective insulation existing at some point of the system, but they are found to occur when all the apparatus and leads are known to be well insulated.

In order to account for their occurrence it becomes necessary to dismiss from consideration the cable and artificial line and to study the connecting wires alone. If this be done and the circuit becomes of the simple character shown in Fig. 2, it is clear that application of the battery E.M.F. to the bridge apex by depression of one of the signalling keys (K) will have no result, since both sides of the observing instrument (R) instantaneously acquire and maintain the same potential.

If, however, the two connecting wires on either side of R have each a capacity S to earth, then we may represent the conditions as in Fig. 3. Here a manifestly unsymmetrical condition is displayed, and it is evident that the application of the E.M.F. will have a transient disturbing effect upon R, greater or less according to the capacity S of the leads.

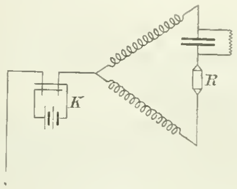

Fig. 2.

We are, in fact, confronted with a condition of things that calls for remedy before the main problem of balancing the artificial line against the cable is attacked. It seems reasonable to suppose that, unless this be done, the elimination of these entirely local effects may considerably aggravate any other difficulty that may be experienced.

We shall be well advised, therefore, to discuss what expedients can be adopted to remedy an obviously undesirable lack of symmetry. Those which suggest themselves are:—

1. To make the connecting wire between the receiving instrument R and the condenser as short as possible, so that the latter becomes, as it were, part and parcel of the former. The objection to this is that the condenser on even moderately long cables may under ordinary circumstances become a very bulky piece of apparatus occupying a prohibitively large space.

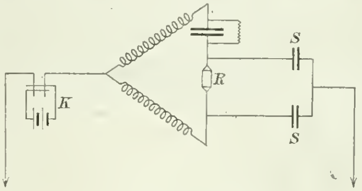

Fig. 3.

2. To use connecting wire having a thickness of insulation so great as to make its capacity per unit length negligible.

3. To divide the condenser into two equal parts and to place one on each side of R. This would involve four times the capacity of the original condensers and would be objectionable on the score of cost.

4. To adopt the Price wire-guard principle in regard to these wires. That is to say, to connect the screen surrounding the wire to the bridge apex and thus nullify the capacity.

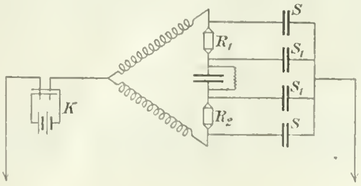

Fig. 4

5. To divide the coil of R into exactly equal parts R_1 and R_2, and to insert the condenser between these two parts as shown in Fig. 4. This provides a symmetrical arrangement at no greater cost than that of two similar additional lengths of connecting wire, the capacity of which is represented by S_1.

The diagrams given show the connections where a magnetic bridge duplex system is in use, but the argument applies equally well to cases where a simple resistance bridge or a double block condenser bridge are employed.

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* An original communication to the "Journal" of the Institution of Electrical Engineers.

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JUVENILE EMPLOYMENT.

The Health of Munition Workers Committee was appointed to consider and advise on questions of industrial fatigue, hours of labour and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops. In less than a year 13 Memoranda on a wide range of subjects have been prepared by the Committee. Of these Memoranda, which may be obtained from any bookseller at trifling cost, the most recent is, in many respects, the most striking. It deals with juvenile employment, and reveals the existence of a state of affairs such as one would not expect to find in a civilised country.

Those who take the trouble to read the Memorandum will agree that it is impossible to find language suitable for describing the degrading and inhuman conditions which prevail in the twentieth century, and under which the poorer members of the rising generation are being brought up. In these days the thought that at one time the State allowed employers to send boys to their death fills one with righteous anger. From Memorandum No. 13 it is evident that vast numbers of juveniles are still compelled to follow their employment, and to eke out their existence, under conditions which can only be compared with living death.

Regarding the boys employed in a steel works, one of the Medical Investigators employed by the Committee reports:

> Of the boys, it may be said for the most part that they are "so spiritless, so dull, so dead in look, so woebegone and attacked with weariness to a dulling of their spirits" as to compel attention. These conditions are attributable in a very large measure to the conditions outside the workshop. . . .

We are told by the Committee that even under normal conditions there is some danger of juvenile employment adversely affecting physique, and that this danger is materially increased by the present conditions of employment.

> A social worker, who has had considerable experience of boys employed in munition works, stated that . . . the boys are drawing on their strength. . . . They have no leisure, no recreation and no classes, and he was very anxious as to what would become of the boys after the war. He suggested that too big a price was being paid for output. . . .

As an example of what we have referred to as degrading and inhuman conditions, we take the following from the section on "Instruction of Young Workers":—

> At present, unfortunately, the stress of work has rendered the continuance of education impracticable. Recently an education authority in a large munition centre has allowed boys of 13 to be employed full time on condition that they attended an evening school.

As pointed out by the Committee, it should be obvious, however, that for a boy who has to work from 6 a.m. to [illegible] p.m., or even longer, subsequent attendance at school is worse than useless.

In the absence of proof that the best use has been made of the material available, we cannot believe that the stress of work has rendered the continuance of education impracticable. Rather are we inclined to imagine that the stress of work has rendered profitable the employment of juvenile labour on munitions. Although we do not suggest that local education authorities are base enough to "allow boys of 13 to work full time provided they attend an evening school" in order that the grant made by the State may be increased, it is, nevertheless, a fact that by so doing the grant to the local education authority is increased. Putting the best construction on the motives of these humanitarians, and assuming that they are endeavouring to work in the interests of the child of 13 years of age, we would first have them send their own 13-year old children to work from 6 a.m. to 5 p.m. and afterwards to the evening school.

The Committee believes that, in addition to the ordinary holidays, boys and girls are likely to benefit greatly by occasional opportunities for a holiday of longer duration. It is suggested that whenever feasible a week's holiday may be usefully granted, perhaps as a reward for regular attendance during the year. In our opinion, it is a national disgrace that holidays taken by the working classes, as often as not, mean empty larders. The experiment is one which might very well be tried in the munition centre where the education authority insists on boys of 13 attending night schools. And to make the little fellows feel that we were giving them nothing, we would compel them to join the Boy Scouts and to attend regularly at Sunday school in order to qualify for the extra week.

In comparison with some examples of which we have knowledge those given by the Committee are colourless. Under the heading "Hours of Labour," it is stated that :—

> Under the Factory and Workshops Act, 1901, boys and girls under 18 years of age . . may be employed for 12 hours (10½ exclusive of meal times) a day during the week, and for 8 hours (7½ exclusive of meal times) on Saturdays—that is to say, for a weekly period of 60 hours. Subject to some exceptions in the case of boys, all night work and Sunday work is forbidden, as also is overtime. Under Section 150 of the Act, the Secretary of State has power in case of public emergency to relax these restrictions, and since the commencement of the war this power has been widely exercised. The weekly hours have frequently been extended to 67, and in some instances even longer hours have been worked.

It is fairly well known that the Secretary of State has widely exercised the power vested in him, but we doubt whether he or many of our readers are aware of the way in which the relaxation of the restrictions has been abused. The Memorandum tells how the daily hours of employment have been extended to 14, and occasionally even to 15 hours. We are told that night work has been common, and that Sunday work has also been allowed.

As to the employment of juveniles from 7 a.m. on Friday morning to 1 p.m. on Saturday morning, a total of 30 hours (26 hours exclusive of meal times), the Committee is silent. Such being the case, it is unnecessary to record that after about 18 hours employment it is found that children reel about the shop as though they were intoxicated, and that after about 20 hours employment it is difficult for children to stand on their legs. Nor are we told that, as a result of overtime and overwork, it is customary in some works for juveniles to try to obtain sleep in filthy places attached to the works. Out of the profits resulting from this unnameable abuse of juvenile employment the lion's share at the present time goes into the coffers of the State but we refuse to believe it is for this reason that the State has done so little.

Equally instructive is the section in which light is thrown on the home life of these juveniles. The following cases, according to the Committee, are typical of many :—

> 1. A boy, aged 14, stated that his average wage was 19s. weekly. He slept in the same bed with two young men, each earning about £2 a week; also in the same room, but in another bed, two young girls slept.
>
> 2. A boy, aged 16, earning about 22s. weekly, slept in a bed with another boy. In another bed, in the same room, a boy and girl slept. In some cases the same beds are occupied by day as well as by night.

With so much of the tragic side of life set out, one would like to see a little more of the humorous side ; but the only humour to be found in the Memorandum is the sentence : "The temptations of the cinema and the amusements of the street tend to keep boys and girls up too late." If the cases quoted above *are* typical of many, we imagine that the children referred to have precious little inducement to go to bed. In our opinion, the barbarism and diabolical inhumanity brought to light by the Committee account in large measure for the alarming increase of juvenile crime, and we wonder what is to become of the children—of the dumb slaves of State-aided tyrannical employers and equally tyrannical parents—brought up under present-day conditions when they become men and women of the Empire.

Many are inclined to the view that the increase of juvenile crime may be attributed to the cinema "palace" and to the streets. We venture to say that the desire to become rich quickly and at any cost permeates the community in varying degrees. The vulgar show of wealth by those who have acquired their wealth easily accounts for much of the increase, as also does the vicious system of primary education under which the majority of juveniles are trained. To these must be added the home influence, which is not the fault of the child. No doubt the cinema and the streets have contributed to the increase, but surely neither the one nor the other can have a harmful effect on the normal mind and well-nourished body ; otherwise why should those responsible for the increase of crime come, for the most part, from poor homes ?

The Memorandum, for which, notwithstanding our criticism, we are exceedingly grateful to the Committee, calls to mind a passage in Mr. JEROME's "Idle Thoughts of an Idle Fellow." The book is one that can be put into the hands of boys and girls. In trying to determine what the future has in store for these abused children of the poor, the picture drawn by Mr. JEROME overshadows everything else. The passage referred to deals with drink and the "ignorant masses," and is as follows :—

> But think, before you hold up your hands in horror at their ill-living, what "life" for these wretched creatures really means. Picture the squalid misery of their bruitish existence, dragged on from year to year in the narrow noisome room where, huddled like vermin in sewers, they welter and sicken and sleep ; where dirt-grimed children scream and fight, and sluttish, shrill-voiced women cuff and curse and nag ; where the street outside teems with roaring filth, and the house around is a bedlam of riot and stench.
>
> Think what a sapless stick this fair flower of life must be to them, devoid of mind and soul. The horse in his stall scents the sweet hay, and munches the ripe corn contentedly. The watch-dog in his kennel blinks at the grateful sun, dreams of a glorious chase over the dewy fields, and wakes with a yelp of gladness to greet a caressing hand But the clod-like life of these human logs never knows one ray of light. From the hour when they crawl from their comfortless bed to the hour when they lounge back into it again they never live one moment of real life. Recreation, amusement, companionship, they know not the meaning of. Joy, sorrow, laughter, tears, love, friendship, longing, despair are idle words to them. From the day when their baby eyes first look upon their sordid world to the day when, with an oath, they close them for ever, and their bones are shovelled out of sight, they never warm to one touch of human sympathy, never thrill to a single thought, never start to a single hope. . . .

In the foregoing, with some difficulty and with all the self-restraint we are capable of exercising, we have endeavoured to fill in certain of the blanks in the Memorandum on Juvenile Employment. That the conditions to which we have referred will be improved in the near future cannot be doubted, and it is certain that they will be the more quickly improved by exposing them than by hiding them. We look forward to the time when it is recognised that humane treatment of every subject in the State is an essential of good government ; to the time when it is recognised that decent treatment of all employés is one of the first principles of works management, and to the time when public opinion makes it impossible for parents to mortgage the future of their children by enslaving them in the present.

THE DEVELOPMENT OF APPLIANCES FOR HANDLING RAW MATERIALS AND MERCHANDISE AT PORTS AND OTHER LARGE CENTRES OF TRAFFIC.*

BY SIR JOHN PURSER GRIFFITH, M.A.I., M.INST.C.E.

The subject chosen by the Council is one of great and increasing importance; but it covers a world-wide field. It is obviously impossible to treat it in detail within the limits of a lecture. The numberless appliances and the various conditions to be dealt with would provide materials for many such lectures. All that I can do in the short time at my disposal is to bring under your notice the objects aimed at by the development of such appliances, and what I believe to be the economic advantages gained by their use. I also propose to touch on some striking examples, and finally to submit for your consideration a plea for their extended use on the ground of the benefit they are capable of conferring upon mankind.

Object of Appliances for Handling Materials.—The introduction of appliances for handling raw materials and merchandise at our ports reduces the cost of raw materials and the finished article to the consumer. Reduction in the cost of transport between the source of supply and the manufacturer or consumer is the primary object of such appliances. Quick loading and discharge of vessels is an important factor in freight charges.

The ship represents capital invested, and has to earn sufficient in freights to cover interest on capital, sinking fund or depreciation, working and maintenance expenses, including port charges. The late Sir William White, at the Engineering Conference in 1907, made the following striking remarks:—

> "As a [illegible] it has been obvious to me for many years that [illegible] with cargoes must be the essence of success [illegible].
>
> [illegible] by Dr. Inglis many years ago (on the basis of [illegible] supplied by shipowners) that one controlling condition [illegible] running of cargo steamers is the time they remain in port [illegible] loading or discharging cargoes, during which [illegible] must be interrupted."

[illegible] of Rapid Discharge on Port Charges.—The earning power of a port may, with advantage, be referred to the income [illegible] per lineal foot of quay, and the cost of the port may be [illegible]. To the cost of the port must be added the annual expenditure on the maintenance and working expenses of the port, together with establishment charges. If the aggregate sum representing these charges is divided by the length in feet of the quay berths, we arrive at the annual expenditure on the port per lineal foot of berthage. In a similar way, if we find out what the annual income of the port amounts to, and divide this sum total by the length of quay berthage in feet, we arrive at the earning power of the port per lineal foot of berthage.

In a detailed examination of different portions of the berthage on [illegible] it will generally be found that berths appropriated to fixed and regular trades yield a higher return than the open berths devoted to the general trade of the port. This all points to the necessity of [illegible] discharge and clearance of ships at these open quays. The importance of appliances for handling raw materials and merchandise [illegible] becomes evident.

[illegible] Appliances for Handling Cargo.—It is impossible to [illegible] appliances [illegible] on vessels in [illegible] for handling cargoes both for loading and discharging [illegible]. With the advent of steamers, the hand winch was replaced by the steam winch worked from the ship's [illegible] boiler. The arrangement is still [illegible] which the ordinary [illegible] derrick posts fitted, and instances have been [illegible] fitted, carrying over 10,000 [illegible] at the rate of 300 tons per hour.

Where a vessel is engaged in a regular trade between fixed ports in which regular berthage is [illegible], elaborate appliances on the ship for discharging and [illegible] cargo are unnecessary. It is [illegible] to have the appliances ashore, where they can be kept constantly at work. There are, however, some large ports such as Hamburg and Rotterdam, on great inland [illegible] where ships discharge [illegible] into the [illegible] trading to these ports [illegible] plant [illegible] the Hamburg-American line [illegible] Hamburg and [illegible] the steamship company [illegible] that it did not desire a permanent [illegible] to the port. It would appear that the German company, with its up-to-date ship equipment, hoped to be able to capture the trade of Boston by embarrassing its competitors, who might depend more upon port equipment supplied by the local authorities.

Our portal authorities have been slow in realising the importance of rapid dispatch in loading and clearing ships frequenting their ports. They have frequently checked the extension of port equipment by excessive charges, forgetting that it is not so much making a profit out of such appliances which should be sought as making the port as a whole more efficient and economical. Shore equipment is essential for the handling of materials on shore, and for hastening the clearing of wharves and sheds. The congestion of our ports from which the nation has suffered during the present war has been largely due to imperfect facilities for handling the goods when landed.

My attention was drawn to the importance of port equipment for handling cargoes more than 40 years ago in a curious way. The late Herr Dalmann, the chief engineer of the Port of Hamburg, visited Dublin in the early seventies, and at the close of his visit invited me to Hamburg, and amongst other attractions mentioned that a greater tonnage of shipping was accommodated in Hamburg per lineal foot of quay than in any English port. The result of my visit was to show me that the equipment of the Hamburg quays with cranes had been carried out to an extent quite unknown in England and our British ports, and arrangements as regards charges for their use were adopted which made it advantageous for the trader to use them. The result was that vessels were discharged and loaded rapidly, and the costly quays worked efficiently.

I now propose to give some instances of appliances for the handling of materials. These have been selected as striking examples of special appliances for particular purposes, which may prove an incentive to the extension of mechanical appliances for handling raw materials and merchandise in our ports and centres of traffic.

Coal Handling.—In the year 1869, when I first became connected with the engineering department of the Port of Dublin, all coal entering the port was carried in sailing vessels. These vessels were practically the coal stores of the city lying in the port for weeks. The coal, which was raised by a hand-winch, was filled into sacks, and weighed on a scale on the ship's deck. It was then carried ashore on men's backs to carts for distribution.

What a change has come over the scene! The sailing collier has disappeared and been replaced by steam colliers, which arrive in port in the morning and leave the next evening. These vessels are designed of suitable size and draft for the particular port with which they trade; they are engined for speeds necessary to meet the tidal conditions of these ports, and are designed with large hatchways.

Coal-loading Appliances.—In the matter of loading coal into ships at the coal ports, there has, perhaps, been less change in principle than in the discharge of cargoes. The modern staith is so designed as to allow trains of coal wagons to discharge in quick succession. In some cases the wagons are run up on high staging commanding the coal shoots; in other cases the wagons loaded with coal are raised vertically to the necessary height for tipping, while in some recent instances the coal wagons discharge into a coal-hopper below the ground level from whence the coal is delivered by elevators into the ships' hatches. The only examples of American coal-loading appliances which I propose referring to are the coal hoists at Toledo, Ohio, constructed by the Brown Hoisting Machinery Co., of Cleveland, Ohio. Records show that each of these machines will handle from 40 to 50 100-ton cars per hour. The car is clamped on the cradle, and as the cradle is hoisted the wagon is turned over through an angle of 160 deg. and emptied.

Coal-discharging Appliances.—The discharging of coal from the ship is still, it may be said, in a transition state. Although the methods described of discharging the old sailing collier in Dublin are out of date, yet a considerable quantity of coal is excavated in the holds by manual labour, and the buckets or skips are filled by the same men. The bucket carrying from 20 cwt. to 30 cwt. of coal is then hoisted either by the ship's own tackle or by cranes on the quays. Considerable advances have been made in the use of grabs or excavators to dig the coal out of the ships' holds, and reduce manual labour to a minimum.

Coal Handling and Water Carriage of Coal on the Aire and Calder Navigation.—One of the most striking systems of the handling of coal from the colliery to the coast for shipment is that devised and carried out by Mr. W. H. Bartholomew on the Aire and Calder Navigation. The port of Goole is the eastern terminus of this navigation, and the improvement of the water way has allowed of the compartment boat system being used. Each compartment forms a rectangular boat, and carries 40 tons of coal. The compartments are coupled together and formed into a train consisting of a tug and 20 to 30 compartments and carrying from 800 to 1,200 tons of coal. Each train is worked by four men. The several compartments are loaded at the colliery staiths, and on arrival at Goole are floated into the cradles of powerful hydraulic hoists, in which they are secured, raised to the required height, and tipped over, discharging their contents into shoots and thence into the ship at the rate of from 200 to 300 tons per hour, according to the suitability of the ship to receive such cargo.

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* [illegible]

It is worthy of note that this navigation is in close touch and competition with the North-Eastern Railway, the Lancashire & Yorkshire Railway, the Hull & Barnsley Railway, the Great Central Railway, and the Great Northern Railway.

Coal Handling Appliances on the Thames.—The enormous importation of coal into the Thames has resulted in some of the best installations in this country for the discharge of coal being found in the Port of London. Although there is some admirable equipment belonging to the several gas companies, yet I propose confining my reference to the plant used by Messrs. Cory & Son (Ltd.), as this represents the experience gained from a very large coal trade, extending over a period of 50 years.

In 1889 Messrs. Cory built a derrick pontoon, 550 ft. in length. This allowed two ordinary-sized colliers to discharge on one side of the pontoon. The pontoon was fitted with luffing cranes and grabs which discharged the coal from the steamers into hoppers on the pontoon. From the hoppers the coal descended into an automatic weighing-machine, which discharged the coal into a reservoir or bin, from which it was discharged into river barges on the opposite side of the pontoon from the ship. This pontoon discharged on an average 1¼ million tons of coal per annum, and was continuously at work on the Thames until 1915.

On account of the obstruction in the river, the London Port Authority would not allow another coal pontoon to be moored in the river channel. Subsequent additions to the coal-handling plant of Messrs. Cory were made ashore.

About the year 1900 Messrs. Cory reconstructed one of their Erith wharves, and erected on it five electric luffing cranes fitted with Hone grabs. A few years later the Erith pier was rebuilt, and furnished with five transporters, to work double-chain grabs. The disadvantage of this form of transporter is that the grab cannot be rapidly lowered into any part of the hatchway, and in their more recent installations Messrs. Cory have reverted to the luffing crane.

Ore and Mineral Handling Machinery.—The success of the steel industry in the United States of America is principally due to the scientific treatment and economical handling of the iron ore and the coal. Some of the most striking developments of appliances for handling minerals and ore have been associated with this great industry. The ore is brought by rail to the lake port, where huge bins have been built, over which the trains of wagons run and drop their loads. From these bins the ore can be discharged by shoots into every hatch simultaneously. The great charm of this arrangement is that the bin storage ensures continuous loading, and vessels are not delayed awaiting the delivery of the ore by the wagons.

Ore Transport Steamers on the American Lakes.—Specially designed steamers are features of this trade. The following is a description of one of the more recent steamers: The vessel is 560 ft. in length, 56 ft. beam and 32 ft. in depth. The hold, which is free from stanchions and cross-bracing or bulk-heads, is in the form of a hopper, 409 ft. long, 43 ft. wide at the top and 24 ft. wide at the bottom. Arched transoms span the hold about 12 ft. apart. The vessel carries 11,000 tons of ore, and is fitted with water-ballast tanks in the double bottom and sides.

The docks are of such a form and size that several vessels can be loaded at the same time. At Duluth in one dock 64,000 tons of ore have been loaded into 14 vessels in 24 hours, or an average load per vessel of 4,571 tons.

The unloading of vessels is what limits the speed, and a study of the various methods adopted is of great interest. The Hulett system is one of the most effective methods in use on the great lakes. These machines have removed, without trimming, 95 per cent. of the cargo of a modern vessel, with a minimum rate of unloading of 200 tons per hour, and a maximum of 680 tons.

The Brown Hoisting Machinery Co., of Cleveland, Ohio, have constructed some excellent coal and ore handling plant, amongst which is the coal handling installation of the Pittsburg Coal Dock Co., at Duluth, Minn. It is said to be the largest in the world, capable of taking coal from the steamers to a million ton storage yard at the rate of 1,500 tons per hour.

Another interesting plant is at work at Fairport, Ohio, and consists of six fast unloading electric trolley grabs, delivering ore from the ship either to rail or store. Five-ton grabs are used, and 10,000 tons of ore have been discharged in nine hours.

Grain-Handling Appliances.—England lagged behind in the adoption of grain-handling appliances, and we are still familiar with old methods of filling the grain into sacks in the holds of vessels, hoisting the sacks on deck by hand or steam winches for weighing and adjustment, transferring the sacks on men's backs to carts or railway wagons, whence they are transferred to the granaries.

In America, at a very early date, the handling of grain became a pressing problem. Dearth of labour gave the impetus to the invention and introduction of mechanical appliances, and the erection of silos, or bin-stores, was one of the earliest and most important steps. The combination of elevators and silos solved the problem of storage, and the force of gravity was utilised in every possible way. Even after great progress had been made in the United States, the handling of grain at the discharging ports of Europe, and specially at those of the British Isles, was antiquated and costly. Considerable progress has, however, been made of recent years in the discharge and handling of grain in our European ports by the introduction of fixed or portable elevators on land, or by floating elevators in the docks and harbours.

The pneumatic discharge of grain, which was introduced by Mr. Duckham, of the Millwall Docks, about the year 1890, has of recent years made considerable progress. Although a British invention, it has been chiefly developed in the principal Continental ports. A large number of floating pneumatic elevators were before the war at work in the Port of Rotterdam, where immense quantities of imported grain were transhipped from ocean-going vessels to the great river barges which navigate the Rhine.

There can be no doubt but that the pneumatic discharge is advantageous to the grain, for it separates the dust from the grain, and removes a fruitful source of heating. And yet, curiously enough, this separation of the dust from the grain has actually proved a deterrent to the use of pneumatic plant, the reason being that the removal of the dust meant a material loss of weight, although the quality of the grain was improved. In many instances arrangements have been made to return the dust to the grain before it is passed to the weighing machines.

Oil-handling Plant.—The story of progress in the handling and transport of petroleum reads like a romance. The important part it and its by-products play in our every-day life has been brought into prominence by the restrictions in its use forced upon the nation by the world-wide war now in progress. We have learned how dependent we are on its supply.

The old system of sending oil in barrels in sailing vessels was in full swing in the eighties, and in the Port of Dublin until 1899, when the Anglo-American Oil Co. opened their tank storage depot. The effect was startling. Instead of a sailing vessel with from 1,000 to 2,000 tons of oil in barrels occupying the harbour quays for weeks, the tank steamer with from 5,000 to 10,000 tons of oil was discharged, and the oil pumped ashore and stored in the depot tanks, within from 24 to 48 hours from the arrival of the tank steamer.

The shortage of tonnage of tank steamers caused by the war has this year forced the Anglo-American Oil Co. to import a certain amount of oil in barrels by sailing ships, and we have been forcibly reminded in Dublin of what this means. The Norwegian sailing ship "Nordfarer" brought 18,500 barrels of petroleum in August of this year, approximately equal to 3,000 tons of oil. This vessel, even with the aid of electric cranes, took 10 working days to discharge, whereas if that amount of oil had been imported by tank steamer, it would have been discharged in one day, a saving to the port of nine working days.

Timber Handling.—The handling of timber, both at the loading and discharging ports, still involves much manual labour. Until quite a recent date balk timber was brought in rafts for shipment, and hauled into the holds of sailing vessels through port-holes formed in the ship's bows. With the advent of the steamship into this trade, the balk timber is generally loaded and discharged through the deck hatches by the ship's steam winches and derricks. In the Port of Dublin the timber is now frequently discharged by the portal electric cranes on the quays with satisfactory results as regards time, and great facilities for stacking and handling timber on the quays.

Planks, deals and boards were formerly exclusively discharged by manual labour, but have of late been discharged, landed and stacked by the electric cranes. Conveyors have been introduced in some places where the timber storage ground is within reasonable distance from the quay, and elevators of a special form have also been adopted in a few places for stacking planks.

Appliances for Handling Heavy Machinery, &c., in Ports.—In a large port it is essential to have appliances to deal with heavy lifts, such as railway rolling stock, engines, boilers and machinery of all kinds. The example to which I would draw your attention is the 100-ton electric crane in the Port of Dublin. Before its erection in the year 1905, it was no uncommon occurrence for heavy loads to be sent round to Belfast instead of being landed in Dublin. The crane capable of lifting loads up to 100 tons at a radius of 75 ft. An auxiliary lift is provided for loads under 20 tons, working to a maximum radius of 80 ft.

Appliances for Handling General Merchandise.—Reference has been briefly made to appliances for loading and unloading vessels; but, in addition to these, there is the necessity of being able to handle the cargo when it is on land either before loading or after discharge. Unless the quays and sheds are cleared rapidly, it is obvious that the discharge and loading of vessels will be delayed for want of quay space to deposit and sort the goods.

If a port is not sufficiently provided with well-designed sheds and ample quay space for the reception of cargoes and appliances for handling and sorting merchandise of all descriptions, loss and extra expense will be incurred. Facilities for the rapid removal of goods from the port are also of the greatest importance, while easy connections with the railways and the inland navigations of the country are essential in the interests of the internal trade of the country.

In this respect some of our older ports controlled by port trusts labour under great disadvantages when competing with more modern ports, and specially with those controlled by railway companies. The defective railway connections of the older ports often necessitate costly cartage between the ships and the railways.

The railway-owned port has the advantage of a co-ordinated control of its railway and shipping traffic arrangements. A similar remark applies to traffic arrangements where railway companies own fleets of steamers trading to a port, and are able to connect their railway system with the berths occupied by these steamers. In this connection I should wish specially to refer to the arrangements of the Lancashire & Yorkshire Railway Co. at the Port of Goole, for handling the company's Continental traffic at that port. A single-storey shed, with large floor area, has been erected at the steamers' berths, into which the railway wagons run. There is ample floor area for depositing goods, and this is commanded by overhead cranes which traverse the shed from the quay to the rails. Moreover, this combination of jib cranes and overhead cranes allows of the cargo being taken out of the ships' holds and landed either in the shed for sorting purposes or into railway wagons standing at some considerable distance away.

One of the best examples of handling goods traffic of a general character which I have seen is at the Oldham road Goods Station, Manchester, where a very complete system of overhead electric cranes deals with all classes of traffic, and electric motor trucks are used on the platforms to supplement the cranes for taking goods from one portion of the shed to another.

The handling of wool and cotton in the manufacturing areas of Yorkshire and Lancashire has taxed the ingenuity of railway engineers and managers. The principle now generally accepted as the best is to pile the bales to a great height, irrespective of their marks, in sheds commanded by overhead cranes. This system has also been adopted in New Orleans. The same principle is adopted in the more modern wool warehouses at Bradford belonging to the Lancashire & Yorkshire Railway.

Influence on Labour of Appliances for Handling Raw Materials and Merchandise.—There is an aspect of the problem under discussion which appears to me of supreme importance and interest, namely, the effect on labour of appliances for handling raw materials and merchandise in our ports. Instead of speaking of "labour-saving appliances," we must gradually substitute the term "labour-[illegible] appliances."

Allow me to quote a sentence of Mr. Harold Cox in his lecture on "Industrial Improvement" last March, with which I am in complete sympathy. His words were:—

> "I [illegible] still find that workmen in many places look upon improvements in machinery with very much the same suspicion which led [illegible] of the century, when they used to break [illegible]. It is very curious, for when you come to think of it [illegible] to make a [illegible], we might almost be defined as a [illegible] that proportion that we are [illegible] dependent upon [illegible]."

Casual Labour and [illegible] in Ports.—Those of us who [illegible] familiar with the [illegible] associated with the [illegible] of our ports. The fluctuations [illegible] of ships in our ports are due to [illegible] conditions. The [illegible] and a certain proportion [illegible] constant employment, but [illegible] come under the [illegible]. [illegible] casual labour earnings are [illegible] which the man does [illegible].

The sad story of the docker's life is told in reports of Royal Commissions, books, pamphlets and magazine articles devoted to the subject. To those interested in it, I would commend a book, published during the current year, entitled "Casual Labour at the Docks," by Mr. H. A. Mess, B.A. No suggestion is made in this little book that advantage should be taken of modern machinery and appliances to amend this state of affairs; and yet this is, I believe, a direction in which we should look for relief.

These labour problems have occupied the attention of many thoughtful minds. Much has been attempted to mitigate the lot of the casual docker, with a certain amount of success where employers and workmen have co-operated. This combination is, unfortunately, too rare, and mutual suspicion has barred progress. May we not hope and work for the day when employers will see that liberality towards their workmen will pay better than the old method of trying to get the largest amount of work for the smallest possible wage, and when workmen will see and acknowledge that low output will necessarily result in low wages?

The solution generally accepted by those who have devoted attention to this difficult problem is to form a staff of permanent labourers in each port, and reduce the casual element gradually. I can only refer you to what has been done in Liverpool and London in this direction. It is only a beginning, but seems to show that the proposition is not impossible or Utopian. Where it has so far failed it has been due to lack of co-operation amongst the employers, and to the ingrained suspicion of the men with regard to any proposal for the abolition of casual labour.

The permanent staff of workmen should be well paid, and work for a reasonable number of hours. They might be divided into shifts, if found desirable. Such a well-paid permanent staff would be well nourished and capable of a reasonable amount of overtime in cases of emergency. Now, with such an effective staff, supplemented and equipped with appliances for handling raw material and merchandise, we have a most elastic and efficient combination.

It is the fluctuating demand for dock labour that has led to the high rates of wages demanded by the men and to the bitter strikes with which some of us are familiar. It is the high rate paid to the casual labourer which lures men to the docks, and is constantly filling up the ranks of the under-employed. They overlook the fact that the high hour rate is only paid for the actual time worked, and they do not take into account the hours of waiting and of unemployment for which no payment is received. Casual labour has been described as a subtle form of sweating.

Engineers know that, even when idle, machinery requires watchful care, yet when the complex human machine is out of work it is often allowed to remain neglected and uncared for. It will probably be said that our poor law relief is intended to meet such difficulties; that the Education (Provision of Meals) Act, 1906, was specially passed to guard the children from the evil effects of their parents' under-employment. Is it not our experience that these costly methods of relief scarcely touch the problems of poverty to which we have referred?

You may naturally ask, What has led me to introduce such social problems in "The James Forrest Lecture"? My answer is, "Nothing but a sense of the gravity of the issues involved."

We have by the continuance of casual labour in our docks maintained an army of under-employed, under-clothed, under-fed and badly-housed men, with their dependent families. We have thereby fomented discontent and trained up a population demoralised by poverty, poor-law relief and so-called charity, and constituting in my opinion a national danger.

I have no doubt in my mind that causes which lead men to combine in the manner in which the members of the Irish Transport Union combined are a danger to the State. Those causes in Dublin were the casual labour of our dockers, with its accompanying poverty and miserable housing.

My desire is that we as engineers may be able to assist in finding a solution of this pressing problem of casual labour. The development of appliances for handling raw materials and merchandise must, I believe, prove a potent factor to this end, bringing increased permanent work, increased pay, shorter hours and better homes to the labourers in our ports.

My experience shows that the position of an engineer frequently affords opportunities for influencing both employers and employed, and of mitigating the suspicion so frequently existing between them. For this reason there would appear to be reasonable hope that our influence may be helpful in promoting the use of appliances for handling raw materials and merchandise.

If this end is attained, we shall, I believe, further the objects for which this Institution was founded, as defined in our charter, by directing the great sources of power in Nature for the use and convenience of man.

CORRESPONDENCE.

THE AIR-GAP FIELD OF THE POLYPHASE INDUCTION MOTOR.

TO THE EDITORS OF THE ELECTRICIAN.

It would appear from Mr. Biedermann's letter that he has not seen paragraphs 4 to 9 of the concluding section of my Paper, which, by some mistake, were omitted from what should have been the final instalment on October 6th, but were printed on pp. 49-50 in the issue of October 13th. The fourth paragraph states that in drawing up Tables XI. and XII. the saturation curve of Fig. 11 (p. 904, Vol. LXXVII.) was employed, and that the maximum ampere-turns acting on a half magnetic line were taken as 450. The ratio=(total ampere-turns)/(air-gap ampere-turns) is for this point 450/320=1·4, a figure which is not likely to be exceeded in motors of normal design.

The table in which Mr. Biedermann compares the results obtained by his method with those derived by mine is very interesting. I cannot agree however, that arguments based on his formulæ are mathematically more exact than those I employed. In the first place his formulæ for β_m are only approximate, and, secondly, it is impossible to assign an exact physical meaning to the term "average coefficient of mutual induction," which shall be applicable to the motor when running. Of course, we can calculate the actual coefficients for a stationary motor with various relative positions of stator and rotor, as Mr. Biedermann and others have done, and, plotting a curve, we can average them in various ways,* but when the rotor is running the coefficient will pass through the whole series of values several times during one cycle of the primary current. The difficulties surrounding the question as to how this average should be taken led me, seven or eight years ago, to abandon methods involving it in favour of the method put forward in my Paper, where I have shown that the mutual action between the windings of a running motor *via* the multiple fields is essentially different in character from the action *via* the fundamental field.

It is unfortunate that several different definitions of the circle coefficient have come into use. The coefficient defined as σ=(magnetising current)/(diameter of current circle), which I use, is the earliest form—*i.e.*, the original "leakage factor" employed by Behrend in his book "The Induction Motor"—and is the reciprocal of the coefficient developed by S. P. Thompson in "Polyphase Electric Currents" (second edition). I have found this form to be the most convenient when designing, because in calculating the circle diagram one determines first the magnetising current, and then, by means of σ, the radius of the current circle.

In dealing with the effects of saturation, the rectangular field form due to a single slot winding should not be taken as the basis of the treatment (as Mr. Biedermann suggests in his letter and in his Paper, p. 57, Vol. LXXVI.), because such fields may not be superposed; it is necessary to consider the resultant distribution of M.M.F., due to currents in the complete winding, and the flux distribution produced by it.

London, Oct. 21. F. T. CHAPMAN.

THE EVOLUTION OF THE ELECTRIC LAMP AND TUNGSTEN FILAMENT LAMP EFFICIENCIES.

TO THE EDITORS OF THE ELECTRICIAN.

I have read with interest Mr. C. C. Paterson's reply to my comments on his statement as to the limits of efficiency of vacuum-type tungsten filament lamps in his interesting article on "The Evolution of the Electric Lamp" in your special issue of Septemebr 15th.

I note Mr. Paterson explains that the efficiencies he referred to were the mean spherical candle-power, and not the mean horizontal candle-power efficiencies, which latter are the usual values taken. This is very surprising, in view of the fact that there appears to be no mention whatever in the article of this basis tor efficiency values. It emphasises all the more the danger of general statements of this kind which are not properly defined or limited. and must inevitably lead to misunderstandings, if not serious harm to the merits of the electric lamp.

I would like to point out that the invariable practice in connection with electric lamps is to assume that the efficiency expressed always refers to efficiency on the mean horizontal candle-power basis, unless otherwise stated. Mr. Paterson, I feel sure, is conversant with this general practice, and should have clearly stated that the efficiencies as described were efficiencies on the mean spherical candle-power basis.

I am seriously in doubt, however, whether Mr. Paterson really speaks in terms of spherical efficiency throughout his article, as the efficiency he gives for the tantalum lamp of 1·7 watts per candle is certainly not a figure obtained on the mean spherical basis. This figure is mean horizontal candle-power efficiency, as these lamps have never claimed an efficiency as high as this on the mean spherical basis.

Again, Mr. Paterson says "the initial claim for tungsten filament lamps was that lamps would yield 1 candle per watt." Here again the efficiency referred to cannot be on the mean spherical basis, but on the mean horizontal, as tungsten lamp manufacturers never attempted to claim a mean *spherical* efficiency of 1 candle per watt.

Again, in speaking of the half-watt type or gas-filled lamp, a statement is made that an efficiency approaching 2 candles per watt is obtained in the large sizes of these lamps. This also considers the efficiency on the mean horizontal basis, and not the mean spherical basis.

Again, coming to Table I., showing the progress of the incandescent lamp on p. 824, we have the efficiency shown for the various lamps in the order of development, and the values here given are certainly on the mean horizontal basis and not the mean spherical basis. Mr. Paterson, for example, shows an efficiency for carbon filament lamps in 1880 of 4 watts per candle (0·25 candles per watt). This is the mean horizontal value, and not the mean spherical, the latter being more nearly 5 watts per candle, or 0·20 candles per watt.

Viewing the situation, therefore, on the whole, it would seem that Mr. Paterson has confused his values.

It is unfortunate that an article dealing as fully as this article does with the question of lamp efficiencies should not have been more specific in its actual statements, so as to make it clear without question what efficiency values were really meant.

Mazda House, London, Oct. 17. F. W. WILLCOX.

ELECTRIC SIGNALLING WITH BARE WIRES.

TO THE EDITORS OF THE ELECTRICIAN.

The Home Office has issued a Report on "Electric Signalling with Bare Wires," which has been prepared by quite a covey of doctors and bachelors of science. The Report is quite interesting, and can be purchased for the sum of 3d.

It is unfortunate that the writers should use the term "efficiency" for "resistance"; it has for many years been known that the ohm was a velocity, but never an efficiency. They also use the phrase "parallel short-circuit winding" for the "short-circuited secondary winding," and this conveys very little meaning to an electrician.

This Report has been sent to all the colliery managers, and although by reason of the fact that they have obtained their certificates they have generally a good knowledge of useful mathematics, it is doubtful if many of them have the time to appreciate the meaning of the negative index $(r+r')t/L$, and one wonders what Bill Hodroyd, whose duties combine the care of the haulage ropes and the underground signals, where no other electricity is used in the pit, will make of the term Ldi/dt.

The quart size wet Leclanché cell is recommended as having a high internal resistance, and consequently limiting the cur-

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* *See*, for instance, H. Meyer-Wülfing, "Die doppelt verkettete Streuung, &c.," "Archiv. f. Elektrotechnik," Vol I., No. 8, pp. 363-382, 1912, where different methods of averaging are compared.

[illegible] electric circuits. The Report fails to point out however, that according to the Mines Act there is no limit to the number of cells [illegible] may be put in parallel, and it is by no means [illegible] practice to find a battery of 100 of these cells [illegible] series parallel to give a voltage within the limits of the Mines Act, namely, 25 volts. It is obvious that quite a large current can be obtained from such a battery.

Any danger from sparking at signal wires can evidently be [illegible] by fitting the Bell magnets with copper sleeves, and [illegible] resistance winding. This seems to be the most [illegible] cannot be tampered with. Also some restrictions should be placed on the connection of batteries in parallel.

The insertion of a non-inductive resistance in series with [illegible] will probably be generally adopted, but there is always a danger in case of the bells not ringing properly that [illegible] of the resistance will be cut out, and anyone [illegible] making inspections underground will know [illegible] to detect this class of offence.

[illegible], Oct. 10. "Holm Oak."

"ON THE RELATION OF IMPORTS TO EXPORTS."

TO THE EDITORS OF THE ELECTRICIAN.

[illegible] review of this article a reference to "the now [illegible] Tariff Reform v. Free Trade arguments." I [illegible] it would be a calamity if they were forgotten, [illegible] Free Trade arguments were based on economic fallacies, [illegible] adduced almost as Nature's laws, [illegible] by the War.

What [illegible] can be anticipated for the producer as against [illegible] of these arguments is to be forgotten?

[illegible], Oct. 21. J. S. Hecht.

THE THEORY OF LEAD ACCUMULATORS.*

BY [illegible]

It [illegible] that, 60 years after the remark [illegible] of G. Planté, the views of authorities are not yet in [illegible] the reactions which take place in a [illegible] the electrolysis of acidulated water between two [illegible].

According to Planté [illegible] Faure, who industrialised his discovery [illegible] of oxygen in the form of PbO_2 [illegible] takes place according to the equation:—

$$[illegible]$$

The [illegible] that due to Gladstone and Tribe, [illegible] the existence of double [illegible]:—

$$PbO_2 + 2H_2SO_4 + Pb = PbSO_4 + 2H_2O + PbSO_4$$

According to [illegible] both plates undergo sulphation during [illegible].

This theory [illegible] supported and opposed by [illegible] Gladstone and Hibbert, [illegible] The opponents of the [illegible] that the [illegible] only half [illegible] that the [illegible] during discharge.

[illegible]

[illegible] in a compact condition. If detached from its support and placed in a porous pot around a sheet of platinum as an electrode this active positive material gives 2·4 volts against a zinc plate as negative. One can obtain in this way a prolonged discharge, which, however, falls rapidly as the material becomes exhausted, just as occurs in the Reynier lead peroxide accumulator. This discharge at 2·4 volts is followed by a second discharge which persists much longer, commencing at 0·7 volt and descending regularly to zero. The capacity of this second discharge is five or six times that of the first one. In repeating the experiment with chemically prepared lead peroxide this second discharge was invariably obtained.

When the active positive material has been detached from its support, well washed and dried, it has a very low resistivity; on the other hand, lead peroxide is a less good conductor, minium still less so, litharge almost an insulator, while lead sulphate has a resistivity even greater (two million times as great as that of electrolytic peroxide). Washed and dried, active positive material is of a smoky black colour, but loses this tint spontaneously when exposed to air for several days, the surface becoming brown.

Finally, when submitted to chemical analysis, this material appeared to conform with the formula Pb_3O_7. M. Tennen and M. Hollard have shown in another connection that the electrolytic determination of lead as peroxide at the positive in a nitrate solution leads to the result $Pb/PbOx = 0{\cdot}852$, corresponding with Pb_3O_7, whereas the dioxide yields the relation $Pb/PbO_2 = 0{\cdot}866$.

All these facts suggest:—

1. That the positive plate in an accumulator contains an oxide richer in oxygen than PbO_2.

2. That the positive at the end of the discharge consists of PbO_2.

3. That only the negative undergoes sulphating during discharge.

4. That the reaction of this discharge can be expressed by the equation $Pb_3O_7 + H_2SO_4 + Pb = 3PbO_2 + H_2O + PbSO_4$.

5. That the lead peroxide Pb_3O_7 is endothermic, and absorbs about 9,000 calories in passing from PbO_2 to Pb_3O_7. Conversely, the dioxide emits about 12,000 calories in passing from PbO to PbO_2.

6. That the discharge of an accumulator is comparable with the process of depolarisation during which the manganese element passes to the Mn_2O_3 condition, or even to Mn_3O_4. In the accumulator, Pb_3O_7 passes to PbO_2, the negative in the meantime sulphating instead of becoming chlorinated, as is the case in a battery employing manganese.

THE EFFECTS OF A DISTURBANCE ON A THREE-PHASE NETWORK.*

BY H. KUHLS AND W. PETERSEN.

The following account relates to a disturbance which took place on the network connected to the main power works, the distributing network consisting of overhead cables with some relatively short lengths of cable. It is connected through a cable 3·2 km. long, and through an oil switch to the 'bus bars at the power station in Höchst, from which a considerable length of distributing cables and overhead wires is supplied. On September 14, 1915, at 6.45 a.m., the oil switch opened in consequence of a short-circuit. The switch was immediately closed again and remained closed. Voltmeters are connected between earth and the various 'bus bars, and these showed on phase I., 5,800 volts, on phase II. 6,700 volts, and on phase III. 6,000 volts. At 6.55 a.m. a factory which had a transformer with a capacity of 100 k.v.a., reported that their motors were slowly running in a backward direction; at 7.15 a similar report was received from another works with two transformers, each of 250 k.v.a. The reverse direction of rotation of the motors also took place in other works. These included works at Hofheim, which had two motors each of 50 kw., one motor of 37 kw., one of 30 kw., and several smaller ones; a leather factory, with one motor of 30 kw., one of 15 kw., two of 11 kw., and several smaller ones; Eppstein's [illegible] factory, with one motor of 22 kw., one of 15 kw., and one of 7·5 kw.; and another factory, with one motor of 22 kw., one of [illegible] kw., and one of 3·75 kw. In the Hofheim factory, the following points were noticed:— At first, there was no voltage available, and the automatic cut-out devices came into action. When the switches were closed and the motors were started again, they all ran backwards in the reverse direction at full speed; they amounted in all to 300 k.v.a. It was also found that in two other places, motors of [illegible] and 3·7 kw. ran backwards at full speed. In one place the [illegible] were changed, and the belt was crossed; and it was then found possible to continue work with the circular saw. After rather [illegible] experiments in the way of division and subdivision of the

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[illegible]

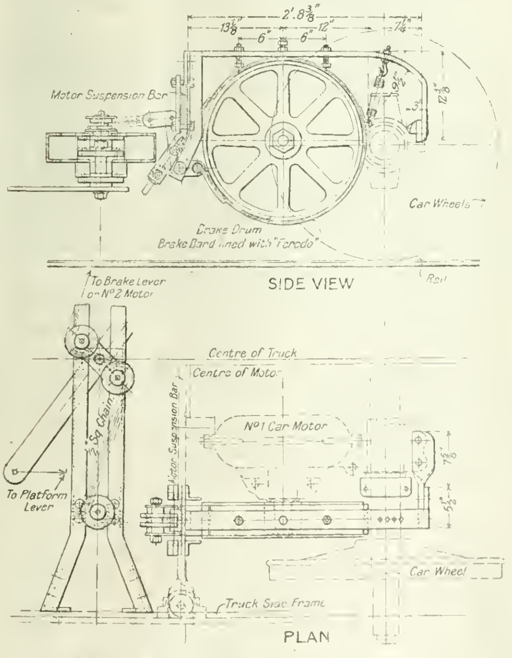
* Abstract of an article in the "Elektrotechnische Zeitschrift," [illegible] 1916.

transmission lines, it was found that the fault was in the power house itself. The oil switch was examined, which connected to the part of the network affected by the disturbance, and it was found that there was a discontinuity in phase II. An insulator that carried the middle contact piece in the oil switch was found to be broken, and the contact piece had fallen to the bottom of the oil case. In consequence of the discontinuity on this phase this part of the network was only connected through two phases to the power house.

The authors give an explanation of the causes of the phenomenon, but this is not here reproduced, as it depends largely on certain theoretical investigations, published in a preceding article. But the facts relating to the disturbance itself are of interest, altogether apart from the causes which contributed to it, which depend on the capacities of the line, the magnetising currents of the various transformers, and the relations of the disturbed to the undisturbed portions of the network. Those interested in the theoretical aspect of the question will do well to refer to the original articles.

THE "WILKINSON" BRAKE.[*]

It will be remembered that Mr. W. T. Robson referred to the "Wilkinson" brake in his Paper, "Tramway Transit and Comfort," read at the Congress of the Tramways and Light Railways Association in June last.[†] During the discussion on the Paper a wish was expressed for further details in regard to this brake. We are indebted to Mr. R. H. Wilkinson, general manager of the Huddersfield Corporation Tramways, for the following description of his brake.



Views showing arrangement of Wilkinson Brake.

This brake is a band brake attached to the extended armature shaft actuated through levers from the usual platform brake spindle. The brake drum, which is of cast iron and keyed on to the armature shaft, is of open section, the arms creating a draught which assists greatly in keeping the drum cool, also reducing to a minimum the "mass" of the drum wheel to facilitate rapid cooling.

The brake band is of mild steel lined with "ferodo," and is in one length, attached at the ends to a bell crank lever by means of rivted lugs, one end being fitted with an adjusting screw. The band and levers are supported by an angle iron and flat bar frame attached to the motor suspension bar, and to the motor shell at the axle bearing. A pull-off spring, and adjusting screws for regulating the clearance between drum and band, are fitted to the frame as shown.

The force applied to the brake band levers is equalised by a differentiating chain gear. A chain passes freely through two fixed pulleys attached to a cross frame, and two pulleys attached to a short lever which is fixed to the main "pull" lever as shown, and moves with it.

The "pull" lever is placed on the under side of the cross frame, owing to lack of clearance above, and is connected by a gudgeon to the short "pulley" lever situated above the frame. The ends of the "pull" lever are connected up to the platform brake spindle in the usual way; a hand wheel being used in preference to a lever.

The brake is quickly applied, there being practically no slack to take up, as with wheel brakes. Braking through the gears, it is similar in action to the electric brake, and has proved very efficient.

Tests were made on the level with a dry rail, and the speed obtained was 16·3 miles per hour. The car stopped 20 yds. in five seconds, which equals 4·8 ft. per second.

LEGAL INTELLIGENCE.

Locker-Lampson v. Isaacs and others.

On Monday this action came before Mr. Justice Sargant, and was brought by Mr. O. S. Locker-Lampson and Mr. P. S. Wright, on behalf of themselves and all other the shareholders of Marconi's Wireless Telegraph Co. (Ltd.) (except such defendants as were shareholders therein), against Mr. Godfrey Charles Isaacs, Messrs. Heybourn & Croft, Messrs. Guglielmo Marconi, H. S. Saunders and Alphonso Marconi, Major Flood Page (since deceased), Capt. H. Riall Sankey, Messrs. S. Geoghegan and Maurice Travailleur, Col. Albert Thys (now deceased), Mr. Harry Michael Isaacs, Messrs. Billett, Campbell & Grenfell, Marconi's Wireless Telegraph Co. (Ltd.), and Mr. S. F. St. J. Steadman. The nature of the action was not stated, but there were five motions by different defendants.

The first of the motions was by Mr. A. Marconi, Capt. Sankey and Messrs. Geoghegan & Steadman, asked (*inter alia*) that plaintiffs' amended statement of claim might be struck out as against them, and the action be dismissed with costs, on the ground that there was no reasonable cause of action against applicants. Alternatively, the motion asked that the action might be dismissed as against the applicants, with costs, on the ground that it was vexatious; or that certain questions raised by certain portions of the pleadings might be tried before the other questions or issues.

For applicants, Mr. Gore-Browne, K.C., argued that no person could (with a few exceptions) bring an action in respect of a cause of action which was vested in someone else. In the present case the wrong (if any) was against the company, which was the only proper plaintiff in respect of the wrong except in one case.

Sir John Simon, K.C. (for the company), interposed, and said that a settlement had been arrived at, apart from the counsel in the case, under which the action was to be stayed on certain terms.

The terms of the settlement were not disclosed.

Toronto Electric Light Co. v. Toronto Corporation.

On Oct. 23 the Judicial Committee of the Privy Council delivered judgment in this action, which was brought by the appellant company for an injunction to restrain the Corporation from interfering with appellants' plant by cutting down, removing or otherwise interfering with their poles and wires in the streets and other public places in the city.

Sir John Simon, K.C., Mr. Hellmuth, K.C., and Mr. Auglin, instructed by Messrs. Blake & Redden, appeared in support of the appeal; Sir Robert Finlay, K.C., and Mr. G. R. Geary, K.C., instructed by Freshfields, for respondent Corporation.

Lord Atkinson said that the appeal was from a judgment of the First Appellate Division of the Supreme Court of Ontario, whereby a judgment of the trial judge in favour of plaintiff company was set aside, and it was ordered that, subject to certain declarations, the action should be dismissed with costs. The case was not free from difficulty, for some important transactions which took place between the parties were not in writing. The company was incorporated in 1883 by an Act which purported to confer the power (inter alia) of manufacturing electric light and power, and the erection of plant and all machinery necessary for lighting the streets and houses of the city. In exercise of that power the company established an extensive system for the distribution of electricity over almost the entire city of Toronto. It supplied current to private customers and to the Corporation for lighting the street lamps. The system in 1912 was partly overhead and partly underground, but much the larger part was overhead. It then covered 370 street miles, 1,450 miles of wire being carried on 15,705 poles. The underground system then consisted of about 350 miles of single conduit laid in 28 to 30 street miles. The two systems were so "interlaced" that if the overhead construction were removed the underground in some instances would have no connection with the terminal stations or sub-stations of the company or with any source of power. It was not disputed that the cost of constructing underground conduits so far exceeded that of carrying wires overhead on poles that, having regard for the prices obtained for the current the former system was only commercially possible of adoption in a limited and favoured area in the city, where customers were both large and numerous. On Feb. 6, 1912, the Corporation passed a resolution denying, among other things, (1) the right of the company to lay any underground conduits outside the limits of the city as they existed in November, 1889, when an agreement was entered into between the company and the Corporation; and (2) its right to construct pole lines within the city, save for the purpose of implementing its contract with the Corporation for street lighting. They followed that up about the middle of October, 1912, by preventing by force the company from erecting additional poles and wires, and also removed certain poles, part of the company's overhead system, which had been in actual use some three years. The action was then instituted by the company claiming an injunction, damages and further relief. As stated above, the injunction granted at the trial was set aside on appeal. On a review of the various agreements entered into between the parties, their Lordships thought that the provision touching the purchase of overhead plant contained in the agreement of November, 1889, meant no more than this, that the Corporation should be entitled to purchase, when they purchased the underground system, such poles and plant of the overhead system as might be then found lawfully erected on the streets and public places of the city. No estoppel arose in the case, as there was no evidence that both the contracting parties were not fully aware of their respective legal rights. It might well be that the company never anticipated that the respondents would insist upon the removal of the poles carrying wires erected with their implied consent, but not in pursuance of any formal agreement. With the hardships (if any) or the moralities of the case this Board had no concern. It dealt alone with the legal rights of the parties, and, having regard solely to them, their Lordships were on the whole case of opinion that the judgment appealed from was right, and should be affirmed, and thus appeal of the company dismissed with costs.

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[*] From the "Journal" of the Tramways and Light Railways Association.

[†] The Electrician, Vol. LXXVII., p. 464.

Petition for Prolongation of Patent.

The petition of F. G. Creed, Wm. A. Coulson and Creed, Bille & Co., Ltd., the beneficial owners of a patent granted to Messrs. Creed & Coulson, was mentioned to Mr. Justice Sargant last week on an application to fix Wednesday, Nov. 1, for the hearing of the petition. The inventions for which letters patent were granted consisted of "Improvements in or relating to means or apparatus for operating or controlling type writing and type-setting mechanism by means of perforated tape." The object of the invention was to reproduce telegraphic messages in ordinary readable printed characters, and the system of telegraphy to which the invention was applicable had long been known as the Wheatstone Morse system.

Mr. [illegible] Cartmell (for the Board of Trade) said the proposed date would suit all parties, and his lordship acceded to the application.

PARLIAMENTARY INTELLIGENCE.

MUNITION PLANT AFTER THE WAR.

In the House last week Major Chapple asked the Prime Minister whether he would set up a Committee to inquire into the financial relations of the State to controlled industries in the munitions department and of reporting on any scheme under which the machinery, plant, buildings or land provided by the Government, instead of being sacrificed or [illegible] with at the end of the war, might be handed over to the manufacturers [illegible] concerned in return for an equitable interest in shares in such post-war industry to which they might be applied, with a [illegible] interest being made available through a Trust Commission for the [illegible] of scientific and technical education and of any other public [illegible] to develop our trade, commerce, and industry.

In reply, Mr. Asquith said both questions would come within the ambit of the inquiries which the Government were instituting into the situation which would arise after the war, and the suggestion would not be lost sight of.

EDUCATIONAL.

Northampton Polytechnic Institute.—Classes for engineer salesmen and other [illegible] trained men engaged in the commercial side of [illegible] engineering have been arranged for the session 1916-17. [illegible] of these classes will cover the syllabus of the City and Guilds of London Institute examination to be held in 1917 in the subject of [illegible] [illegible] and estimates. The lecturer is Mr. [illegible] [illegible] of construction of sub-stations to the [illegible] Co. The lectures are given on Fridays, [illegible] Applications for admission must be sent to the Principal, Dr. R. M. Walmsley, Northampton Polytechnic Institute, [illegible] London, E.C.

University of Bristol.—The Dean of the Faculty of Engineering [illegible] has proposed to introduce a modified "sandwich" system of training for engineering students.

It is proposed that a student [illegible] should enter the university [illegible] passing the [illegible] examination [illegible] is good and [illegible] be recommended to a firm, which will allow him to enter their works for 14 months. This will enable the student to judge to what extent he is fitted for an engineering career, and will also enable the manufacturers to form an impression as to his suitability. He will then return to the university for a further period of two years—in some cases spending the long vacation in the works; after that he will return to the same works, if he has given satisfaction, for another period of 14 months, so that the course in the case of a student who enters, say, in the session 1916-17 will be, approximately, as follows:—

Period.	No. of months in works.	No. of months in university.
October, 1916—July, 1917	...	10
August, 1917—September, 1918	14	...
October, 1918—July, 1919	...	10
August, 1919—September, 1919	2	...
October, 1919—July, 1920	...	10
August, 1920—September, 1921	14	...
	30	30

A number of firms are considering these proposals, but the names of several who have already agreed to take part in the experiment are given. These include the Electric Construction Co., R. A. Lister & Co., Mather & Platt, Midland Railway Co., Plenty & Son, A. Ransome & Co., Robey & Co., Swan, Hunter & Wigham Richardson, John I. Thornycroft & Co. (Ltd.), George Waller & Son, and Messrs. Yarrow & Co.

Association of Technical Institutions.—At the general meeting on Friday last Lord Haldane delivered an address on "Education after the War, with Special Reference to Technical Instruction."

In the course of his address Lord HALDANE said that we needed a greatly improved level of technical training. He was against undue specialisation of secondary schools. Some form of continuation school was needed. We should have to put into modern form the doctrine of apprenticeship, so that an employer might employ boys of between 14 and 17, but on terms of letting their education be provided in the daytime.

Sir A. TREVOR DAWSON read a Paper on "Education after the War, with Special Reference to Engineering Instruction." He said that never in the history of the country had there been a greater need for stimulating industry either for the perfection of design or of the methods of manufacture. We had to make up for the wastage as well as the deficiency in wealth-producing media neglected during the war. It was a remarkable commentary on our education system that there are in this country about 1,000,000 boys between 14 and 18 who are not attending any day or evening school. In London there were relatively fewer opportunities for boys entering engineering works within easy reach of their homes in the metropolis than was the case in some of the other cities. That involved a problem for the State. It was of the greatest importance that the available man-power of London as well as that of the rural districts should be utilised. He suggested that apprenticeship should begin at an earlier age than at present and that the most promising boys should devote part of each day to the workshop and part to the school. The continuance of the privilege of alternation should depend on aptitude and application, and boys who survived successive elimination tests might eventually be given a course of training at a technical college or university.

In the course of the discussion, Principal GARNETT suggested that the Association should issue a statement giving its view on the training of engineers. The public schools and the people all over the country were looking for a lead in this matter.

Mr. BURKHARDT moved that the Council be instructed to consider the issue of a statement to the nation dealing with the immediate necessity of the further development of technical education.

Principal FORTH seconded, and the resolution was carried, subject to the Association approving the statement before it was issued.

Empire Industrial Policy.—The Prime Minister of New Zealand, the Right Hon. W. F. Massey, has promised to speak at a luncheon of the British Empire Producers' Organisation at the Waldorf Hotel on Tuesday next, when Sir Henry Birchenough, K.C.M.G., will preside. The guests will also be addressed by Mr. F. R. Davenport, chairman of the British Electrical and Allied Manufacturers' Association, which represents various important sections of the engineering industry. Delegates of Canadian, Australian, South African, Indian, West Indian and other dominion industrial interests will be present, and the list of great industries represented will include railway and shipping, sugar, jute, tea, timber and rubber, general agriculture, engineering, chemicals, textile, shipbuilding, leather and other manufactures, besides technical institutions and chambers of commerce. It is the aim of the British Empire Producers' Organisation to co-ordinate the efforts of sectional trade associations and further the gradual formation of a practical Imperial economic system, under which British national resources and manufactures will be developed for the benefit of the whole population.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

The Board of Trade and Consular Reports. We desire to draw our readers' attention to the communication recently sent to the President of the Board of Trade by Messrs. Benn Bros. on the reorganisation of the Commercial Intelligence Department of the Board, on the administration of the Board of Trade "Journal," &c. The communication is set out on page 132.

We need scarcely add that we are in entire agreement with Messrs. Benn Bros., and on more than one occasion we have called attention to this subject. We would go further, and say that the suspension of the publication of Consular Reports on the plea of economy is an unwise and retrograde step. It is true that short abstracts of the reports are given in the "Journal" of the Board, but these are of little value, and we rely on the American Consular Reports, which are usually much fuller and more up to date than our own, on the foreign technical Press and on our own organised methods of collecting information to keep our readers acquainted with foreign engineering matters.

In pre-war days it was no uncommon thing for consular reports to contain statistics and information two or three years old and quite out of date. Abstracts of these reports by clerks in the Commercial "Intelligence" Department of the Board of Trade are of little value whether they be copyright or not. Therefore the policy of the department is not likely to be of great advantage to British trade and industry, as it is not calculated to keep manufacturers and engineers in touch with current foreign demands or with the latest developments in foreign invention and progress. The consular service must be improved, consular reports must be prepared more expeditiously and published as soon as they are received, and British manufacturers and merchants must have ready access to them. We agree with Messrs. Benn Bros. that the Board of Trade "Journal," which is subsidised and run by public money, is an unfair and specially favoured competitor of trade journals, though we think it can never become a serious rival of up-to-date technical organs.

* * * *

Metal Trade After the War. The President of the Board of Trade (Mr. Runciman) has appointed a committee to consider the position after the war, especially in relation to international competition, of the lead, copper, tin, and such other of the non-ferrous metal trades as may be referred to the committee, and to report what measures (if any) are necessary or desirable to safeguard that position. The members of the Committee are Sir Gerard A. Muntz (chairman), Mr. C. L. Budd, Mr. Clive Cookson, Mr. C. W. Fielding, Lieut.-Col. A. J. Foster, Mr. A. W. Tait and Mr. A. H. Wiggin. The secretary of the Committee is Mr. James F. Ronca, 7, Whitehall-gardens, London, S.W.

* * * *

Foreigners as British Agents. The Association of Chambers of Commerce is informed that in a recent despatch from Sir Claude Mallet, British Minister to Panama and Costa Rica, it is suggested that Chambers of Commerce in the United Kingdom should be asked to take action to induce British manufacturers and exporters not to employ foreigners of enemy nationality after the war to represent them abroad.

Sir C. Mallet states in his despatch that, before the war, it was quite common to meet travellers with German names representing British firms. Such men were placed in a position to acquire very valuable information regarding our goods which would be of the greatest use to our German competitors trading with Panama and Costa Rica.

* * * *

Commercial Libraries. The Chairman of the Liverpool Public Library, Museum & Arts Committee (Ald. F. J. Leslie) is advocating the creation of a commercial museum in Liverpool, which would show by practical specimens (kept up to date) the progress and development of the principal trades and industries of the city.

Ald. Leslie would also like to see the Committee giving its attention to exhibitions of arts and crafts. The most important of the new activities he advocated was the formation of a commercial library. Every year their shelves received enormous additions from all parts of the world of trade returns and statistics, consular reports, Blue-books, trade journals, commercial summaries, reference books, catalogues and treatises. The mere existence of these was known to very few, but those business men who occasionally came there for information were astonished at the wealth of commercial and industrial literature at their disposal, and expressed a wish that it was more easily accessible. He suggested that they should establish a branch commercial library in the immediate neighbourhood of the Exchange, in which they should try to provide everything that could be useful and quickly accessible to the business community. In America such libraries were frequently to be met with. In this country the only example he knew of was at Glasgow, but there it had not been attempted on the scale that would be needed to make it a success in Liverpool.

* * * *

Restriction of Imports. The B.E.A.M.A. announces that the Department of Import Restrictions (Board of Trade) has granted to the Association a special licence to import insulating materials in certain classes which are included in the list of prohibited imports. Electrical manufacturers, whether members of the Association or not, can avail themselves of this licence by making application to the secretary of the Association.

The Department of Import Restrictions desires it to be known that the granting of licence is a temporary measure to meet present urgent needs. This licence extends to Jan. 16, 1917, at which time the necessities of the situation will be again reviewed. It is expected that firms in the meantime will make every effort to obtain in this country the supplies of insulating material which they require.

* * * *

Trade Marks in Australia. The Commonwealth Government "Gazette" (Aug. 23) contains descriptions of a number of goods of enemy manufacture which are protected in various States of the Commonwealth by trade marks registered in those States.

The Federal Attorney General (Mr. W. M. Hughes), who is the Minister administering the Commonwealth Patents, Trade Marks, and Designs Act, 1914-15, has decided that the registration, and all rights conferred by the registration, of these trade marks shall be suspended in favour of the Minister for Trade and Customs or of such persons as the Attorney-General may approve from time to time. Articles of enemy origin, whether protected by registration under the Federal or the States' laws, are now transferred to the jurisdiction of the Minister for Trade and Customs.

* * * *

Alien Members of Chambers of Commerce. The new directors of Manchester Chamber of Commerce propose to amend their articles of association in such a way as to exclude the following from membership of the Chamber:—

Any German, Austrian, Bulgarian or Turk who has not become a naturalised British subject.

Any firm, corporation, company, association or society, or any representative of a firm, corporation, &c., in which an unnaturalised German, Austrian, Bulgarian or Turk is a partner or director or (in the case of an incorporated association or society) a member.

Any corporation or company in which one-fifth or more of the issued stock or share capital or of the debenture or loan capital is held by or for the benefit of any unnaturalised German, Austrian, Bulgarian or Turk.

Birmingham Chamber of Commerce has asked all members of the Chamber of enemy origin who have not become denationalised of their enemy origin, and have not been naturalised in the British Empire for at least 20 years, to resign their membership. The request applies also to limited liability companies or firms whose share capital is held to the extent of one-third or more by persons of enemy origin, and to limited liability companies one third or more of the directorate of which are held by persons of enemy origin.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Oct. 14, 1916, *to* Oct. 20, 1916.

IMPORTS.

[illegible] E[illegible] carbons [illegible] 11 [illegible] 21 [illegible]. [illegible] E[illegible] 5 [illegible]. [illegible] Elec. carbons, 27 [illegible] *U.S.A.*: Instruments [illegible], 27 cases. [illegible] *Canada*: Unenumerated, 8 [illegible].

[illegible] *U.S.A.*: Wire and cable, £451; [illegible] lamps, £2,603; [illegible] candles, £675; [illegible], £432; telegraph material, £31; unenumerated, £5,905—156 pkgs. [illegible] 115 [illegible]. *Holland*: Elec. lamps, 934 pkgs.; elec. glow lamps, 303 pkgs.; unenumerated, £2,324. *Japan*: Elec. [illegible], 20,717 [illegible]; unenumerated, £4,070—182 [illegible]. [illegible] Carbon candles, £79[illegible]; unenumerated, £2,106. *France*: Carbon [illegible], 78 [illegible]; unenumerated, 114 [illegible]. *Denmark*: Unenumerated, £49. *Norway*: Unenumerated, £913. *Sweden*: Glow lamps, £676; unenumerated, £573. *India*: Elec. [illegible].

[illegible] 47 [illegible].

[illegible] E[illegible] unenumerated, 62 pkgs.

EXPORTS.

[illegible] AUSTRALASIA: *Auckland*: Elec. [illegible], £139; elec. lamps, £38; unenumerated, £[illegible]. *Melbourne*: Wire and [illegible], £341; elec. machinery, £481; unenumerated, £3,209. [illegible]: Elec. machinery, £809; [illegible] cable, £415; telegraph material, £8; [illegible]; unenumerated, £2,865. *Wellington*: Wire and cable, £492; elec. machinery, £44; unenumerated, £486. *Lyttelton*: Wire and cable, £212; elec. machinery [illegible]; unenumerated, [illegible]. *Adelaide*: Wire and cable, £100; telegraph material, 258; [illegible]. *Christchurch*: Unenumerated, £1,278. *Perth*: Elec. machinery, £4[illegible]; unenumerated, [illegible]. *Brisbane*: Wire and cable, £2,035; unenumerated, £97. [illegible]: Elec. machinery, £646; unenumerated, £112. *Dunedin*: Wire and cable, [illegible]. *Hobart*: Wire and cable, £[illegible]7; unenumerated, £434. [illegible]

[illegible] £1,990; telegraph material, £27[illegible]; unenumerated, [illegible] £1,324. [illegible]: Elec. machinery, £52; [illegible] £323. [illegible] *London*: Elec. machinery, £300; [illegible] £325. [illegible] *Bay*: Unenumerated, £25. *Mom-*[illegible] E[illegible] Elec. machinery [illegible]

[illegible] Telegraph material, £19.

[illegible] STRAITS SETTLEMENTS: [illegible] Wire and cable, [illegible] £130. [illegible] Wire and cable, £129; [illegible] £79; elec. machinery, £32[illegible]; unenumerated, [illegible]. [illegible] Elec. machinery, £[illegible]7; unenumerated, £40[illegible]. [illegible] Unenumerated, £108. *Fort* [illegible] Elec. machinery, £3[illegible]; telegraph material [illegible] Wire [illegible] £16; elec. meters, £365; [illegible]

[illegible] £1,202; unenumerated, £82. [illegible]

[illegible] Wire [illegible] £463; elec. machinery, [illegible] Elec. machinery, £24; telegraph [illegible] Unenumerated, £52. [illegible] Wire and cable, £460 [illegible]

[illegible] £22; [illegible]

[illegible] £485.

[illegible] £1,750.

[illegible] £168. [illegible] Elec. lamps [illegible] Elec. [illegible]

[illegible] £670. [illegible]

[illegible]

FOREIGN GOODS (duty paid and free).

[illegible]

IN TRANSIT.

[illegible]

NOTE.—The large number of items in these official returns under the [illegible] heading "Unenumerated" relate to what is described as "[illegible] goods" and "electrical materials."

BUSINESS NOTICES.

[illegible] in another column that they [illegible] which they [illegible].

[illegible] make it known that he [illegible] street [illegible].

[illegible]

Mr. J. V. Rex, late electrical supplies manager for Siemens Bros. Dynamo Works (Ltd.) at Sydney (N.S.W.), has resigned that position and commenced business as an electrical and engineering purchasing agent at Vickary's-chambers, 82, Pitt-street, Sydney.

Stephen Richards and Joseph S. Rhodes, electrical engineers, Station-buildings, Keighley, have dissolved partnership. Debts by Mr. Richards, who continues the business in his own name.

BANKRUPTCIES, LIQUIDATIONS, &c.

A third and final dividend (1s. 0¾d.) is payable at 30, Mosley-street, Newcastle-on-Tyne, to creditors of Arthur Faraday Rawdon, electrical engineer, Yetholm, Elmfield-gardens, Gosforth.

Claims against the Mitcham Motor Co. (Ltd.) are to be sent by Dec. 7, 1916, to the liquidator, Mr. John Baker, Eldon-street House, London, E.C.

On the liquidation of the Consolidated Diesel Engine Manufacturers (Ltd.), a first distribution of 10d. per share has been made to the contributories. There is £33,700 in hand, and it is thought there will be a further return of about 1s. 3d.

Deed of Assignment.—Claims against Geo. Hy. Turner, electrician, &c., 2, Wellington-road, Dewsbury, under a deed of assignment executed by him on June 27 last, are to be sent by Nov. 4 to Mr. C. H. Baker, 1, Albion-street, Leeds.

ELECTRICITY SUPPLY.

EXTENSIONS.

Birmingham.—The Birmingham Tame and Rea District Drainage Board have agreed to sell to the Electric Supply Committee 3½ acres of land at Nechells at £450 an acre.

On June 6 the Council sanctioned an expenditure of £140,000 upon a further extension of the Nechells temporary generating station, including £12,700 for three cooling towers and foundations.

The Electric Supply Committee decided to erect those cooling towers as near as possible to the existing towers, but the idea of using the proposed site had had to be abandoned, and the only other suitable site was on a portion of the land intended for the permanent station. The total extra cost involved was estimated at £7,530, and the proposed alteration has been approved by the Government department concerned. The alteration has been approved by the Council, and the L.G. Board has been asked to sanction the necessary loan.

Bo'ness.—The Council have now received sanction to borrow £12,000 for extensions of the plant at the electricity station.

Glasgow.—At the meeting of the Corporation last week the minutes of the Electricity Committee included an important report by the engineer (Mr. W. W. Lackie).

Mr. Lackie's report stated that the position of the electricity department was getting serious, due to shortage of plant to meet the continually increasing demand, and the whole matter was now in urgent need of careful and prompt consideration. The load this winter would call for the simultaneous use of practically the whole of the generating plant belonging to the Corporation, including the Pinkston power station. The installation of additional boiler plant in Pinkston station would enable them to get through the winter of 1917-18, but generating plant of the size which they must now buy would take at least two years to get installed and running. Hence the reason for his request that the matter should be immediately considered. In November, 1911, a site for a new generating station was purchased at Dalmarnock Bridge. It was agreed that that new station should be proceeded with in the beginning of 1914, with a view to having the new works running during the winter of 1916. In March and during August, 1914, offers were accepted for the clearing of the ground and for the construction of foundations for part of the works. On the declaration of war in August, 1914, the Corporation decided that, beyond completing the contracts which had already been placed, the erection and equipment of the works should be postponed. They had now, however, arrived at a stage when it appeared to Mr. Lackie that they must (*a*) instruct him to stop connecting new consumers, or (*b*) empower him, if new consumers were to be connected, to withdraw the supply from them during the winter months, or (*c*) proceed with a portion of the new generating station at Dalmarnock.

The Committee approved generally of the proposal to proceed with the erection of a portion of the new generating station at Dalmarnock, and remitted to a special committee to consider the matter in detail with the engineer and to report.

Southampton.—The Borough electrical engineer (Mr. H. F. Street) has reported on the necessity for increasing the boiler plant so that when the lighting restrictions are moved it will be possible to cope with the load.

Mr. Street states that in the winter before the war the margin was none too great, and during the whole time since their connections had been increased. The question which he was most concerned about was, when would be the cheapest time to buy. Prices were greatly inflated now, but he was of opinion that when peace was declared there would be a tremendous rush of orders from companies and corporations which would not tend to decrease prices. He believed that next spring would be as economical a time to proceed with the scheme as any. They would have to approach the L. G. Board with a complete scheme, and the Council have directed Mr. Street to prepare such a scheme.

Southwark.—An extension of cable to cost £80 is to be laid to supply current to Messrs. F. A. Norris & Co., engineers and ironfounders.

The Borough Engineer has been empowered to purchase a new motor for the crushing plant at the Manor-place depot, at a cost not exceeding £150.

GENERAL.

Blackburn Automatic Telephone Exchange.—The change from the manual to automatic working was accomplished at Blackburn last week in 70 seconds.

Carlisle.—The Council have granted to the electricity and gas works labourers an additional 4s. per week, subject to their working a full working week and a minimum of four hours' overtime at overtime rates if called upon.

Eastbourne.—The whole of the electrical staff is to receive an additional war bonus of 1s. per week.

Ripon.—The Council have decided to apply for a provisional electric lighting order.

St. Pancras.—The Electricity Committee reports having had under consideration a communication from the Provost of the University College, on behalf of the College Committee, asking that the Council share the expenses involved in changing over the electricity supply at the College from the 110-volt to the 220-volt system.

The cost of the work executed amounts to nearly £2,000, and the work outstanding would normally be about another £1,000, but in all probability will be in excess of this having regard to the war. The committee has decided that, as the change over was made for the convenience and advantage of the consumer, it is unable to recommend the Council to share any of the expenses incurred.

Application is to be made to the L.C.C. for sanction to borrow £11,934, the estimated capital expenditure on the electricity undertaking up to March 31, 1917. The chief items are: Buildings extension at King's-road, £6,811; machinery extension, £1,432; services, £2,845; switches, £702; meters and indicators, £401. A portion of the amount will be defrayed from a loan in hand.

Owing to the greatly increased cost of carbons and of arc lamp globes, the committee has considered the further substitution of half-watt lamps for arc lamps. In April, 1915, the Council authorised the substitution of a number of half-watt lamps, and these half-watt lamps have justified the claims made for them as regards economy and durability, besides enabling the release of two arc lamp trimmers. The chief electrical engineer (Mr. S. Baynes), who suggests that 100 further half-watt lamps be converted, at a cost of £325, states that owing to the difficulty in obtaining materials and men, the work will be completed in about eight months, if the orders are placed forthwith. The cost of the present arc lighting system, based on last year's price for carbons, globes, &c., is about £4. 10s. per lamp, and the half-watt lamp would cost about that figure for the first year's upkeep and capital outlay included. On the second year there will be a considerable saving, the consumption of energy being the same as that required by arc lighting, and the illuminating power will be quite equal when the lamps are again unmasked. The committee have authorised Mr. Baynes to proceed with the substitution of a further 100 half-watt lamps for the arc lamps, at a cost of £325.

All men in the employment of the electricity department in receipt of a war bonus are to be granted an increase of wages for the period of the war equivalent to 1d. an hour. Boys, youths and women are not to get the increase of 1d. an hour, but are to receive an additional 10 per cent. war bonus. All men who are not in receipt of a war bonus are to be granted an increase of 10 per cent. on their present wages up to £160 a year. The total cost of the foregoing will be £1,500 a year.

Tottenham.—The General Purposes Committee is to report on a suggested purchase from the North Metropolitan Electric Power Supply Co. of the gas engine formerly used in connection with the electric lighting of the Council offices, for the purpose of a stand-by agent to drive the fans of the refuse destructor in the event of a breakdown of the existing machinery.

Tynemouth.—Owing to the increasing demand for electrical energy the Corporation's steam plant is being prepared for running.

Wigan.—The Investigation Committee recently reported to the Council on the causes of the breakdown at the electricity works in December last.

The committee reported that they had arrived at the conclusion that the principal cause leading to the breakdown was the use of canal water, the unsuitability of which as feed water had been from time to time during the past eight years (and particularly since 1911) demonstrated to the Electricity Committee, and had been the subject of analysts' reports. The committee recommended that the use of canal water be abandoned, that only town's or other suitable water be used, and that only after being properly treated. It was also recommended that the officials of the electricity department and of the water department be requested to co-operate on all matters in which they may be respectively interested in regard to the electricity works.

The report and recommendations have been approved.

TRACTION NOTES.

Glasgow.—The Electricity department, which has had four electrically-propelled delivery vans in use for some time, has now added a 5-ton electrically-driven tipping wagon for the conveyance of ashes from the generating stations to the coups. Another wagon of the same design is in course of construction for the same department, while one is also on order for the Cleansing Department.

Liverpool.—In reply to a vote of thanks for his conduct in the chair during the past year, the chairman of the Tramways Committee (Mr. Russell Taylor) stated last week that the nine months of the present year had been a record as regarded the total receipts and the number of passengers carried.

The increase in the receipts had been £27,547, and the increase in passengers was 4,451,477, but the mileage decreased by 56,044, while the earnings per car-mile had increased 0·76d. They had been handicapped owing to the war in many directions. The greater part of the male staff had joined the army, and they had had to supplant them by inexperienced men and women, who were doing the work fairly satisfactorily. The balance-sheet might not be as satisfactory at the end of the year as they would like, as they had had considerable additional expense owing to army allowances, war bonuses to employés and increased outlays in other directions. The number of people they carried was greatly in excess of pre-war times, and that might account for some of the inconvenience, but he was going to ask the public to still endure it, as they had no alternative.

So far as the electrical department was concerned it practically was also a record year, and that concern was becoming an ever-increasing asset to the city. The profits from the business had provided sums of £942,740 to be set aside towards repayment of capital, £341,000 to reserve and £335,000 towards the relief of the rates, the contribution for the current year being £50,000. The increase in consumers was 500 over last year, making 12,000 in all. When all the machinery was installed they would have an output of 55,000 kw., which, he believed, would meet the needs of Liverpool for a considerable time.

Thanks were also accorded to the managers and staffs of the various departments.

At the last meeting of the Finance Committee, the chairman (Sir Chas. Petrie) asked the Tramways Committee to consider the advisability of making some rearrangement of the penny stages. There were many overlapping stages that might very well be done away with. He also thought that in a time like this, when everything had gone up in price, people could not expect to have 3-mile journeys for a penny as in pre-war times. If in that way the Tramways Committee could contribute £50,000 to the Corporation finances it would be very acceptable.

Southampton.—A tramway shelter is to be erected on the terminus of the Common

EMPIRE NOTES.

Australasia.—The Council of the Melbourne University was recently informed that the State Attorney-General has decided to introduce a bill to authorise the granting of posthumous degrees to university students who had qualified for them, but have since lost thier lives at the front.

Prof. Henry Payne, Dean of the Faculty of Engineering at Melbourne University, is opposed to the proposal that, instead of the present system of giving degrees in the several branches of engineering (civil, mining, mechanical and electrical), only one degree in engineering should be given. Prof. Payne told the University Council recently that, since he had occupied the Chair of Engineering, there had been no case of a graduate being unable to obtain employment in his profession. He received 30 per cent. more applications by prospective employers of young graduates than could be met. The Melbourne engineering degrees were recognised by public bodies and other employers throughout the world. The Council has decided to make no alteration in the practice.

A deputation representing the New Industries Committee, and which included Profs. Payne and Ewart (Melbourne University), Sir Frank Madden (Speaker of the Legislative Assembly), and Messrs. C. F. Kernot, J. C. Boyce, R. Grundy, J. Cameron, M.L.A., and W. M. McPherson, M.L.A., recently waited upon the Victorian Premier, Sir Alexander Peacock, and asked that the Government should officially recognise the work of the committee, and provide £1,000 for experimental work, as well as a building to be used as an industrial museum and information bureau. It was also proposed that provision should be made for the printing of literature for the information of the public on the industries which might be established or further developed, a salary provided for an engineer to investigate various problems, and an information bureau established so that manufacturers could be informed of the resources of the country and the purchasing public educated to the importance of buying articles of Australian manufacture.

Sir Alex. Peacock said (in reply) nothing would be wanting on his part to assist the object in view. The Government would do everything it could. After having conferred with the Cabinet, he would ask the committee to meet him again, in order that they might determine the best way to develop the scheme.

The "Australian Mining Standard" correspondent at Wallongong states that Coalcliff's colliery, which has been in operation some five years, is one of the most completely furnished collieries in the country. Electrical energy which is used for haulage, &c., is generated by a Bellis-Siemens 400 kw. 250 volt direct-current cross compound set. There are also a 200 kw. and a 15 kw. Bellis-Siemens sets as auxiliaries which also supply current for lighting and for the Illawarra coke ovens adjoining. The boilers are by Babcock & Wilcox. There are two electric coal-cutters, one a Sullivan, the other a Jeffrey. Ventilation is obtained by a Sirocco fan, using induced draught.

At the recent half-yearly meeting of Amalgamated Wireless (Australia) (Ltd.), the chairman (Mr. H. R. Denison), in submitting the directors' report, which was abstracted in our issue of Oct. 13 (p. 65), said he thought it was an extraordinary waste of the taxpayers' money for the Federal Government to pay £55,000 for the plant, patents and land of the Shaw Maritime Wireless Co. These had been offered to their company two years ago, but the offer had been declined. Practically all the wireless stations required on the coast of Australia had been erected and there was little or nothing for such an elaborate plant as that of the Shaw Co. to do in connection with wireless manufacture. Mr. Jensen, Minister for the Navy, while stating that the purchase was made for naval defence purposes, added that the plant would be used not only for making wireless equipment for Australian installations, both land and sea, but for the production of electrical apparatus of many kinds. Moreover, he had been advised by the engineer for radiotelegraphy that there was two years' work in sight for the plant, and that no fear of its lying idle need be entertained. It was proposed to increase considerably the number of land stations in Australia in the near future.

It is reported that good progress is being made with the installation of the Hydro Electric Power & Metallurgical Co.'s first unit of plant for the manufacture of calcium carbide at North-west Bay, Tasmania. This will have a capacity of 5,[illegible]00 tons of carbide per annum, and, it is believed, will be ready by the time the transmission line connecting the works with the Government's hydro-electric scheme is completed, which is promised for the end of March next. Work on the company's electrolytic zinc works is to be put in hand soon.

The Tasmanian Government has been approached by the Australian Electric Steel Co. in regard to a supply of electric power to the company, which is already erecting works in New South Wales, and is prepared to extend its operations to Tasmania. Two of the directors waited on the Tasmanian Attorney-General recently and explained that the company intended to use an electrolytic process for producing steel direct from the ore. They asked whether the Government would make power available for working the iron deposits in the north-western part of the State. The Attorney-General replied that until the amount required, and the place of supply were stated, terms could not be quoted. The Government was investigating the power possibilities of the Lake River and the Arthur Lake, and these might provide power for the northern part of the island. The [illegible] would require about 1,500 H.P. at the outset.

MISCELLANEOUS NOTES.

B.E.A.M.A.—It is announced that the following firms have been elected members of the Association:—

[illegible] Buckley & Taylor, Clayton, [illegible] & Co., [illegible] Tiverton, Hodgart & Barclay, Galloway (Ltd.), [illegible] & Kennedy, [illegible] Co., Mardens' Engines (Ltd.), [illegible] Platt & Wizzell, Robey & Co., Scott & [illegible] (Ltd.), Tyer & Co., Wood [illegible] & Thom.

Commercial Intelligence Department of Board of Trade.—The following letter has been addressed by Messrs. Benn Bros. (Ltd.) to the President of the Board of Trade:—

[illegible] of the reorganisation of the Commercial Intelligence [illegible] of the Board of Trade. This [illegible] for a reform which, in our opinion, [illegible] to you. The [illegible] Board of Trade "Journal" and the [illegible] reports, &c. There are [illegible]

The Board of Trade "Journal" [illegible] Board of Trade news, the usefulness of the Board's efforts and the interest in its doings would be much increased. We shall be glad to elaborate the point if you desire it.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding up of 340 businesses controlled by alien enemies.

Amongst the latest lists are Hessberg Brothers, 60, Mark-lane, London, E.C., ebonite manufacturers, &c. (Controller: A. Turquand Young, 41, Coleman-street, E.C.). Kampe & Co., 2, Sandland-street, Red Lion-street, High Holborn, London, W.C., machinery merchants. (Controller: T. A. Fox, 79, Mark-lane, E.C.). Burstinghaus & Co. (Ltd.), 41, East-cheap, London, E.C., agency and hardware business. (Controller: A. J. Foster, 37, Walbrook, E.C.). United Carborundum & Electrite Works (Ltd.), Apollo Works, New Southgate, N., agents for the sale of machinery. (Controller: C. Eves, Capel House, 62, Broad-street, E.C.).

Highways Restoration.—The Lewisham Highways Committee report with reference to the increase of 15 per cent. on the schedule of prices for the reinstatement of trenches opened under statutory powers, that all the authorities concerned have agreed to the increased scale.

Increased Charges for Electrical Energy.—The following increases are being made in rates charged for electricity supply:—

Hackney Electricity Committee is fixing a minimum charge per quarter, and the charges for current for lighting is to be 20 per cent. above normal rates, less 5 per cent. for prompt payment, instead of 17 per cent., less 2½ per cent., while for power the increase in the rate will be 30 per cent., less 5 per cent. instead of 17½ per cent., less 2½ per cent.

Newcastle (Staffs) Council is increasing its charge for current for lighting to 7½d. per unit, less 5 per cent. for prompt payment.

Weymouth Council has decided to charge 6d. per unit for lighting and to add 20 per cent. to the fixed price lighting charges.

At Stirling the charges for lighting is increased from 4½d. to 5d.

Inquests.—An inquest was held last week on the death of Walter Pearmain, electrical engineer, who was killed on the 14th inst. at Acton.

Mr. G. Scott Ram, H.M. electrical inspector of factories, and Mr. E. V. Clark, inspector of factories, represented the Home Office, and Mr. K. E. Bartlett (solicitor) represented Messrs. Johnson & Phillips, deceased's employers.

Dr. DOROTHY KATE MAUD HENRI, medical officer at the factory where deceased was working, said that at noon on Wednesday she was informed that a man had been caught on the "live" wire. She ascended the ladder and found deceased hanging on the cross bars of the post supporting the electric cables. He was being supported by a man on the ladder, and it was with difficulty that the man was brought down. She tried to restore life for 2¾ hours. The post-mortem showed that deceased was a normally healthy man with the exception of having a fatty heart, and death was due to electric shock acting on that organ. There were no burns or scars on deceased.

ARTHUR ALBERT SPRINGER, a joiner's mate, said he was working with deceased, who was engaged putting tape on the terminals on overhead wires to make them safe. In the course of the work witness left deceased to go into the transformer house, just for about a minute and on coming out shouted "Walter." Getting no answer, he ran to the ladder, and on reaching him found his hand on the steel part of the screw driver, and the handle was up against the second line terminal, which caused a contact. Witness put his arm round Pearmain's body, and gave a sharp pull, which broke the contact. He was still alive. Witness called for assistance, and Pearmain was got down. Deceased knew that the line was alive because he had worked on it before. When he reached the spot deceased was lying across the cross bars and Springer was holding him to prevent him falling.

Mr. CUTHBERT W. BANTLEY, electrical engineer at the factory, said as soon as he was informed there was someone up the pole he ran to the transformer house and shut the current off the whole of the factory. It gave him quite a fright to think that all those people were up the pole with the current on. Deceased was hanging with his head down and appeared to be black in the face. The voltage was only 380. If the connectors had been thoroughly insulated one at a time the accident probably would not have happened. He did not know that the Board of Trade would consider 380 volts dangerous. He thought a man with a good heart might stand it. Alternating current was rather more severe than direct current. It was the practice to work without gloves unless it was high tension work.

Mr. LAWRENCE H. BURTON, electrical engineer in the employ of Messrs. Johnson & Phillips, said deceased was a highly skilled workman. It was not usual to wear gloves; the work was quite simple for a skilled man. He thought deceased intended to put on all the nine connectors, and then to insulate the lot at one time.

By Mr. RAM: Deceased had instructions to proceed with the work while the wires were alive, and being a competent man it was quite a safe way to tape up each one as he completed it. He had to make bare about two inches of the overhead cable and then affix a connector clamp. He was standing on a wooden cross arm which would make it safe. On the following morning deceased had five connectors made and not one was insulated in any way. Probably deceased was working on the last one and moved his body, head or hand, which came into contact with one or the other. Deceased had done similar work during the past six months there.

The Jury returned a verdict of "Accidental death," adding that Pearmain met his end by incorrectly carrying out the insulation.

At Sheffield on the 13th inst., an inquest was held on Geo. Edward Smith, who died on the previous Thursday.

Smith was an electrician and was employed by Messrs. Thomas Firth & Sons. A fellow-workman, who went into the hydraulic pump-room said he saw Smith standing in front of a switchboard, putting the fuses in their places. As he turned to go out there was a brilliant flash, which blinded him for a minute or so. The next thing he knew was that they were taking Smith away, he being badly burned. Witness thought that the accident was due to a short circuit, caused by putting a 200-volt lamp on to a 1,000-volt circuit. It was a very dangerous thing to do, and it must have been a mistake on the part of Smith to use a 200-volt lamp on a 1,000-volt circuit. Prior to the accident Smith was engaged in testing the 1,000-volt circuit to find a fault, and must have been using the 200-volt lamp for testing purposes.

The motor-house attendant said he received instructions from Smith to switch on the current. There was a notice board up over the switch warning the workmen that it was a 1,000 volt switch.

Mr. S. D. Schofield, works engineer, said Smith was a thoroughly competent electrician and a good workman. It was quite possible that the wires of the 200-volt lamp, which Smith was carrying, came into contact with the 1,000-volt circuit accidentally. On behalf of the firm he expressed deep sympathy with the relatives.

Medical evidence showed that deceased had died from septic poisoning following burns, and the jury returned a verdict of "Accidental death."

Will.—Mr. Geo. Keith, late chairman of the Cuba Submarine Telegraph Co., and chairman and managing director of the Amazon Telegraph and the Chile Telephone Companies, who died on Aug. 22, left estate valued at £60,452 gross, with 1915 :—

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during September, 1916, and (*b*) the aggregate figures from Jan. 1 to Sept. 30, with increase or decrease compared with corresponding periods of 1915.

Electrical machinery, (*a*) £104,457 (increase £348), (*b*) £913,505 (decrease £311,095); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £24,782 (increase £3,035), (*b*) £165,758 (decrease £42,995); and electrical machinery unenumerated, (*a*) £79,675 (decrease £2,687), (*b*) £747,747 (decrease £268,100); telegraph and telephone cables, other than submarine, (*a*) £5,054 (increase £166), (*b*) £60,244 (increase £34,629); telegraph and telephone apparatus, (*a*) £5,006 (decrease £7,194), (*b*) £206,698 (increase £144,983); other electrical wires and cables, rubber insulated, (*a*) £8,882 (decrease £1,420), (*b*) £91,807 (increase £16,992); with other insulations, (*a*) £5,474 (decrease £3,665), (*b*) £12,574 (decrease £28,440); carbons, (*a*) £7,389 (decrease £4,118), (*b*) £67,416 (decrease £39,679); glow lamps, (*a*) £28,332 (increase £12,504), (*b*) £220,647 (increase £113,850); arc lamps and electric searchlights, nil; parts of arc lamps and search lights (other than carbons), (*a*) £10,636 (increase £2,265), (*b*) £80,559 (increase £12,142); primary and secondary batteries, (*a*) £18,675 (increase £3,420), (*b*) £148,572 (increase £49,508); meters and measuring instruments, (*a*) £4,480 (increase £2,909), (*b*) £39,504 (increase £18,832); switchboards, (*a*) nil (decrease £175), (*b*) £257 (decrease £5,007); electrical goods and apparatus unenumerated, (*a*) £38,651 (increase £20,518), (*b*) £262,565 (increase £108,612). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £132,579 (increase £25,210), (*b*) £1,190,793 (increase £424,665).

Exports.—The exports of electrical machinery, material, &c. (*a*) during September, 1916, and (*b*) from Jan. 1 to Sept. 30, with increase or decrease compared with corresponding periods of 1915, were as follows :—

Electrical machinery, (*a*) £180,998 (increase £67,048), (*b*) £1,115,316 (increase £86,812); including railway and tramway motors, (*a*) £6,187 (increase £2,383), (*b*) £28,945 (decrease £67,970); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £99,821 (increase £44,176), (*b*) £615,158 (increase £132,036); and electrical machinery unenumerated, (*a*) £74,990 (increase £20,489), (*b*) £471,213 (increase £22,746) telegraph and telephone cables, submarine, (*a*) £11,051 (increase £7,795), (*b*) £382,658 (increase £104,813); other than submarine, (*a*) £44,986 (increase £19,390), (*b*) £384,473 (increase £62,792); telegraph and telephone apparatus, (*a*) £18,551 (decrease £5,788), (*b*) £193,102 (increase £40,052); other electrical wires and cables, rubber insulated, (*a*) £86,622 (increase £43,396, (*b*) £425,911 (increase £192,674); with other insulation, (*a*) £79,136 (increase £7,778), (*b*) £632,678 (increase £283,041); carbons, (*a*) £568 (decrease £171), (*b*) £7,988 (increase £1,734); glow lamps, (*a*) £16,001 (decrease £1,990), (*b*) £140,437 (increase £26,897); arc lamps and searchlights, (*a*) £412 (decrease £116), (*b*) £6,571 (increase £2,729); parts of arc lamps and searchlights (other than carbons), (*a*) £775 (decrease £2,008), (*b*) £12,824 (decrease £5,906); primary and secondary batteries, (*a*) £23,057 (increase £11,190), (*b*) £210,989 (increase £63,608); meters and measuring implements, (*a*) £20,136 (decrease £10,322), (*b*) £159,430 (increase £47,036); transformers, (*a*) £10,103 (increase £7,664), (*b*) £78,568 (increase £27,864); switchboards, (*a*) £4,192 (decrease £1,426), (*b*) £45,618 (decrease £2,003); electrical goods and apparatus unenumerated, (*a*) £81,691 (increase £39,157), (*b*) £513,633 (increase £79,282). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £397,281 (increase £135,193), (*b*) £3,194,880 (increase £924,613).

TENDERS INVITED.

Telephone and Telegraph Material, &c.

Tenders are invited up to Dec. 22 for the supply to the Australian Commonwealth Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492.

Tenders are invited (up to Nov. 15) by the Postmaster-General's Dept., State of South Australia, for the supply and erection at the telephone exchanges of Glenelg and Brighton, of Automatic Switchboards and all associated apparatus (schedule No. 426). Tender forms, &c., in above case from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are also required by 3 p.m. Nov. 8 for the supply of Accumulator Parts (100 positive and 24 negative plates) to the Australian Commonwealth Postmaster-General's Dept., Perth (W.A.). (Schedule No. 527, W.A.) Specification, &c., from the Deputy Postmaster-General, Perth, Western Australia.

The Deputy Postmaster-General, Melbourne, will receive tenders until 3 p.m. Nov. 8 for the supply of Sounders, Non polarised Relays, Morse Keys and Galvanometers (schedule 1,368) for the Australian Commonwealth Postmaster-General's Dept. Specifications from the Deputy Postmaster-General, Melbourne.

Carbon Brushes.

Johannesburg Municipal Council require tenders by noon Nov. 27 for the supply of 12 gross of Carbon Brushes for Electric Motors. (Contract No. 178.) Specifications, &c., from the Controller of Stores, Municipal Offices, Johannesburg.

Cut-outs.

Johannesburg (Transvaal) Council require tenders by noon Nov. 27 for the supply of 1,000 sets of Single Pole Ironclad House Service Cut outs (Contract 187). Specification, &c., from the Municipal Offices.

Electric Crane.

The N.S.W. Railway and Tramway Department require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Electrical Stores, Lamps, &c.

The Great Northern Railway Co. (Ireland) require tenders by 10 a.m. Nov. 2 for 12 months' supply of Electrical Fittings, Lamps, Cable and Wire, Carbons, Signalling Materials, &c. Forms of tender from Secretary, Amiens-street, Dublin.

The South African Railways Administration require tenders by noon Nov. 13 for the supply during 1917 of 71,778 Tungsten Wire-drawn filament Lamps; 19,741 Solid Wire-drawn Tungsten filament Lamps; and 2,412 Carbon Filament Lamps. (Contract 733). Specification and form of tender from the secretary to the Tender Board, South African Railways Headquarters Offices, Johannesburg.

Sydney (N.S.W.) Council require tenders by 3 p.m. Jan. 8 for (*a*) 33,000 volt Switchgear; (*b*) Conduit and Fittings; (*c*) Fuses; (*d*) Insulators; (*e*) Insulator Straps and Bolts; (*f*) Lamp Holders; (*g*) Mica; (*h*) Switches; and (*i*) Wire Flexible, &c. Specification of (*a*) and particulars with regard to other items may be obtained at the Town Hall, Sydney.

Glasgow Corporation require tenders by Oct. 28 for six months' supply of Electrical Material, Rubber and Asbestos Goods, &c., to the cleansing department. Specifications, &c., from the Superintendent of Cleansing, 20, Trongate, Glasgow.

Motor-Generator, &c.

Dunedin (N.Z.) Council require tenders by 5 p.m. Jan. 21 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer

Tramway Material, &c.

JOHANNESBURG (Transvaal) Municipality require tenders by noon Nov. 6 for supply of 18 Grooved 12 ft. Points and 24 Grooved 9 ft. Points and six Ordinary Crossings (contract No. 171). Specifications from the Municipal Offices, Johannesburg.

The Direccion General de Obras Publicas, Ministerio de Fomento, MADRID, requires tenders by noon Nov. 24 for the Construction and Working for 60 years of an Electric Tramway at Saragossa. An option on the concession is held by the Sociedad Los Tranvias de Zaragoza.

WALSALL Corporation require tenders by Nov. 4 for the supply of Trolley Wheels, Castings, Oils, &c., for their tramways department. Forms of tender from the Tramways Manager.

JOHANNESBURG (Transvaal) Council require tenders by noon Nov. 20 for supply of 500 or 1,000 Trolley Wheels for their tramways department (Contract 181). Specification, &c., from the Municipal Offices.

TENDERS RECEIVED AND ACCEPTED.

METROPOLITAN ASYLUMS BOARD.—The agreements with the [illegible] Co. for the maintenance of the batteries of [illegible] Nos. 2 and 3, at Queen Mary's Hospital, which [illegible] Sept. 29, have been extended for 12 months. The agreement [illegible] for the payment of 1¼d. and 1½d. per mile run respectively for the two vehicles, one of which is 25 cwt. and the other [illegible]

[illegible].—The British Electric Transformer Co. recently [illegible] that the present market prices of 50 k.v.a. and 20 k.v.a. [illegible] were £54. 5s. and £34. 10s. respectively. [illegible] the Council were £51. 5s. and [illegible] asked that they should be met [illegible]. The Council have resolved to pay 50 per cent. of the [illegible]

[illegible].—The Council have accepted the tender of Gib[illegible] steelwork to the boiler house at [illegible] £183, and that of Melville, Dundas, & Whitson [illegible] gantry at £811.

[illegible].—The [illegible] Committee has accepted the tender of H[illegible] at £151. 10s. 6d. for the supply and delivery of a [illegible] crane.

[illegible].—The [illegible] have accepted the tender of the [illegible] at £139. 2s. 6d.

SUNDERLAND.—The Corporation have accepted the following tenders:—

J. Thompson & Co., creosoted redwood troughing; Everett, Edgcumbe & Co., surge arresters; W. T. Henley's Telegraph Works Co., cable.

VIEDMA (ARGENTINA).—The Municipality has decided to install public electric lighting, and has placed the order for the equipment with the Anglo-Argentine General Electric Co.

Buenos Ayres.—An order for three electric lifts for the National Institute of Bacteriology has been given to Florencio Martinez de Hoz & Co. at $18,020 m n. (about £1,570).

Government Contracts.—The following tenders were accepted by the British Government Departments during September:—

War Office.—Evershed & Vignoles, bridge meggers; British Insulated & Helsby Cables, Connolly Bros., W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works, Johnson & Phillips, St. Helens Cable & Rubber Co., and Siemens Bros. & Co., electric cable and wire; Gutta Percha Co., Chatterton's compound; Simplex Conduits (Ltd.), conduit fittings, &c.; Austin Motor Co., generating sets; Automatic Telephone Co., switchboard indicators; British Thomson-Houston Co., Dick, Kerr & Co., and Z Electric Lamp Mfg. Co., electric lamps; Sperryn & Co., switches; W. Jones, tramway track.

India Office. Peel Conner Telephone Works, bells; Bullers (Ltd.), brackets; General Elec. Co., cells.

H.M. Office of Works. Cecil Cooper & Co., elec. wiring Kew Insurance Office.

Post Office.—Gell Telegraphic Appliances Synd., telegraph apparatus; Siemens Bros. & Co., telephone apparatus; Bullers (Ltd.), telegraph pole arms; British L. M. Ericsson Mfg. Co., telephone bells; Siemens Bros. & Co., submarine cable; British Insulated & Helsby Cables, Connolly Bros., Fuller's Wire & Cable Co., General Electric Co., W. T. Glover & Co. (Ltd.), Hackbridge Mfg. Co., Henley's Telegraph Works Co., India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips, London Electric Wire Co. & Smiths, New Gutta Percha Co., Siemens Bros. & Co., Telegraph Construction & Maintenance Co., Union Cable Co., and Western Electric Co., telegraph cable; Siemens Bros. & Co., dry cells; Bullers (Ltd.), insulators; General Electric Co., elec. lamps and fittings; British Insulated & Helsby Cables, cable distribution plugs; Bullers (Ltd.), stay rods and insulation spindles; L. Herve, test-hole terminals; T. Bolton & Sons, British Insulated & Helsby Cables, Shropshire Iron Co., and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; Shropshire Iron Co. F. Smith & Co. (inc. in London Elec- tric Wire Co. & Smiths), copper wire; Dorman, Long & Co., Johnson & Nephew, and Whitecross Co., g.i. wire.

N. Z. Government Contracts.—The following tenders have been accepted by the Public Works Department, Wellington (N. Z.):—

Saml. Brown (Ltd.), bare copper wire and cable, £2,140. 6s. 6d.; Lawrence & Hanson, braided copper wire and cable, £3,853 6s.; Turnbull & Jones, insulated cable, £2,876.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

[illegible] department for the half [illegible] compared with £8,380 for the [illegible] last year.

[illegible]

[illegible] department for the [illegible]

[illegible]

The net cash expenditure on construction account amounted at the end of the year to $5,897,627.82, while the net cash proceeds of the debenture issues received from the City amount to $5,287,589.44. Pending provision by the City for the necessary working capital of the system, especially referred to in the third annual report, the Commissioners have been compelled to employ the depreciation reserve funds for working capital purposes. These funds were established for replacing the existing plant and equipment as they wear out, and as the need for replacement arises they will be required for that purpose.

A new and reduced scale of rates was adopted at the beginning of the present year, under the advice of the Hydro Electric Power Commission of Ontario. For residence lighting the average rate was reduced from 3·73 cents to 2·86 cents, for commercial lighting from 2·70 cents to 2·26 cents, and for commercial power from 1·35 cents to 0·97 cents. Satisfactory progress was made during the year. Notwithstanding the reduction in rates ranging on the average in the different classes of service from 13 to 28 per cent., the gross income showed an increase over that of 1914 of 7·9 per cent. The increase in the commercial income over that of 1914 was 12·3 per cent. The commercial income amounted to nearly 66·4 per cent. of the total, against 63·9 per cent. in 1914, and 59·05 per cent. in 1913. The municipal income represents the balance of the year's [illegible], or about one third of the whole. There were 38,831 customers (against 34,400 in December, 1914), 13,411 street lanterns in use (against 10,[illegible]) and 109,411,981 units were sold ($2,927,015), the connected load being 111,113 h.p. (90,162 h.p.) and the peak load (December each year) 40,180 h.p. (28,753 h.p.). The expenditure upon the additions to the physical system and equipment made during the year amounted to [illegible],012.42. These additions covered necessary extensions in progress and contemplated at the end of 1914. In the new street lighting system [illegible] the latest [illegible] type of lamps has been used, with excellent effects.

COMPANIES' MEETINGS AND REPORTS.

BAHIA TRAMWAY, LIGHT & POWER CO. (LTD.)—A meeting of the debenture holders was held last week to receive a report on the present position from the trustees. Sir Wm. Plender, who presided, gave particulars of the outstanding debentures of the Bahia Company and the Cie d'Eclairage de Bahia. The new contract with the intendente was approved by the municipality of Bahia, and on March 19, 1914, the undertakings of both companies were transferred to the municipality in exchange for a provisional bond for £1,521,000, bearing 6 per cent. interest from March 1, 1914, and redeemable by a sinking fund of ½ per cent. per annum, the first payment of interest for a broken period of four months being due on July 1, 1914, and amounting to about £30,000, the provisional bond being exchangeable in due course for definitive bonds. The loan was collaterally secured by a mortgage on the undertakings transferred to the municipality, and also by a second charge on certain taxes already pledged to the holders of a 5 per cent. municipal loan for £1,600,000 issued in 1912. Some time elapsed in settling with the municipality the exact wording of the definitive bonds, and difficulties also arose with reference to their signature. Eventually it was arranged that the Bank of Scotland should sign the bonds on behalf of the municipality. In the meantime the four months' interest due on the loan on July 1, 1914, had been left unpaid. That failure to meet their obligations was followed up by the municipality defaulting on the coupon due in August, 1914, of their 1912 loan, and in October, 1914, the trustees heard that the municipality were diverting in favour of the State of Bahia one-third of the taxes in question, leaving the remaining two-thirds applicable to the service of the loan of 1912. That was a distinct breach of faith towards the holders of both loans. In the same month the municipality brought forward a project of law to enable them to work temporarily the undertakings themselves instead of leasing them in accordance with the contract entered into with the trustees, which would have enabled them to receive the rent, and they also reduced the tramway fares, thereby diminishing the security. Those breaches of the municipal undertaking were brought to the notice of the Brazilian Minister in London. In December, 1914, the Municipal Council contemplated the reduction of the amount of the loan from £1,521,000 to £1,349,200, and that the State Governor supported the Council. In common with other creditors of the municipality, the trustees obtained a "sequestro" on 3,300 contos (approximately £165,000) lying at the Banco do Brazil. That was the only effective remedy, since they were advised that there were insuperable difficulties in the way of collecting the taxes on which they had a second charge, while the idea of resuming possession of the undertakings sold to the municipality was impracticable. The Bank of Scotland finished signing the definitive bonds (64,050 in number) by the end of 1914, and thereupon telegraphed to Bahia for authority to deliver them to the trustees in exchange for the provisional bond. In view of the course adopted by the municipality in endeavouring to reduce the amount of the loan, notice was given to the Bank of Scotland that the definitive bonds must not be parted with except in accordance with instructions. On March 17, 1915, they heard that the municipality had instructed the Bank of Scotland only to deliver definitive bonds for £1,350,000 in exchange for the provisional bond for £1,521,000. Mr. Farquhar suggested that, using the "sequestro" as a lever, they should endeavour to strike a bargain with the municipality on the lines of releasing the "sequestro" (which was contested by other creditors) in exchange for payment of the overdue interest and sinking fund instalment, partly in cash and partly in paper carrying interest at 6 per cent. per annum, on condition that, in return, the municipality issued to them the whole of the bonds. As he advised that any other course would probably involve years of litigation, they authorised him to negotiate on that footing, subject to the compromise being sanctioned by the English Courts. That proposal was fortunately successful. The new intendente (Col. Fernandes) authorised on March 29, 1915, the delivery of the definitive bonds for £1,521,000, in exchange for the provisional bond of the same amount, and promised to make a cash payment of 800 contos (about £40,000), and to give promissory notes payable in 12 months for the balance of the interest and sinking fund due up to January, 1915, and on July 17, 1916, the municipality paid the 800 contos and gave promissory notes, due July 17, 1916, for the balance (£42,009. 9s. 2d.) The expenses of the long negotiations with the municipality and the necessity of taking legal steps against them were unfortunately very heavy, so that Mr. Farquhar found it necessary to retain a considerable part of the 800 contos to defray expenses, and of the balance (£25,172. 10s. 6d.), a sum of £15,210 was paid to the Inland Revenue for stamp duty on the municipal bonds. Shortly after taking over the bonds they were approached by representatives of the municipality with a view to induce them to agree to the funding of interest during the next four years on the lines of a scheme which they had proposed to the holders of the 1912 loan. As the scheme was not an attractive one they did not accept it, preferring to press the municipality for payment of at least a substantial part of the interest in cash, rather than in paper of very doubtful value. In the latter part of 1915 a fresh intendente (Dr Mendes) was appointed and he inaugurated his term of office by endeavouring to persuade them to cancel the loan, which he alleged to be illegal, and to take back the light and tramway undertakings with a prolongation of the concession, and he was supported by the State of Bahia. This proposal was declined, as there was no guarantee that a new concession would be more respected by the municipality than the previous one had been. Owing to the turn which events had taken and the necessity for having a representative on the spot, they temporarily re-engaged the company's former manager, and on his arrival at Bahia he reported that the undertakings had fallen into such a state of neglect since their transfer to the municipality that a capital outlay of no less than £140,000 would be required to ensure their proper working. Their representative had several interviews with the intendente, in one of which the latter offered £300,000 cash in full and final settlement of everything. He subsequently talked of possibly raising that offer to 50 per cent. of the amount of the bonds—or, say, £760,000—but they could not attach any importance to that, as it was not a firm proposal, and was subject to negotiations with a third party. They were advised not to entertain such an offer, as the municipality would not be allowed to default indefinitely, but would sooner or later have to recognise its obligations. They consequently replied to the intendente that the lowest offer which they could submit to the debenture holders would be 80 per cent. in cash of the face value of the bonds (that is, the price at which they took them), plus the arrears of interest. The intendente, after consultation with the State Governor, expressed himself as unable to improve upon his previous offer. On July 12 their representative telegraphed that the municipality, in total disregard of its contract obligations and of the compromise arrived at in July, 1915, had published a formal protest against its own contract of purchase of the undertakings. They had since received a translation of that document, from which it appeared that the town clerk of Bahia protested against the sale and the issue of the bonds on the grounds that the contract was contrary to the law and constitution, that it exceeded the authority granted by the Town Council, and that it had caused enormous loss or damage to the coffers of the Council. He further advanced the startling proposition that, according to Brazilian law, "contracts that caused enormous injury to one of the parties could be cancelled," which view, he added, was supported by the French, Austrian and Italian codes. That protest could not be regarded seriously. They were advised on all hands that their bonds were absolutely unimpeachable. The protest, however, constituted an excuse for the municipality of Bahia evading its obligations until such time as they had, by proceedings in the Brazilian Courts, disposed of the allegations. They were advised not to fall into that trap, which would involve years of litigation in the Brazilian Courts and a large expenditure of money. On July 20 they were informed that the promissory notes of the municipality for £42,009. 9s. 2d., due on July 17, under the compromise referred to, had been dishonoured and protested for non-payment, while the municipality had, of course, paid not a penny in respect of the interest and sinking fund instalments (amounting altogether in round figures to £150,000), which had become due since January, 1915. Matters had thus come to a deadlock, and those who were most competent to advise them in the matter being unable to suggest any certain means of escape from the impasse, they had though it right to call the debenture holders together and lay all the facts before them. Threats without action were of no avail, negotiations proved fruitless or at best led to compromises which were repudiated by the municipality at the first opportunity, while litigation in the Brazilian Courts would not only be costly and indefinitely protracted, but would result only in the confirmation of rights which the Courts had already recognised. The company did not approach the municipality with a view to sell the undertakings; on the contrary, the municipality voluntarily came forward to negotiate, and as a result they made an offer which was submitted to and approved by the proprietors. They knew the physical condition of the plant, works, &c., of both the tramway and electric lighting systems. They also knew (or should have known) the possibility of the earning power when relieved of the illegal competition which they, as a municipality, had fostered and protected, and the offer they made was justified to the Town Council and approved by them. Bahia had a population of over 200,000, and was one of the most important cities in Brazil. Its Municipal Council had deliberately avoided its obligations, disregarded its admitted liability and behaved in a manner which was a disgrace to any civilised community. Nor was the behaviour of Bahia any credit to a great and friendly country like Brazil, and it might, unfortunately, injure the finances of the State of Bahia (of which the city was the capital) and of the country generally.

After some of the bondholders had given forcible expression to their views, the Chairman said there was no official resolution to be submitted, but he would like to say how much the trustees appreciated the support of their action by the bondholders. A vote of thanks to Sir William Plender closed the proceedings.

HURST, NELSON & CO. (LTD.) The report for the year ended July 15 states that the gross profit was £73,426, against £61,819. Income tax and interest accounts absorbed £4,048 and depreciation, &c., £18,085, leaving £66,989, including £15,697 brought forward, against £68,390. It is proposed to place to general reserve £25,000 (against £15,000), to pay a dividend on the ordinary shares at rate of 10 per cent., also a bonus at rate of 2½ per cent. (both tax free), leaving to be carried forward, subject to payment of excess profits duty, £11,989.

CITY NOTES.

MEMORANDA (Oct. 25).—**Bank rate 6 per cent. (since July 13, 1916). Consols** 56¼. Consols Pay Day, Nov. 2. **Stocks and Shares Ticket** Days, Nov. 14 and 29. Pay Days, Nov. 15 and 30. Price of Silver, 32½d.

ANGLO AMERICAN TELEGRAPH CO. (LTD.) The directors have declared an interim dividend for the quarter ended Sept. 30 of 1½ per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock (less tax), payable on Nov. 1.

BABCOCK & WILCOX (LTD.)—The directors have declared an interim dividend for the half year to June 30 of 6 per cent., tax free.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of 1 per cent. on the ordinary stock, payable Dec. 1.

COMPANIES STRUCK OFF THE REGISTER. The following were struck off the Register of Joint Stock Companies on Oct. 10: Animatophone Synd., Australasian Vacuum Cleaner Synd., British Motobloc Synd., British Tungsten Lamp Co., Bullough's Adjustable Rail-Joint Support Co., Compagnie Generale Electrique de la Champagne, Doncaster Electrical Co., Electrical Advertising Co., Electric Safety Boiler Cleaner, Ernest Scott & Mountain, Glamorgan Tram & Constructional Works, Kevan Electric Co., Marples, Leach & Co., Mica Mfg. Co., National Lighting Corpn., Platinum Corpn.

CONSOLIDATED SIGNAL CO. (LTD.)—A dividend of 6d. per share (less tax) has been declared on the ordinary shares for the past year.

KAMINISTQUIA POWER CO.—A dividend of 1¾ per cent. (at rate of 7 per cent. per annum) has been declared for the quarter ended Oct. 31.

NORWICH ELECTRIC TRAMWAY CO.—The directors have declared a dividend of 3 per cent. (6s. per share) for the past year, after placing £5,0[illegible] to reserve and £1,000 to 1914 Act account, carrying £429 forward.

UNITED ELECTRIC TRAMWAYS OF CARACAS (LTD.)—The directors recommend a dividend of 7 per cent. (1s. 4⅘d. per share), less tax, for the past year, carrying £2,428 forward.

WESTERN TELEGRAPH CO., LTD.—The directors have decided after transferring £100,000 towards reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £100,000 to general reserve fund, £30,000 to land and buildings depreciation fund, and £100,000 to provision on account of investment fluctuations, to recommend a final dividend of 3s. per share, making with the previous distributions a total dividend of 6 per cent. for the year ended June 30, 1916, and also the payment of a bonus of 4s. per share, both tax free. The balance of the account is carried forward. For the purpose of paying the above dividend and bonus on the 9th prox. the register of transfers will be closed from Oct. 31 to Nov. 8 inclusive.

METAL PRICES.

Messrs. J. B. Ca[illegible]m & Sons, 132, Upper Thames-street, London, E.C., quote under date Oct. 24 the following as the present basis prices of—

New Metals	Per lb.
S[illegible] Drawn Brass Tubes	16½d.
S[illegible] Drawn Copper Tubes	19½d.
Brazed Copper Tubes	19½d.
Brazed Brass Tubes	1[illegible]d.
Brass Wire	15½d.
[illegible] Wire	1[illegible]d.
R[illegible] Brass	15½d.
B[illegible]	16½d.
	Per ton.
[illegible]	£168 0 0
[illegible]	54 0 0

	Per ton
English Lead	Nominal.
Antimony	Nominal.
Old Metals.	Per ton.
Clean Copper Scrap	£113 0 0
Clean Brass Scrap	66 0 0
Braziery Copper Scrap	93 0 0
Old Lead	26 10 0
Old Zinc	40 0 0
Hollow Pewter	130 0 0
Black Pewter	90 0 0
Gun Metal	87 0 0

M[illegible] A. J[illegible] Earl-street, London-road, Southwark, London, S.E., quotes under date Oct. 24 [illegible] approximate prices of Scrap Metals:—

	Per ton.
A[illegible]	£110 0 0
[illegible] Brass	6[illegible] 0 0
[illegible]	1[illegible] 0 0
B[illegible]	[illegible] 0 0
[illegible] Metal	[illegible] 0 0

	Per ton.
Old Lead	£4 under English lead price
Old Zinc	40 0 0
Hollow Pewter	132 0 0
Shaped Black Pewter	90 0 0

M[illegible] offer at the following prices per ton: Plumber's Solder (in bar [illegible]) £[illegible], [illegible] Tinman's Solder, £97, Blowpipe Solder, £107.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Oct. 24.

Shrs.	Last Dividend	NAME.	Price, Tues., Oct. 24	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
[illegible]	[illegible]	[illegible]	8¼	7 1 2	Mar., Sept.
[illegible]	[illegible]	[illegible]	7¼	5 10 2	Feb., Aug.
[illegible]	[illegible]	[illegible]	[illegible]	6 1 6	Feb., Aug.
[illegible]	[illegible]	[illegible]	[illegible]	7 6 9	Mar., Sept
[illegible]	[illegible]	[illegible]	7	5 0 0	Mar., Aug
[illegible]	[illegible]	[illegible]	[illegible]	4 19 5	..
[illegible]	[illegible]	[illegible]	[illegible]	5 0 [illegible]	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	6 10 11	..
[illegible]	[illegible]	[illegible]	[illegible]	7 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6 18 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	12[illegible]	6 13 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	4 17 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	11 11	[illegible]

† [illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Oct. 24	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6¼	6 8 0	Feb, Aug
5	7%	Do. do. Pref.	5 5/32	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72¼	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1⅛	6 14 8	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6⅝	5 5 11	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4 1/16	5 10 9	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	83½	5 19 9	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	78½	7 12 10	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	68	5 17 8	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82½	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	73	5 9 7	Jan, July
St.	4%	City & S. London Deb.	74¾	5 7 0	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2 5/32	5 17 0	Jan, July
St.	4%	Do. 4% Pref.	62	6 9 0	Mar, Sept
St.	4%	Do. 4% Debs.	72	5 11 1	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	22⅞	4 7 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	59	5 18 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	58	6 0 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	62	5 12 7	Jan, July
St.	3½%	Do. 3½% Debs.	63	5 11 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	69	6 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	70½	5 14 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2 31/32	5 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1 11/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1 5/16	5 6 8	Mar
100	5%	Do. Prior Lien Debs.	91	5 9 11	Jan, July
1	6%	Do. 6% Pref.	29/32	6 12 5	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12⅜	7 1 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 9/32	5 13 7	Jan. July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 7 5	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2½	6 0 0	April
100	6%	Do. 6% Prior Lien Debs.	99¾	6 0 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12⅝	7 18 5	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	29/32	6 12 5	Sept.
5	..	Edison, Swan Co. A. £3 pd.	7/16	..	Feb, Aug
St.	4%	Do. 4% Deb.	61¼	6 10 7	Jun, Dec
1	7½%	Elec. Construction Ord.	31/32	7 14 10	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
10	6%	Do. 6% Pref.	9 15/16	6 0 9	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16	6 5 0	Feb, Aug
5	5%	Do. 4½% Cum. Pref.	4 3/16	5 7 6	..
St	4½%	Do. 4½% Db.	89	5 2 2	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	12⅛	8 4 11	Feb, Aug
10	5%	Do. Pref.	7⅞	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38	6 6 4	Mar, July
100	4%	Do. 4% Debs.	95⅛	4 4 1	Jan, July
1	12½%	Vickers Ord.	1⅞	6 13 4	May, Aug
1	5%	Do. 5% Pref.	29/32	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	75	5 6 8	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¼	4 10 8	June, Dec
St.	4½%	Willans & Robinson B. Cm. Pref.	41½	9 18 10	..
St.	4%	Do. 1st Mt. Deb. St.	56¾	7 1 0	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	98	6 2 5	Fb, My, Aug, N
St.	1½%*	Do. Def. Ord.	23	7 5 8	Fb, My, Aug, N
St.	4%	Commercial Cable 4% Debs.	70½	5 13 5	Ja. Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅜	6 5 6	Ja, Ap, Jly, O
St.	8%	Eastern Tel. Co. Ord.	141	5 13 6	Ja, My, Jly, O
St.	3½%	Do. 3½% Pref.	65	5 7 8	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	79	5 1 3	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	13⅜	5 19 8	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. With Coup. 11	38	5 15 9	Ja, My, Jly
25	13%	Indo-European	50½	6 8 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2 15/16	3 8 1	April
1	7%	Do. 7% Pref.	2 13/32	2 18 2	July
10	1%	West India & Panama Ord.	1 1/32	9 13 11	May, Nov
10	6%	Do. 1st Pref.	7 11/32	6 11 9	May, Nov
10	8%	Western Telegh. Co.	14⅜	5 11 4	Mr, Jly, O, Dec
St	4%	Do. 4% Deb. St.	76½	5 4 7	June, Dec
..	4½%	Western Union 50-yr. B[illegible]	99⅛	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	21/32	9 2 10	Nov
1	10%	Oriental Telephone Ord.	2 5/16	4 6 6	Apl, Oct
St.	4%	Do. Db. St.	78¾	5 1 7	Jan, July
St.	4½%	Teleph. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	6 13/16	5 17 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4 25/32	5 4 7	Jan, July
St.	4½%	Do. Deb. St.	85½	5 5 3	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	12⅜	4 17 0	Sp, Dc, Mr, Jn
10	6%	Do. 6% Pf.	10⅝	5 12 11	Sp, Dc, Mr, Jn
100	[illegible]	M[illegible] Common	85½	5 17 6	Ja, Apl, Jly, O
	4%	Do. $10 Pref.	70	5 14 3	Ja Apl, Jly, O
1[illegible]	6%	[illegible] Trust Certs.	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4 15/16	6 1 6	Mar, Sept
St.	5%	Do. 5% Deb.	94½	5 5 10	Jun, Dec
10	6/0	Bombay E. S. & T. 6% Pref.	10⅜	5 15 8	..
St.	4½%	Do. 4½% Deb.	83	5 8 5	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	6⅝	6 15 10	May, Nov.
5	5%	Do. 5% Pref.	4¼	5 17 8	Mar, Sept

* [illegible] † Ex dividend or interest.

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NOTES.

Disclosing Manufacturers' Costs.

WE have little sympathy with those who hold that manufacturers can be expected to disclose their works costs either to a committee or to an official from a Government department. Many will agree that it would be more reasonable to compel every paid servant of the State to present his bank-book for periodical inspection. The other day a well-known cloth manufacturer from the West Riding informed us that under no circumstances would he disclose his costs. He was willing, he said, for the State to purchase his mills at a fair valuation and for the State to manufacture its own cloth. No sensible person would assert that the offer was an unreasonable one either to make or accept, and we admire those who help their country and who, at the same time, have the courage to champion a good cause. The objection to disclosing manufacturing costs is that the figures may and in all likelihood would get into the hands of competitors who would profit by the information. What is true of the cloth trade is equally true of the engineering trades. In every case common sense dictates that those who are deputed to examine the costs should be experts in the particular business under examination. As such, in one way or another, they are connected with the business. Although we do not suggest that any of these men would, knowingly, disclose any of the information obtained in virtue of their appointment, it stands to reason, nevertheless, that the information would be used unconsciously and to the detriment of those from whom it was obtained. From every point of view it is better that all firms engaged in the manufacture of munitions should work to specifications, and, as a rule, men qualified to analyse works costs in any particular industry are competent to draw up such specifications. In this way the State would get goods of known quality, and encouragement would be given to those who by scientific management are able to do better in business than their neighbours.

◆

The Government and Reserve Plant.

THE attitude of the Government in regard to the extension of certain electricity works is so important that we make no apology for referring to this question once again. As is well known, Birmingham has recently suffered much inconvenience through the inability of the electricity department to maintain a sufficient supply, and, apart from public inconvenience due to failure of the tramway service, it has at times been necessary to curtail the supply to certain power consumers. Similar difficulties are now arising at Glasgow, where, at a recent meeting of the Council, the city electrical engineer, Mr. W. W. LACKIE, submitted that one of three courses must be adopted. The first alternative was to discontinue the connecting up of new consumers: the second was to accept new consumers subject to disconnection during the winter months; and the third was to proceed with a portion of the new generating station at Dalmarnock. The second alternative would manifestly be unsatisfactory, and therefore it is not surprising that the Council have decided to proceed with the Dalmarnock station.

◆

IT is reported that Mr. LACKIE presented the following interesting figures showing the proportion of spare plant in various undertakings:—

Name of Undertaking.	Maximum demand.	Plant Capacity. kw.	Spares.	Percentage of spares. Per cent.
Glasgow	50,000	54,550	4,550	9
Birmingham	33,000	41,505	8,500	25
Edinburgh	11,400	20,390	8,990	80
Dundee	7,014	16,500	9,486	120
Leeds	16,700	26,600	9,900	60
Liverpool	23,511	44,600	21,089	90
Manchester	49,897	57,300	7,403	17
Sheffield	23,618	26,000	2,382	10
Charing Cross	12,664	26,480	13,816	100
Central	10,443	19,695	9,252	90
Chelsea	19,739	30,000	10,261	50
City of London	13,700	20,300	6,600	50

It should be noted that these data, with the exception of Glasgow, appear to be taken from the tables published by our contemporary, the "Electrical Times," and therefore refer to conditions in 1914 and 1915, which may differ materially from those of to-day. Such figures as 100 and 120 per cent. spares over the maximum demand are, of course, due to special circumstances—probably the recent addition of some large units of plant, which it may be worth while to instal and use in preference to the older plant. On the other hand, such figures as 10 per cent. at Sheffield, and 9 per cent. at Glasgow are very unsatisfactory for undertakings in which the loads are rapidly [illegible] The most serious feature is the time that is necessary to get the plant installed and in operation. This, for the [illegible] proposed at Glasgow, is stated by Mr. LACKIE to be at least two years.

Equality of Sacrifice in Practice.

Sacrifice is defined as loss of anything to gain some object: that which is given up, destroyed, or lost for some end: mere loss of profit. For more than two years our Statesmen in their speeches have been giving utterance to the phrase "Equality of sacrifice," which, we take it, means that in order to win the war all must be prepared to lose equally. When our politicians have next to face their electors we believe that many of the latter will demand an explanation of this monstrous falsehood. The equality of the sacrifice in practice is being illustrated daily. The following examples of "sacrifice" will serve to make our meaning clear:

> Amongst the applicants for advice at —— was a man wearing the badge of the R.G.A. He looked very ill as he stepped into the witness box.
>
> "I am a discharged soldier," he said to the magistrate. "I have served my King and Country for 12 years 8 months. I have been in France, gassed and wounded. I came out, time expired, and went back again for 180 days in the R.G.A. Since I have been discharged I have only had two sums of 10s. from the Soldiers and Sailors Association. I have been sleeping out for several nights, and have had no food for two or three days."

The second is the case of a firm of shipowners:

> The sum of £200,000—equal to a dividend of 140 per cent. on the paid-up capital of the company—has been set aside to meet excess profits tax by the *Nil Desperandum* Shipping Co. (Ltd.), whose annual report is just issued. The year's earnings, though not disclosed in the accounts, appear to amount to £397,400, or about six times those of the pre-war period. Payment of a dividend and bonus equal to a total of over 31 per cent. is recommended, after setting aside for depreciation and reserve £113,822.

We purposely give these examples, but we do not propose to offer any comment on either of them. Now that Parliament is again assembled, perhaps attention will be given to these matters of public interest.

Works Organisation.

It is seldom that Papers devoted to the discussion of problems connected with works management are read before the engineering institutions. To a certain extent, no doubt, this is due to the fact that those who know how to manage works prefer to keep their knowledge to themselves. In some cases this is a perfectly reasonable attitude to take up, but in our opinion there are many fundamental subjects under this heading which could profitably be discussed and which it would be [illegible] under the heading either of trade secrets or of rival interests. For this reason we are pleased to note that the North-East Coast Institution of Engineers and Shipbuilders is an exception. Elsewhere we refer to the first part of an informative Paper on "Works Organisation" [illegible] the Institution by Messrs. [illegible] The authors [illegible]

Excess Profits in the Electrical Industry.

It will be remembered that under the Finance (No. 2) Act of 1915 the percentage standard for excess profits was fixed at 6 per cent., but the decision whether a higher percentage profit should be permitted in special cases was left to a Board of Referees. The Board has recently given a number of decisions increasing the statutory percentage, and we are glad to see that among these are concessions obtained by the British Electrical & Allied Manufacturers' Association for firms manufacturing electrical generators, motors, switches, arc lamps, cooking and heating plant, meters, transformers and lamp holders. In such cases the statutory percentage is increased to 7 per cent. for companies and to 8 per cent. in other cases, the latter figure being due to the fact that the remuneration of partners cannot be deducted in arriving at the profit in the same way as the fees of directors. At the instance of the Tramways and Light Railways Association the Board has also raised the standard for tramways and light railways to 7½ per cent. for companies and 8½ per cent. for private firms. It may be that these concessions will not be regarded as a compliment to the electrical industry, for the simple fact that if the pre-war profits of any undertaking are considerable such pre-war profits are taken for fixing the datum line above which excess profits are to be reckoned. It is, therefore, something of an admission of want of prosperity on the part of the electrical industry, though doubtless even in the most flourishing days we should not expect all firms to be making large profits and, therefore, a certain proportion of undertakings would desire the assistance given by the Board of Referees.

Unremunerative Appointments.

The following advertisement appeared recently:—

> Wanted, immediately, a LECTURER IN ENGINEERING (preferably Electrical). Salary £150 to £175, according to experience and qualifications. The appointment is for the period of the War, but will probably be made permanent in the case of satisfactory service.

Our advice to engineering lecturers is that they should give such places as wide a berth as possible. Unless technical teachers are prepared to take up a firm attitude now they will find themselves in the near future in receipt of wages on a level with, or below the level of, those of labouring men. In these days lecturers on engineering, who know anything about engineering, can command salaries greatly in excess of those offered at many of our technical colleges, and can help to win the war by engaging in the manufacture of munitions. Lecturers on engineering are not wanted to teach children when work for men is crying out to be done.

American Cyanamide. In view of the great development attributed to Germany in the direction of fixation of atmospheric nitrogen, it is interesting to note that the American Cyanamide Co. appears now to have turned the corner and is producing on an increasing scale. Among other departures, a small experimental factory has been erected for the manufacture of nitric acid which is expected, according to report, to be of considerable value to the United States Government in connection with munition work.

Memorial to Sir Wm. Ramsay. At University College, London, on Tuesday, a meeting was held to consider the question of raising a memorial to Sir William Ramsay.

Lord Rayleigh, who presided, made brief reference to his work with the late scientist.

The Postmaster-General (Mr. J. A. Pease) moved a resolution in favour of taking steps to raise a substantial fund as a memorial to Sir William Ramsay, to be utilised for the purpose of promoting chemical teaching and research. The resolution was adopted, and an executive committee, under the chairmanship of Lord Rayleigh, and including many other leading scientists, was appointed to make arrangements for the memorial.

Electric Supply Development in Edinburgh. Important additions to the electricity supply in Edinburgh are now contemplated, the total cost of which is estimated to reach £200,000.

An interesting feature of the scheme is the method adopted of securing a sufficient supply of cooling water. At Portobello a shaft is being sunk which will communicate with a channel running out to sea well beyond the low water mark. There will thus be an unlimited supply of salt water available, which, after fulfilling its purpose, will be returned to the sea.

Electrical Limit Gauges.—In the accurate testing of limit gauges electrical methods are being found very helpful. For example, in the gauges used for testing time-fuse firing pins, described in a recent issue of "Machinery," two points are connected with an electric circuit. If the firing pin touches either of the points it completes the circuit and the sounder clicks. The first contact point is adjusted to such a height that if the tip of the firing pin touches it, it shows the work is too long; similarly, if the pin does not touch the second contact point, it is too short. In either case the work will be rejected.

Excess Profits Decisions.—On Oct. 26th the Board of Referees appointed to decide cases relating to the assessment of excess profits duty under the Finance Act (No. 2) of 1915, gave the following decisions :—

On the application of the Tramways and Light Railways Association the Board has raised the statutory percentage for companies engaged in the business of tramways and light railways in the United Kingdom to 7½ per cent. and for private firms to 8½ per cent.

On the application of the Melbourne Electric Supply Co. (Ltd.) and the Electric Supply Co. of Victoria (Ltd.), the Board has raised the percentage as regards electricity supply and tramways in the State of Victoria, 7½ per cent. for companies and to 8½ per cent. for private firms.

On the application of Mr. Sydney Morse the Board has raised the percentage in the case of electrical supply and electric traction in India to 7 per cent. for companies and to 8 per cent. for private firms.

Mercury Damping of Waves.—We have received a copy of a new publication of the Bureau of Standards (Scientific Paper No. 289), entitled "The Damping of Waves and other Disturbances in Mercury." It is sometimes of great importance that the mercury be prevented from freely vibrating under the actions of a disturbing force, and this is especially true when the mercury is used in accurate scientific instruments, as, for example, mercurial barometers. It was found that the disturbances in the mercury is practically eliminated if it is subjected to a strong magnetic field, *e.g.*, by placing it in certain positions between the poles of a strong magnet. This method may be used when it is desired to obtain accurate adjustments of mercury surfaces at sea and in other places.

Electrical Units and Standards.—A circular on this subject has recently been issued by the Bureau of Standards. This publication gives comprehensive and up-to-date information regarding the units and standards in terms of which electric and magnetic measurements are made. It includes the history of the units and the evolution of the definitions upon which the laws on electrical standards are based. The laws of this and other countries are given. These laws are in substantial agreement, and the various national bureaux of standards co-operate in maintaining the fundamental standards. The circular gives conversion factors, by means of which measurements may be expressed in any desired unit. The information on electric units and standards had not previously been available in a single publication. The pamphlet will be sent free on application.

Forced Life-Tests.—A Paper read at the tenth Annual Convention of the Illuminating Engineering Society (U.S.A.), by Mr. L. J. Lewinson, discusses the value of life-tests of glow lamps, carried out at an efficiency exceeding that at which the lamps are normally run. This process greatly shortens the time spent on such tests, but their interpretation presents some difficulties. The relation between efficiency and life is approximately as follows :—

$$\frac{\text{Life}_1}{\text{Life}_2} = \left(\frac{\text{Lumens per Watt}_2}{\text{Lumens per Watt}_1}\right)^b.$$

Prior to 1914 the value assumed for the exponent b was 6·65. It appears, however, that its value varies somewhat according to the type of lamp, tending to become smaller for lamps of low wattage. As a result of an extensive series of tests on lamps of 60 and 100 watt types, values for b ranging from 5·6 to 8·2 are recorded.

Books for British Prisoners of War.—The Committee of the Board of Education in charge of this subject has issued a classified list of books, each item of which represents an actual request received from some British prisoner. The following engineering books are included :—

Transformers (Still). Alternating Currents (Still). Alternating Currents (Siemen). Electrical Hand-book (Trautwine). Kurzes Lehrbuch der Electro-technik (Thomälin) English translation, Electric Brake (Westinghouse). Propagation of Electric Currents (Fleming). Dynamo Electrical Machinery (Thompson). Modern Electrical Practice, Electrical Engineering (Slingo & Brooker). Alternating-Current Dynamos & Machinery (esp. Induction Type Dynamo). Country House Electric Lighting Plant, Hydro-Electric Power Transmission, Electric Tramways, Technical Electricity (Davidge). Magneto & Electric Ignition (Hibbert). Molesworth's Pocket Book of Formulæ. Engineer's Hand-book (Adams). Structural Engineering (Elem.). Practical Tunnelling (Simms & Kinneard), Metal Turning and Working, Pattern Making and Castings, Submarine Cables, Cable Testing, Hydraulics, Machine Drawing and Design (Low & Bevis). Draughtsmanship for Engineers. Drawing Instruments, &c.

The Chairman of the Committee is Mr. Alfred T. Davies, J.P., of the Board of Education, Whitehall, S.W.

Carrying Capacity of Underground Power Cables.—An informative report on this subject by Mr. H. Matsumoto has recently been published by the Electrotechnical Laboratory of Tokio, Japan. The report is divided into 15 sections and is profusely illustrated. Of the subjects dealt with may be mentioned the following: Geometrical form of underground cable system; heat conduction in homogeneous material; general equations of isothermal surface in earth cylinder; thermal resistance of earth cylinder with only one circular layer of cable and with a number of cable layers; thermal resistance of cables and generating heat in cables; general equation of temperature rise of underground cables; specific thermal conductivity of dielectric substances and of sand and gravel; temperature of air and earth in Japan; laying of cables; experimental verification of general equations of temperature rise of underground cables; experimental verification of general equations of thermal resistance of multicore cable; and calculation of carrying capacity of underground cables. No cable engineer or manufacturer can afford to be without this very important report, which is well printed in English.

OBITUARY.

A. H. HOWARD.—We regret to learn as we go to press that Mr. Albert Harris Howard, A.M.I.C.E., M.I.E.E., who was for some years secretary of the Cable Makers' Association, died on Wednesday at 64, Victoria-street, London, S.W., at the age of 54. Mr. Howard had been in indifferent health a long time, which necessitated his relinquishing the secretaryship of the Cable Makers' Association recently.

CHARLES A. HARRISON.—We regret to record the death of Mr. Charles A. Harrison, which occurred on Saturday. Mr. Harrison, who was 68 years of age, was consulting engineer to the North-Eastern Railway Co., having relinquished the position of engineer-in-chief last year. He was in the company's service 48 years.

J. J. HICKS.—We regret to record the death on Oct. 25 of Mr. James Joseph Hicks, K.C.S.G., electrical and scientific instrument maker, of Hatton Garden, London, E.C. Deceased, who had been ill for some time, had a good reputation as a glass blower and as a maker of medical and electrical instruments, &c.

KILLED IN ACTION.—The following deaths in action or of wounds are reported :

Second Lieut. J. S. Gibson (Bedfordshire Regt.), who has died of wounds, was 32 years of age. He was articled to an electrical engineer, and was subsequently an associate member of the Institution of Electrical Engineers.

Second Lieut. A. B. Drewery (R.F.C.), who was accidentally killed on active service, received engineering education at Birmingham Municipal Technical School, where he secured high honours. He was subsequently apprenticed with Kynochs (Ltd.), and was afterwards employed at the works of Messrs. Willans & Robinson and the Wolseley Motor Co. For the last two years prior to joining the Army he was in business at Scarborough as a motor agent.

Rifleman W. F. Mitchenall (London Regt.), who was killed on Sept. 18, was formerly on the general office staff of the India Rubber, Gutta Percha & Telegraph Works Co., Silvertown. We regret to learn that many of the company's old employees have fallen in action.

Sapper Percy C. Day (R.E.) was mortally wounded on Sept. 16, and died on the same day. He received electrical training for three years at the Battersea Polytechnic Day College, and was subsequently on the engineering staff of the G.P.O. Telegraph Dept.

PERSONAL.

The Council of the Institution of Electrical Engineers have elected Prof. George Carey Foster, LL.D., D.Sc., F.R.S., past president, to be an honorary member of the Institution.

At the annual meeting of the North-East Coast Association of Chartered Secretaries at Newcastle on Tuesday, Mr. M. Short, secretary of the Newcastle-on-Tyne Electric Supply Co. (Ltd.), was unanimously re-elected president for the ensuing year.

Mr. J. H. Wild, who has been with the Lancashire Dynamo & Motor Co. (Ltd.), Trafford Park, Manchester, since it started, severed his connection with the company on Oct. 31, 1916, and on Nov. 1, 1916, joined the electrical department of Messrs. Vickers Limited, and will be stationed at Broadway, Westminster, S.W.

ROYAL ENGINEERS (T.F.).—The following appointments have been made:—

London Electrical Engineers: Sergt. F. Goble, Sergt. R. Francies and Acting L.-Corp. C. S. [illegible] to be second lieutenants (on probation).

Tyne Electrical Engineers: Staff Sergt. T. S. Marshall and W. M. [illegible] to be second lieutenants (on probation).

WAR CASUALTIES.—Lieut. W. H. Kember, of the S. Lancashire Regiment, who was employed at the British Westinghouse works before the war, has been wounded.

In addition to the casualties amongst former employés of the Marylebone electric supply dept. recorded in our obituary column, the following have been wounded or have become unfit through sickness:—

Lance-Corp. F. Boyall (3rd Essex), Driver W. Curtis (R.F.A.), Rfn. A. [illegible] (K.R.R.), Pte. G. Gall (10th Middlesex), Sergt. W. Gregory [illegible] E. [illegible], Rfn. B. C. Hartopp (18th County of London), Sergt. T. [illegible] (A.O.C.), Pte. W. Higgins (3rd Middlesex), Spr. G. Lobb (R.E.), [illegible] Driver G. A. Oliver (R.F.A.) (all the foregoing have been discharged from H.M. service), Pte. G. Rolf (3rd County of London), Rfn. F. G. [illegible] (9th County of London), Corp. G. Sell (21st County of London) and Pte. A. W. Turner (R.B.). Pte. A. J. Snow (13th County of London) [illegible] of war in Germany.

APPOINTMENTS VACANT AND FILLED.

The Government of India require three assistant electrical engineers, [illegible] for a factory at Arnwankadu and one for a factory at [illegible]. Five years' engagement. Salary 280R., rising to 340R., per mensem. Particulars from the Director-General of Stores, India Office, Whitehall, London, S.W. *See also an advertisement.*

A [illegible] and assistant are required for the department of [illegible] at the South African School of Mines and Technology, [illegible]. Salaries £800, rising to £1,000; and £350, rising to [illegible], respectively. Applications to Messrs. Chalmers, Guthrie [illegible], London, E.C., by Nov. 16.

Mr. [illegible] for [illegible] at the Postmaster-General's [illegible], has been appointed electrical engineer to the [illegible] in Victoria, in succession to Mr. [illegible], who has been appointed electrical engineer of the [illegible] Wales.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—[illegible] On November 23rd, [illegible] Operation of Electric Power Stations," by Mr. J. S. [illegible] Telegraphs and Telephones," [illegible] Principles [illegible] the Distribution of Plant," by Messrs. [illegible]

Institution of Engineers and Shipbuilders in Scotland.—During the [illegible] Papers will be read: [illegible] "The Problem of [illegible]" [illegible] "Electric Vehicles and [illegible]" [illegible] "Notes of Design and [illegible]" by Mr. [illegible]; [illegible] by Mr. F. W. [illegible]

North-East Coast Institution of Engineers and Shipbuilders.—[illegible]

Faraday Society.—On Wednesday, November 8th, a general discussion will be held on "Refractory Materials" from 5.30 to 7 p.m. and from 8.30 to 10.30 p.m., at the Institution of Electrical Engineers. Sir Robert Hadfield, F.R.S., president, will take the chair and will deliver an introductory address. The opening Paper will be given by Dr. J. W. Mellor, and will deal principally with "The Texture of Refractories." Dr. H. G. Colman will speak on the work of the Joint Refractory Materials Committee of the Institution of Gas Engineers and the Society of British Gas Industries. Mr. Albert Cliff will deal with "The Manufacture and Prospects of Refractories," and Mr. E. P. Page will speak on "The Classification of Refractory Materials and Some Notes on Method and Points of Investigation." Mr. J. Allen Howe will make a statement on "The Recent Work of the Geological Survey on Refractory Materials." Papers will be read by Prof. W. G. Fearnsides on "The Application of Petrographic Methods to the Study of Refractory Materials," by Mr. Cosmo Johns on "Silica as a Refractory Material," and Mr. Ezer Griffiths, M.Sc., on "The Transmission of Heat through Materials Employed in Furnace Construction." Dr. P. G. H. Boswell will speak on "Refractory Sands," and it is expected that Mr. F. W. Harbord, Prof. J. W. Cobb, Dr. W. Rosenhain, F.R.S., and Mr. W. C. Hancock will take part in the general discussion.

Institution of Automobile Engineers.—The second general meeting of the session of the Institution of Automobile Engineers will be held in the hall of the Royal Society of Arts, John-street, Adelphi, W.C., on Wednesday, November 8, 1916, when a Paper by Mr. A. Ludlow Clayden, entitled "Electrical Car Equipment," will be read. The Chair will be taken by the President of the Institution, Mr. L. A. Legros, at 8 p.m. Cards of invitation to the meeting may be obtained on application to the Secretary, Institution of Automobile Engineers, 28, Victoria-street, Westminster, London, S.W.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 3rd (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster. The "Thomas Hawksley" Lecture.

TUESDAY, Nov. 7th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. Address by the President, Sir Maurice Fitzmaurice, C.M.G.

WEDNESDAY, Nov. 8th

INSTITUTION OF AUTOMOBILE ENGINEERS.

8 p.m. At the Royal Society of Arts, John-street, Adelphi, W.C. A Paper on "Electrical Car Equipment," by Mr. A. Ludlow Clayden.

FARADAY SOCIETY.

5.30 to *7 p.m.* and *8.30* to *10.30 p.m.* At the Institution of Electrical Engineers. General Discussion on "Refractory Materials," to be opened by the President, Sir Robert Hadfield, F.R.S. (See note above for Agenda)

THURSDAY, Nov 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Presentation of Premiums, followed by the Eighth Kelvin Lecture: "Some Aspects of Lord Kelvin's Life and Work," by Dr. A. Russell.

FRIDAY, Nov. 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute road, South Kensington.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut. Col. C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week. Platoon Commander Hughes Hallett.

Next for Duty. Platoon Commander J. O. Cheadle.

Monday, Nov. 6.—Technical for Platoon No. 9, at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.25-8.

Tuesday, Nov. 7.—School of Arms, 6-7; Lecture 7.15, by Sergt. J. Roberts, "The Measurement of Angles"; Range Practice.

Wednesday, Nov. 8.—Instructional Class, 6.15; Platoon Drill, Platoon No. 2; Range Practice.

Thursday, Nov. 9.—Platoon Drill, Platoon No. 7; Range Practice; Ambulance Class, by M.O., 6.

Friday, Nov. 10.—Technical for Platoon, No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.25-8.25.

Saturday, Nov. 11.—General Parade, 2.15. Uniform, for Drill in Battersea Park.

Sunday, Nov. 12.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday ration to be carried. Railway voucher will be provided.

Musketry.—For all Companies, see Notice and Tables A and B at Headquarters.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

SMOKE ABATEMENT AND ELECTRIFICATION OF RAILWAY TERMINALS IN CHICAGO.*

BY W. F. M. GOSS.

As an outgrowth of the feeling that Chicago's atmosphere is more smoky than it need be, a Committee was appointed in 1911 to report upon the practicability of electrifying the steam railway terminals of Chicago. The report found that it was technically feasible to electrify the railway terminals of Chicago; that when electrification had been accomplished it would be of advantage to the railroads; that the electrical operation would be safe; but that any plan for electrification would be difficult to carry through because of its financial requirements. The railway companies of Chicago declined to accept the findings of this report, on the grounds that the conclusions of the Committee were merely the conclusions of the individual members of the Committee; that the members of the Committee had had no information upon which to base their recommendations, not possessed by other people; and that consequently no great credence was to be given their conclusions. It was finally agreed that if the Chicago Association of Commerce would organise a Committee of investigation and would conduct a broad inquiry into the whole matter of atmospheric pollution, of the sources of smoke, and of the technical and financial practicability of electrification, the railway companies would undertake to pay the costs. As the result the Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals was brought into existence, and its results have been published in the form of a voluminous report.

There has been some criticism concerning the procedure of the Committee, especially with reference to the programme underlying the estimates of cost. With reference to this aspect of the work, it should be observed in the beginning that the whole problem of the Committee, the report of which I am to discuss, was based upon the contention of the City Council that the steam locomotive should be eliminated from the City of Chicago. The complete elimination of the steam locomotive was interpreted to imply the complete electrification of the railroads of the city. The Committee's action in this matter was, therefore, responsive to the prescription which was given the Committee, and its procedure in this respect was not dependent upon its choice.

In this Address the results of the Committee's study of the problem of electrification will be discussed.

One of the early questions which the Committee sought to answer was: What has been accomplished in the electrification of steam railroads? In answer to this question, a thorough study was made of the actual electric installations in this country and in other countries on roads of steam railroad standards.

In connection with a study of electrification as it might be applied to the Chicago terminals, it is important to understand clearly the changes in physical conditions which would be introduced by the installation of either the third rail, or the overhead contact systems. The position of the third rail makes it an obstruction of the free movement of trainmen, especially in yards, and the objection is urged by many railwaymen as a serious one in Chicago, where yard tracks constitute a large percentage of the total trackage to be electrified.

The third rail at switches, where special track work occurs, and at highway and railroad crossings at grade must be interrupted, presenting gaps over which trains must coast, or in case the gaps are long, which must be bridged for continuous contact by the installation of an overhead conductor rail. The electrification of the Chicago terminals through the uso of the third rail system would present 737 gaps aggregating about 16 miles for which the overhead conductor rail installation would be required. Including the shorter gaps which could be coasted over, there would be approximately 4,000 gaps totalling about 56 miles in the third rail in the Chicago terminals. It has been found also that there are about 75 miles of track in Chicago which because of physical conditions could not be equipped with any known form of contact system.

If choice were to be made of an overhead contact system using high-voltage current, clearance is a matter of great importance. Not only must the wires be placed at a suitable height to permit the contact to be made from a moving train, but it is desirable that they be sufficiently high to allow a trainman standing on the top of the highest car to give signals with a lantern swung overhead. This requirement demands that the contact wire be maintained at a height of approximately 25 ft. above the track rail. Overhead obstructions, such as bridges or viaducts, which cannot be raised to a height sufficient to permit the maintenance of this clearance, require the wire to be depressed, in many cases to the minimum height of 16 ft. 6 in. There are 222 overhead structures in Chicago, which do not afford sufficient room for the installation of the overhead contact at the safe clearance of 25 ft.

Overhead contact systems involve the installation of supporting structures at intervals of from 150 ft. to 300 ft. on tangent track and at lesser intervals on curves. The structures consist of structural steel or tubular poles set on either side of the tracks and of structural steel or wire brigdes supported by the poles or posts. Suspended from these bridges are the messenger cables and contact wires.

The overhead contact construction of whatever type is complicated and not particularly pleasing to the eye, and it constitutes some obstruction to vision along the right-of-way. It is conceivable that if adopted for general use throughout the terminals of Chicago, it might offend those who have waged war on the presence of overhead wires for other purposes in our great cities.

These considerations suggest the range of choice which may be exercised in the selection of a contact system for use on the railroad terminals of Chicago.

Concerning rolling equipment with which to operate the Chicago railway terminals, it may be said that electric locomotives have been designed and built for all classes of passenger, freight and switching service. Motor cars, whether operated singly or in trains under multiple unit control, have proved their value for handling passenger traffic involving frequent train movements and short runs between stops.

Passing from the details of construction to a more general view of electrification projects, we may consider for a moment a few of the installations that have been widely discussed.

The West Jersey and Seashore Railroad early electrified one of its two lines from Camden to Atlantic City, New Jersey, a distance of 65 miles. This installation was undertaken chiefly to ascertain the economic possibilities of main-line electric traction and its effect upon traffic. Electric operation is conducted wholly by multiple-unit motor car trains. Freight trains and a number of passenger trains are operated over portions of the electrified trackage, but by steam locomotives.

The electrification of the Long Island Railroad is one of the most important electric installations in the United States. It operates electrically a network of lines covering the western end of Long Island, and delivers heavy commutator and excursion traffic to the Brooklyn and Manhattan terminals. The Long Island Railroad electric operation, however, is confined to multiple-unit service. It handles no freight or heavy passenger service, and is comparable to our suburban operation.

Important among the projects to be referred to are the three railroad electrifications of New York City.

The New York Central and Hudson River electrification, supplies the means by which passenger trains are operated electrically into the Grand Central Station of New York City. A study of the conditions under which this road operates, however, reveals the fact that it is not comparable with the situation to be met in Chicago. The electrification of the New York Central Railroad was made necessary in order to eliminate the smoke and objectionable gases arising from steam locomotives in the long tunnel entrance to the Grand Central Station. The density of traffic had become so great that steam operation in this tunnel was no longer practicable. The electrification of the main-line sections beyond the portals of the tunnel was necessary in order to secure continuous operation of the large number of local trains to the end of runs within suburban limits. It is a passenger terminal project.

The New York, New Haven and Hartford Railroad undertook electrification primarily for the same reasons as those which influenced the New York Central Railroad. Its extension to main lines beyond the limits of the terminal section has been due primarily to the operating necessity of conducting continuous service to the limits of the local service zone. The density of traffic over the electrified sections of this road, as is the case with the New York Central, is very great.

The Pennsylvania Railroad tunnel under the Hudson River to the terminal station on Manhattan Island, and thence continuing under Manhattan and under the East River to Long Island was electrified as an operating necessity. Like the other electrifications already mentioned, it is not comparable to the Chicago situation, and the reasons which prompted it do not exist in Chicago.

It will be noted that justification for all of these projects is to be found in density of traffic requiring frequency of movement, or in tunnel operation, and that the service is chiefly passenger service. In Chicago the density of traffic over much of the trackage is low. There are no tunnels, and the greater part of the total traffic is freight and freight switching.

The number of steam railroad electrification projects in America and in other countries is 37. The combined electrified mileage of these roads is 3,000. The number of different railroads represented in the activities of the Chicago terminals is 37, and the mileage which is involved in the Committee's plan of electrification in Chicago is 3,139.

The record of work already accomplished in electrification is significant in that it presents no instance in which a steam railroad occupying surface or elevated lines has been electrified primarily to avoid the pollution of the atmosphere of the city. It shows also that nowhere in the world has a railroad having a city terminal, which, from an operating standpoint, has been satisfactory, changed its operation from steam to electric.

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* Abstract of Address to the Western Society of Engineers.

At the beginning of its investigation the Committee undertook a detailed study of the area, trackage and railroad facilities involved in the proposed plan of electrification. A discussion of some of the historical facts which this study revealed would be very interesting, but I shall pass over these and confine my remarks to the problem involved in electrifying the terminals as we find them to day.

The Committee made a detailed study of operation, traffic and train movements, and upon the basis of facts thus obtained has determined the amount of electric energy which would be required for the operation of the terminal electrically. Underlying this determination are certain fundamental facts which will be of interest. Figs. 1 to 5 show in graphical form the locomotive-mileage performed, the number of ton-miles handled, the number of tons of coal burned, the total number of locomotive hours of service, and the energy required for the electric operation of the Chicago terminal.

The Committee also made a study of the growth in track mileage, passenger traffic, and freight traffic which may be expected to take place in the 10 years following 1912. This estimated growth is based upon the rate of growth which took place during the 10-year period prior to 1912. As a result of this study it is estimated that the trackage within the Committee's area of investigation will increase approximately 31 per cent. during the 10-year period from 1912 to 1922, or from 3,988 miles in 1912 to 5,220 miles in 1922. The number of through passengers handled will increase from 11-million in 1912 to 15½-million in 1922, or about 40 per cent. The number of suburban passengers will increase from 42-million to 45-million,

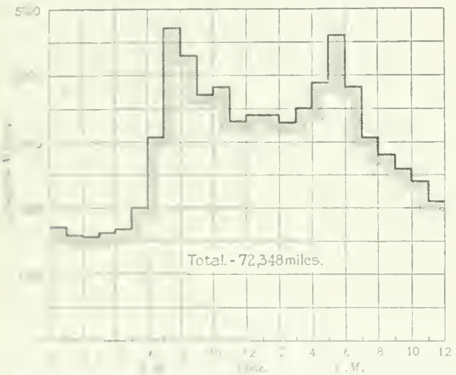


Fig. 1.—Traffic Diagram. Total Locomotive Mileage for the Average Day for Steam Operation in all Classes of Service within Area of Investigation.

or 7 per cent. The total number of passengers will increase from [illegible] or 11 per cent. The number of tons of [illegible] freight handled will increase from 8,500,000 [illegible] in 1922, or 19 per cent. The number of freight cars [illegible] will increase from 15 million in 1912 to [illegible] in 1922, or 41 per cent.

[illegible] to provide for this growth in the activities of the Chicago [illegible] it was necessary for the Committee to base its [illegible] upon the electric establishment which would be [illegible] at a date when it might be expected that the [illegible] would be completed. The date as [illegible] 1922.

Another problem which [illegible] careful study was that of fixing the limits of [illegible] for each railroad. It was early [illegible] limits, [illegible] the corporate limits of the city. [illegible] the effect of [illegible] would be negligible [illegible] the entire territory of [illegible] reported by [illegible] of the [illegible] apply to [illegible] operation of a [illegible] limits of the city [illegible] operation should [illegible] assumed that the [illegible] passenger service originating beyond the city limits, if required to electrify to the city limits, would, for the greater convenience of its patrons, be justified in continuing its scheme of electrification on to some more distant point. A railroad operating within the city might need to go a considerable distance beyond the limits of the city to find available land upon which to develop the necessary transfer yards and other terminal facilities.

The Committee gave careful consideration to these and other conditions affecting each of the railroads involved in the proposed plan of electrification. The outer limits of complete electrification were fixed for each railroad substantially upon the basis of the following considerations:—

1. In the case of each railroad, it has been sought to terminate complete electrification at the first satisfactory point beyond the limits of the city.

2. In the case of railroads having large yards, repair shops, or other facilities outside of the city and within a short distance therefrom, the location of such facilities has been accepted as a reasonable terminus for complete electrification.

3. In the case of railroads presenting no feature which might suggest a choice of location, a point has been selected as near the city limits as practicable, which gives promise of supplying land upon which to develop the necessary terminal and transfer facilities.

The fixing of limits under these principles has necessarily led to differences of opinion. There was danger on the one hand that the estimates of cost might be overlooked by adopting too large a plan. There was danger, on the other hand, by adopting too meagre a plan,

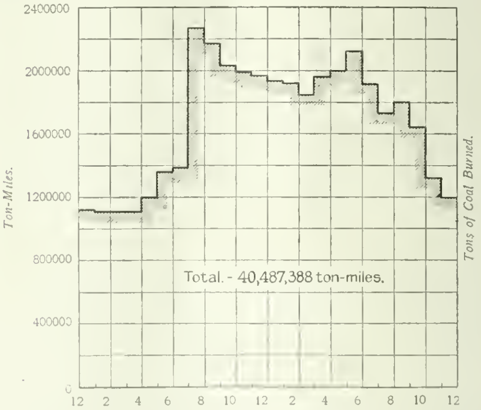


Fig. 2.—Traffic Diagram. Total Ton Miles for the Average Day for Steam Operation in all Classes of Service within Area of Investigation.

of having an establishment which, from an operating point of view, would be unmanageable. The Committee did what it could to escape the danger of both these extremes.

By comparing the extent and activities of the railroad establishment included within the proposed limits of operation with electrification projects elsewhere in the world, we may note the following significant facts:

1. The mileage of track involved by the proposed electrification of the Chicago railroad terminals is nearly twice as great as the mileage of all existing electrically operated steam railroad track in America, and exclusive of foreign light service lines, is about 15 per cent. greater than the combined total mileage of all existing electrically operated steam railroad track in the entire world.

2. The number of through passenger trains required by the traffic of the Chicago terminals is 85 per cent. of the total number of such trains at present operated electrically on all American steam railroads.

3. The number of suburban passenger trains is approximately one half the number of such trains at present operated electrically on all American steam railroads.

4. The passenger train miles in through and in suburban service in Chicago amount to 70 per cent. of the total number of passenger train miles operated electrically on all American steam railroads; the total passenger car miles are, however, greater for the Chicago terminal.

5. Freight traffic, exclusive of switching service, is ten times greater in Chicago than on all existing electrified steam railroads in America.

6. Switching service in Chicago is 65 times greater than on all existing electrified steam railroads in America.

7. The number of multiple-unit cars required to operate the Chicago service amount to 66 per cent. of the total number of such cars in service on all American electrified steam railroads.

8. The number of electric locomotives required for the Chicago service is approximately four times the number now in service on all American electrified steam railroads, and is approximately 2½ times the number now in service on all electrified steam railroads in the entire world.

These statements of fact cannot fail to give a measure of the size of the Chicago problem. It is equivalent to undertaking at a single stroke an electric installation greater than all steam railroad electrifications in the entire world.

The Committee made no pretence at choosing a system of electrification, but it worked out its estimates of cost for each of three systems, as follows:—

1. Third rail, 600-volt, direct-current.
2. Overhead contact, 2,400-volt, direct-current.
3. Overhead contact, 11,000-volt, alternating-current.

In making up these estimates of cost the Committee assumed that if electrification is entered upon in Chicago, it will be undertaken as one great problem. Consequently, instead of 37 different railroads, building 37 different power stations, there will be one or perhaps two power houses to supply all of the energy necessary for the electric operation of all roads. Similarly for the transmission system, it is assumed that the energy will be transmitted by such a system as will be most efficient in reaching all of the railroads, irrespective of the location of individual lines. The same applies also to the arrangement of sub-stations, switching stations, telephone systems, &c. The estimates are based upon plans designed to meet the requirements of the terminal as a whole.

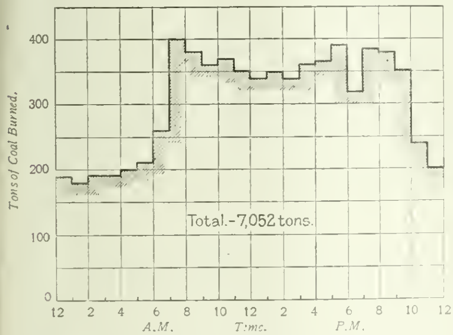


Fig. 3. Diagram of Coal Consumption. Total Tons of Coal Burned during the Average Day for Steam Operation in all Classes of Service within Area of Investigation.

Estimates of the cost of electrification have been made up item by item, the larger sub-divisions being as follows:

(*a*) Power station; (*b*) transmission system; (*c*) sub-stations; (*d*) switching stations; (*e*) overhead contact system; (*f*) bridge warnings; (*g*) prevention of inductive effects and electrolysis; (*h*) return circuit; (*i*) telephone system; (*j*) electric locomotives, multiple-unit equipment, work inspection equipment; (*k*) spare parts; (*l*) alterations to bridges and buildings; (*m*) changes in wire lines; (*n*) changes in signal systems; (*o*) removal and re-establishment of steam locomotive terminals; (*p*) rolling equipment released.

The total estimated cost of electrification for the 11,000-volt alternating-current system was found to be approximately £37,000,000. By deducting from this the salvage from facilities to be abandoned or utilised for other purposes and the salvage value of rolling equipment to be released, the net cost of electrification by the 11,000-volt alternating-current system is reduced to £35,600,000. It must be remembered, however, that this figure represents the cost on the basis of the Committee's plan which is to be regarded as a minimum plan. It does not cover the cost of improvements which would be precipitated by the proposition to electrify. For instance, the railways of Chicago have spent large sums of money in elevating their tracks, and the whole scheme of track elevation is not yet finished. A railway would not feel that it could afford to place the facilities and structures of electrification at the present grade if within the next 10 or 12 years it would be called upon to raise that grade. It would be compelled, as a preliminary to electrification, to make the remaining improvements for track elevation. These improvements, of course, would ultimately have to be made, and the charge to cover them is not a charge against electrification, but the adoption of electrification would bring them forward, and by so doing would increase the capital requirement incident to electrification. Again, in the case of signals, which in the event of electrification would need to be rebuilt to permit of their operation in the presence of propulsion currents, many railroads would regard it as good business to make at this time complete installation of new signals rather than spend money in the repair of old signals which might, within eight or ten years, be renewed in any event. This cost of new signals would, therefore, be precipitated as a result of the proposal to electrify, although it could not of course, be included as an item chargeable to electrification. It has been estimated that the total cost of betterments which will be precipitated by electrification will amount to £19,200,000 bringing the total capital requirement for the 11,000-volt alternating-current installation to a total of £54,800,000.

Let us consider now just what the railroads might expect to get from their investment of £54,800,000. The changes in operating conditions, which will result from complete electrification, are of a threefold character:—

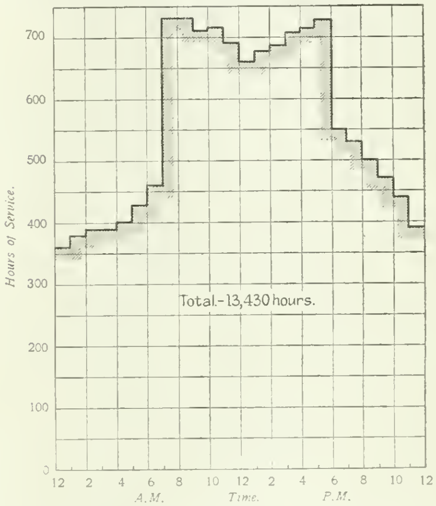


Fig. 4.—Traffic Diagram. Total Locomotive-hours of Service for the Average Day for Steam Operation in all Classes of Service within Area of Investigation.

1. Those incident to the introduction of electric operation on trackage within the proposed limits of electrification as defined by roads.

2. Those incident to the operation of transfer stations at which change of motive power is to be made.

3. Those resulting from the shortening of the steam-operated divisions at present terminating in Chicago.

These changes will introduce changes in operating expenses, the nature and extent of which will be influenced by the character of the electric installation. The Committee found, after a careful study in which each operating account was considered separately, that the electric operation of the Chicago railroad terminals would result in a reduction in operating expenses on the electrified trackage of £740,000 per annum under the 11,000-volt alternating-current system; that the additional operating expenses incident to the new transfer stations required would amount to £300,000 per annum; and that additional constructive mileage to steam locomotive crews due to the shortening of steam operated divisions would cause an addition to operating expenses of £90,000 per annum. By combining these three totals it will be noted that the net decrease in operating expenses which will result from the introduction of electric operation, will amount to approximately £350,000 per annum. It must be remembered, however, that this estimate does not include any amount to cover interest or depreciation on the proposed new electric establishment. The railroads will have to provide capital for the electric installation, and the interest on the capital will amount to £1,780,000 per annum. Depreciation on the new establishment will amount to £1,560.000 per annum. and the railroads will have to replace assets dissipated by the introduction of electric operation to the amount of £46.000. If this item of dissipated assets is spread over a period of 10 years following the completion of the electric installation, the charge will be £46.000 per annum. The total of these three items amounts to nearly £3.400.000. After credit is taken for the estimated increase in net revenues, the annual deficit still remaining will be about £2.900,000.

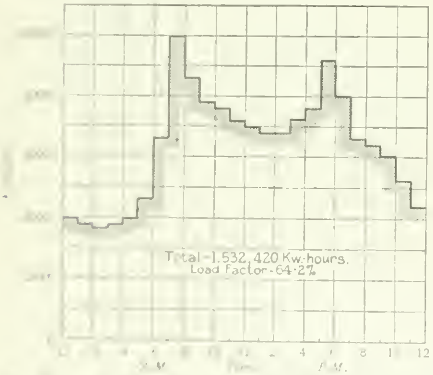
It is obvious from these facts that if we view electrification purely as an investment, the railroads would find it impossible to furnish the necessary capital for the project.

If we go a step further and consider whether there is any way by which the railroads might get the £2,900,000 annually required to sustain the investment, we will see that the electric installation will give some increase in track capacity, especially in the case of tracks used for suburban service; that there is a possibility of extending electric service to provide additional returns to the railroads; and that there will be some reduction in noise and smoke. The extent to which electrification will serve to reduce smoke is the matter in which we are most interested, since electrification has been proposed solely as a means of smoke abatement.

Smoke has been defined by the Committee under these heads :—

1. Visible smoke.
2. Solid constituents of smoke.
3. Gaseous constituents of smoke.

It has been shown that the elimination of all the steam locomotives of Chicago would reduce the visible smoke or the cloud effects of smoke by about 22 per cent. It has also been shown that the



[illegible] Chart.—Total Kilowatt-hours at the Panto[illegible] October Day for 11,000 volt Alternating-[illegible] Operation, [illegible] Service.

construction of the new power plant necessary to electrification, or the purchase of the output of existing power plants, would introduce a new source of smoke amounting to about 2 per cent., so that the net reduction in visible smoke through electrification would be about 20 per cent.

The amount of [illegible] which include the dust and dirt emitted from [illegible] would be reduced through the elimination of the steam locomotives by about [illegible] per cent., and there would be introduced through the [illegible] of the new electric power station something over [illegible] per cent., so that the net reduction would be about [illegible] per cent.

The gaseous products of combustion would be similarly affected, and the net reduction would be about [illegible] per cent.

The effect of [illegible] upon the safety of the public and of [illegible]

It has been suggested that it might be possible to increase the returns on the investment through the more intensive use of railroad property [illegible]

and track facilities did not have to be made. Second, property obtained by railroads by right of eminent domain is not free fo commercial uses by the railroad company. The abutting propert owners retain rights in the property which would preclude suc intensive use. While it would be possible for a railroad compan to build a two-deck station or an office building for its own use abov its tracks, it would not be possible for it to erect on land which it ha obtained through right of eminent domain, a building for genera commercial purposes to be used as a source of income. The con clusion of the Committee is, therefore, that while there are possi bilities of gain through intensive use of property, a limit to the gain which are possible is soon reached.

When we count the costs and give considerations to the rathe indefinite character of the possible returns, it is quite evident tha the proposal to electrify the Chicago railroad terminals present many serious difficulties. The Committee's conclusions are to th effect that while it would be technically feasible to electrify th entire railroad terminal of Chicago, the proposal under present-day conditions is financially impracticable.

WORKS ORGANISATION.*

BY A. D. C. PARSONS, B.A., EDWIN L. ORDE, AND G. H. TWEDDELL.

At the present moment the problem of works organisation is one of extreme importance. No one can say definitely what the conditions, as affecting the engineering trade as a whole, will be after this great war has come to an end; but it seems certain that international competition will be keener than ever, as soon as those countries at present at war have had time to recover from the strenuous exertions they are now putting forward.

If the war ends in the way in which we all believe it will, the possibilities offered to the engineering trade of this country cannot be taken full advantage of unless the industry is organised in all its branches so as to enable it to hold its own in those markets previously supplied by the countries who are now our enemies.

In this paper it is proposed to divide the question of works organisation into three main parts covering :—(1) Manufacturing, (2) Costing, and (3) Selling, of the works product.

Part I. Manufacturing Organisation.

BY A. D. C. PARSONS.

Manufacturers in this country labour under a considerable disadvantage as compared with those, say, in America, in that the manufactured product is not as a rule so standardised. In the latter country it is usually the case that the manufacturer has a much greater say in the details of his product, than they do in this country. The conditions are different; labour is more expensive, and therefore the demand for mechanical power is greater.

We will, however, first consider the question of those works where the product is not of a particularly standard type, and then take the case of some of the more elaborate system of organisation now adopted in the United States.

We must assume that the design of the apparatus which the works has to manufacture is thoroughly sound, so that when the drawings are complete there will not be numerous alterations to be made to the article during the time of its manufacture. With a good designing staff such changes after the design has been approved will be reduced to a minimum. The draughtsmen would always consider what can be easily machined and manufactured in the shops, and what is liable to cause difficulties. Also to specify materials and details which they know to be kept in stock. In other words the design should be built by the draughtsmen before the drawings are sent to the shops.

General Layout of Works.—The general layout of works will necessarily have a great effect on speed of manufacture, and it is in this respect that new works have a great advantage over some of the older ones. In modern up-to-date works the machinery departments form main parts, the assembling, and the testing departments for any particular type of machine are usually adjacent to one another, and if possible, continuous. This obviates any unnecessary handling of material, and also allows the foremen in charge to be in constant touch with one another without leaving their departments.

Furthermore, the same group of overhead cranes can serve them all. The painting and despatch departments can with advantage be made continuous with the testing department, so that the raw material is delivered at one end of the shop, is manufactured and tested in that aisle, and is despatched completed at the other end without [illegible]

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* Abstract of Paper read before the North-East Coast Institution of Engineers and Shipbuilders.

In like manner the detailed departments will also be placed as near as possible to those departments which they have to supply.

Possibly the most convenient way of dealing with the question of the manufacturing side of works organisation is to consider each section of the works in the order in which these sections will have to deal with any particular contract, and then to discuss some system of production designed to follow through the manufacture methodically. Two natural divisions present themselves, viz., (1) preliminary to receipt of contract, (2) after the contract has been obtained.

Preliminary Work prior to Receipt of Order.—Before an order for any particular machine is received a considerable amount of preliminary work has to be done to enable an estimate to be prepared in accordance with the specifications issued by the intending purchasers. To do this the estimating department must be supplied with the necessary information by the designing staff to enable the former to determine what will be required in the way of new tools and special appliances to carry out the manufacture of the plant. They will also require to know with considerable accuracy the amount of labour and material necessary.

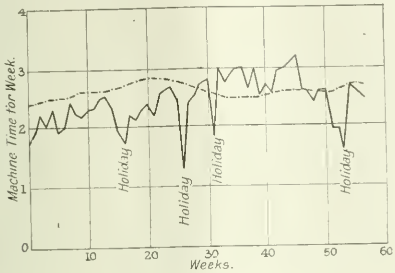


FIG. 1.

In determining the time promised for delivery the capacity of the works and the number of orders on hand must be carefully considered. It will be useful, therefore, to have some graphical representation of the fullness of the factory. Fig. 1 shows one way of arriving at this.

The ordinates in Fig. 1 may be in any convenient unit such as £'s, H.P., K.W., or number of machines, but in many cases the most convenient unit will be "Machine time per week." In the majority of works each machine-tool will be rated at a certain figure per hour, depending upon the capital expenditure on the tool, and all work done on any particular tool will be charged with that rate per hour.

The estimating department will know with considerable accuracy the amount of machine time necessary in the manufacture of a plant, and if by means of some equation this can be spread out over the time during which the order is going through the works, an approximate idea can be formed as to how much machine time will be expended per week. This then is done for each order and the results are superimposed on one another, thus obtaining a curve shown by the continuous line in the figure.

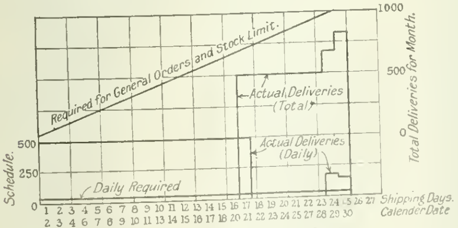


FIG. 2.—IRREGULAR PRODUCTION FEEDER.

It is also possible to plot the total actual machine time used in the manufacture of these orders, thus giving a fair idea as to whether the output bears a satisfactory relation to the amount of work actually on the books. The latter curve is shown dotted, and from this a measure of the capacity of the works can be found by averaging up the actual machine time per week over the period of say one year.

Diagrams of the nature of Fig. 1, rough though they may be, should prevent totally unreliable promises being made so far as the delivery of orders is concerned. In order to follow through a scheme which has as its aim the prevention of delays, it is proposed to trace an order through the various departments of the works from the time it is received to when it is dispatched.

Supplying the Manufacturing Information.—After the contract has been obtained it is best to determine how long can be given to the various operations such as drawings, patterns, obtaining raw material such as castings and forgings, machining of these parts, completion of details, assembling, testing, &c. One very convenient means of doing this is to lay out a rough time table covering the various operations, starting with the delivery date and working backwards to the date of receiving the order. Any surplus time, should there be any, can be apportioned to those departments where there is likely to be any congestion.

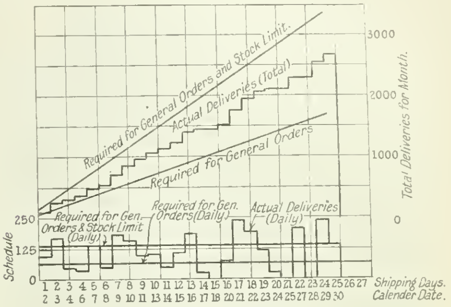


FIG. 3.—GOOD RECORD FEEDER.

We have now determined how long the drawing office can be given for completing full working drawings. From this a list can be prepared which is sent to the drawing office specifying when full manufacturing information for the various parts must be sent into the shops.

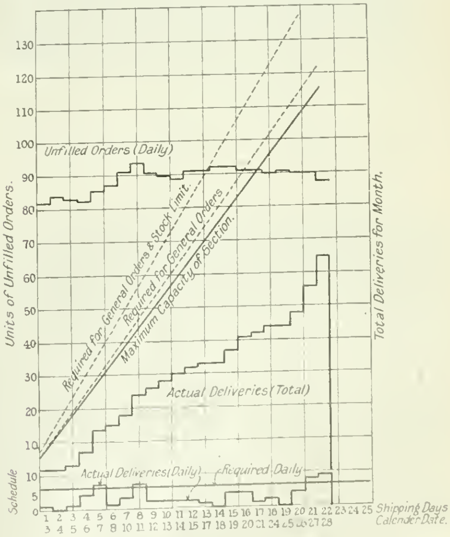


FIG. 4.—POOR RECORD ASSEMBLY.

As soon as the design is well advanced, the drawing office (or in some works the purchasing department) will send out inquiries for such forgings, castings, raw material, and completely manufactured parts necessary for the manufacture of the machine. On receipt of tenders from the outside suppliers, the official orders will be sent out and these will state clearly by what date the materials must be delivered.

Production Department.—The specification sheets furnished by the drawing office should pass through the Production Department on their way to the shops. It is the work of this department to see that all details required, whether manufactured in the works or supplied from outside, shall come to hand when required by the machining or assembling departments.

Some method must be adopted whereby all material can be traced in a systematic way, for on this will depend the satisfactory feeding of the factory.

The [illegible] time table of manufacture is based on the expected delivery of the material, and should this be much overdue the time given for the completion of the various parts must be seriously interfered with. It is therefore essential that this work shall be done well and efficiently.

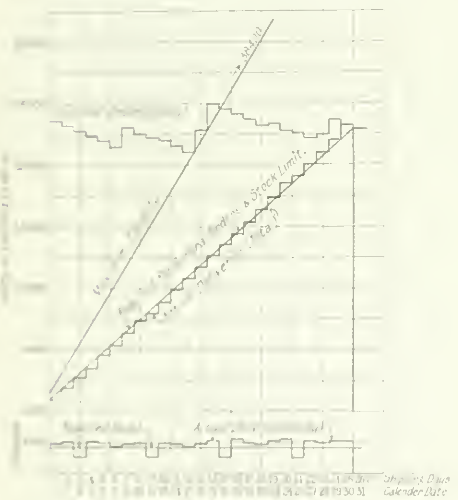
It [illegible] to keep a record arranged in a suitable form [illegible] much detail as is thought necessary those parts [illegible] machine. From this record the Production Department [illegible] glance how the material is coming in, what [illegible]-red, and what requires to have pressure applied [illegible] delivery.

[illegible] the drawings are complete they are forwarded to the works [illegible] Production Department.

When the specifications have been received by the works it is necessary to have some system whereby each foreman can at any [illegible] what his shop has to complete and by when. It is, however, [illegible] the clerical work should be kept down to the minimum. In those departments engaged in machining large pieces there is [illegible] little difficulty, for the number of parts are few and [illegible].

[illegible] feeder departments, however, will usually require considerably more attention than other sections of the works, and there must be some means of tabulating the work in hand in the order in which it is required.

A [illegible] form in which to lay out an index of this sort is to have



Fɪɢ. [illegible].—[illegible] Record Assembly.

[illegible] each week has a certain [illegible]. As the specifications are received marked with the date by which the material has to be complete, the details are [illegible] under the week in which they become due. As the work is completed the index is marked off, so that the [illegible].

[illegible] Department.—When [illegible] to assemble all the main [illegible] there should be no difficulty [illegible] have delivered their details by the [illegible]. It is [illegible] all delays which may have [illegible] much more [illegible].

[illegible]

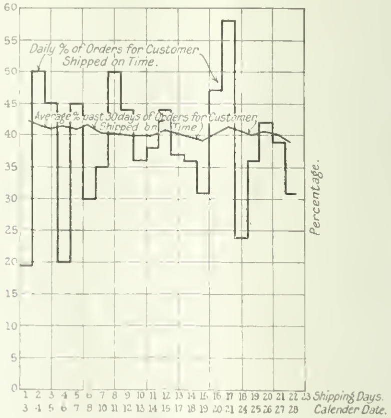
to the stores; some similar method also being adopted for those parts delivered complete from outside sources and for stock material not manufactured in the works.

Stores.—Although the manufacturing feeder departments play such an important part in the organisation of the factory, the various stores for raw materials and manufactured parts supplied from outside sources comprising as they do hundreds of items in various forms, are absolutely vital to the successful feeding of the factory. These stores, too, will contain stocks of expensive materials, which it will be necessary to keep down to the lowest possible limit. It is therefore usual for the storekeeper to keep a systematic record covering all items in his stock and specifying the maximum and minimum allowed, the ordering quantity and the ordering level.

Manufacturing of Standard Apparatus.—In what has already been said it has been assumed that the works product is not manufactured chiefly to standard designs; when, however, the factory is principally employed in turning out an article in large numbers made to an approved design, the system may require some elaboration.

Deliveries will to some extent be standardised for any particular size and type of machine.

The specifications will also probably be standardised, and it will only be necessary to select those specifications applying to the order, to fill these in for the required number of machines, and to forward them to the works *via* the Production Department. These specifications together with the detailed drawings which will already be in the works will constitute the entire manufacturing information. In any system adopted care must be taken to guard against the tendency of building up a system of forms only, and so eliminating the human element of interest and responsibility.



Fɪɢ. 6.—Delivery Efficiency Chart.

As previously stated, it is in the assembling department that the efficiency of the works in production is best gauged. It is, therefore, well to have some method whereby the management can see at a glance whether the organisation of the works as a whole is such as to insure the factory producing the right quantity at the right time.

A large American works employed in the manufacture of all kinds of electrical machinery, and where the output of machines and accessories, all more or less standard, is large, has devised a very complete system for accomplishing this. Graphical records are kept of the output of the feeder and assembling departments. These records are known as load diagrams, and contain curves indicating for each day the total number of units on order not delivered, the number of units wanted each day, and the number of units actually delivered each day. Results thus obtained are shown in Figs. 2 and 3 for feeder departments, and in Figs. 4 and 5 for assembling departments. In examining these it can be easily seen whether any section of the works is turning out what is required from it, or whether it is lagging behind.

In addition to these load diagrams, another chart is made out showing how the dates given to the customers are met. This is known as the delivery efficiency chart, a typical case being shown in Fig. 6. On this chart are plotted curves showing the daily percentage of dates kept, the average percentage of apparatus shipped on time for the past 30 days, and the percentage of overdue orders on hand. In some cases the chart is amplified by adding curves showing the percentage of orders overdue by varying amounts, such as 5, 10, or 20 days late. Copies of these charts are circulated through the works with the result that very considerable interest is taken by those departments concerned, and a certain amount of friendly rivalry is set up between them.

Conclusion (of Part I.).—In this section the author has endeavoured to point out some of the essential details necessary in the manufacturing side of the works organisation; but no matter whether the works are large or small, whether the apparatus manufactured is standard or special, the human element is bound to play an all-important part. No works can ever be independent of this factor, indeed the co-operation of individuals and departments is so vital that it may well be considered as the foundation of any system.

Furthermore, heads of the departments must be men of broad mind, capable of handling those under them, so as to encourage them to have real interest in their work, to treat their profession as something in which they can have real pleasure and not just as a dull monotony. The result of this will be that individuals in subordinate positions will gradually be found capable of taking more responsibility, so that when the time does come for the heads of the departments to move on into other positions, there will be someone so trained to carry on the organisation of the department.

(*To be concluded.*)

BRITISH WESTINGHOUSE ROTARY CONVERTERS.

The British Westinghouse Co. have issued a pamphlet, in which an interesting description is given of their rotary converters.

Dealing first with the construction, it may be said that the yokes of machines of all sizes are made of cast steel, and are divided horizontally to facilitate the removal of the armature. Commutating poles are provided on all sizes. The shunt field coils, which are interchangeable, are wound with cotton-covered copper wire, thoroughly impregnated with varnish. No spool is required to support the coils, the construction being such that each coil forms a solid unit. A heavy damper winding is fitted to each of the main poles. It consists of a shaped copper grid fitting round the pole tip, two or more copper bars being passed through the pole face and riveted into the sides of the grid to ensure good electrical contact. (*See* Fig. 1.) In some cases a complete squirrel cage is fitted to the field system.

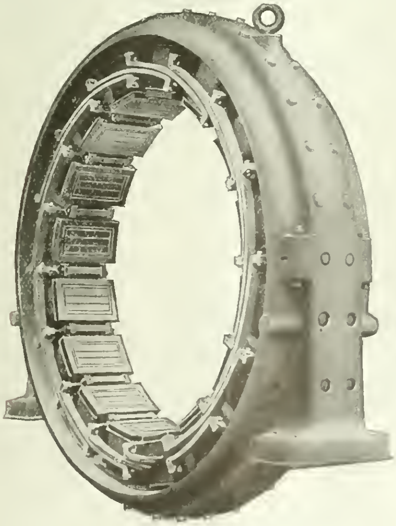


Fig. 1.—Field System showing Dampers.

The armature is invariably of the slotted drum type, built up of high permeability steel punchings, and ventilation ducts are provided in the core. The armature coils are former wound, and consist of copper strap or wire, thoroughly insulated and impregnated before assembly. Those parts of the coils which are inside the armature core are surrounded by mica taped up with the coil in addition to the usual slot insulation. The coils are held in place in the slots by means of hard fibre wedges, and outside the core by steel binding wire.

The commutator is built up in the usual way between the spider and a V-ring, the segments being insulated from one another and the spider by means of good quality built-up mica. To remove the possibility of the mica segments projecting above the surface of the commutator, they are grooved to a depth of $\frac{1}{32}$ in. before shipment.

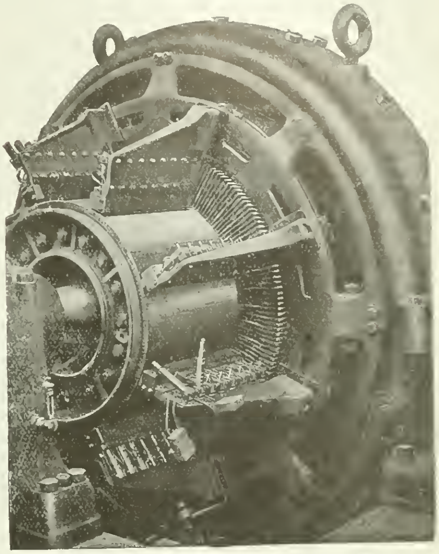


Fig. 2.—Direct-current End of Rotary Converter, showing Brush Gear.

The slip-rings are of bronze, shrunk on or bolted to a cast-iron bush, which is keyed to the shaft. Slip-rings and bush are insulated from one another by means of a mica cylinder or mica V-rings.

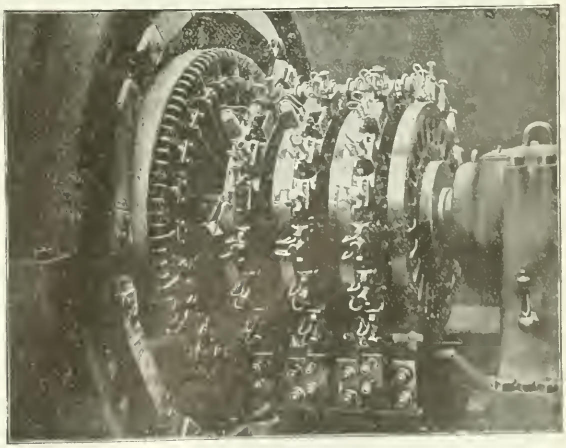


Fig. 3.—Alternating-current End of Rotary Converter showing Brush Gear.

Typical standard types of brush gear are shown in Figs. 2 and 3. For the continuous current end the carbon holders on the large machines are of the cartridge type, as shown in Fig. 2, and have been specially designed with a view to obtaining a maximum distance between adjacent brush arms, thus reducing the possibility of machines flashing over under abnormal conditions. The brushes are provided with flexible copper wire shunts clamped to the brush arm. In the smallest machines the brush-holders, which are of the Westing-

[illegible] standard box type, are insulated from the brush arm by means of [illegible], the arm being screwed directly into the rocker frame. In this case the flexible copper shunts from the brushes are clamped [illegible] to the brush-holders. Carbon or graphite brushes are used in all cases for the commutator.

For the alternating-current end the bracket for supporting the brush arms is mounted on the bedplate, except in the case of very small rotaries. In the larger sizes the brush arms encircle the slip-rings and are insulated from the bracket. The brush-holders are of the box type, as shown in Fig. 3, and are attached at intervals to the brush arms. In the smallest size of rotaries the brush arm is screwed directly into the bracket, and is insulated from the brush-holder. On all sizes of machines a self-lubricating type of brush is used, the use of which reduces the friction, and therefore the wear, on the slip-rings to a minimum value.

Synchronous Booster Rotary Converters.—This type of converter has practically superseded all other types for securing a greater variation of direct-current voltage than is practicable with reactance and variable field excitation in the ordinary form of converter. In construction it is the same as a standard converter, but a revolving armature synchronous alternating-current generator or "booster" is added. The booster is placed between the converter armature and the slip-rings. Fig. 4 shows a longitudinal section of a [illegible] the various parts. [illegible]

Power delivered from	Voltage.	Booster operates as	Rotary operates as
A.C.—D.C.	Raise D.C.	A.C. generator.	Partly as rotary, partly as synchronous motor.
A.C.—D.C.	Lower D.C.	Synchronous motor.	Partly as rotary, partly as D.C. generator.
D.C.—A.C.	Raise A.C.	A.C. generator.	Partly as rotary, partly as D.C. motor.
D.C.—A.C.	Lower A.C.	Synchronous motor.	Partly as rotary, partly a A.C. generator.

to provide in addition to the main series interpole winding a second winding to look after the change in armature reaction—*i.e.*, to be energised by a number of ampere-turns which are proportional to the amount of power absorbed or given out by the booster. It is often sufficient to connect this second winding in series with the shunt winding of the booster field, although theoretically this is not quite correct. In certain cases, however, it is necessary to take special precautions to obtain theoretically correct adjustment.

Inverted Running Rotaries.—Where rotaries are required to run inverted *i.e.*, direct-current—alternating-current—an exciter is direct-coupled, so that the machine when supplying alternating-current power to a system by itself may not speed up unduly on account of a load with a lagging power factor coming on. The exciter is so designed that its voltage increases very much faster than in proportion to its speed, and so offsets to a large extent the weakening of the rotary field due to the lagging current. In cases where the rotary has to run either direct-current—alternating-current or alternating-current—direct current the exciter is used for field excitation in both cases, but, with the difference that when running direct current—alternating current its rheostat is practically all in circuit, while when running alternating current—direct current it is practically cut out of circuit. If the exciter rheostat were all cut out when running direct current—alternating current its voltage would not increase rapidly with change in speed, and the exciter would not fulfil its function properly.

Full instructions are given in the pamphlet as to erection and various adjustments. We reproduce some of those which are of general interest.

Adjustment of Commutating Pole Field.—The commutating pole adjustment to give the best commutating conditions is made at the works where the rotary is run on load and, in general, no [illegible] touching it after the converter is installed will arise. The following method of procedure is used when the adjustment has to be made.

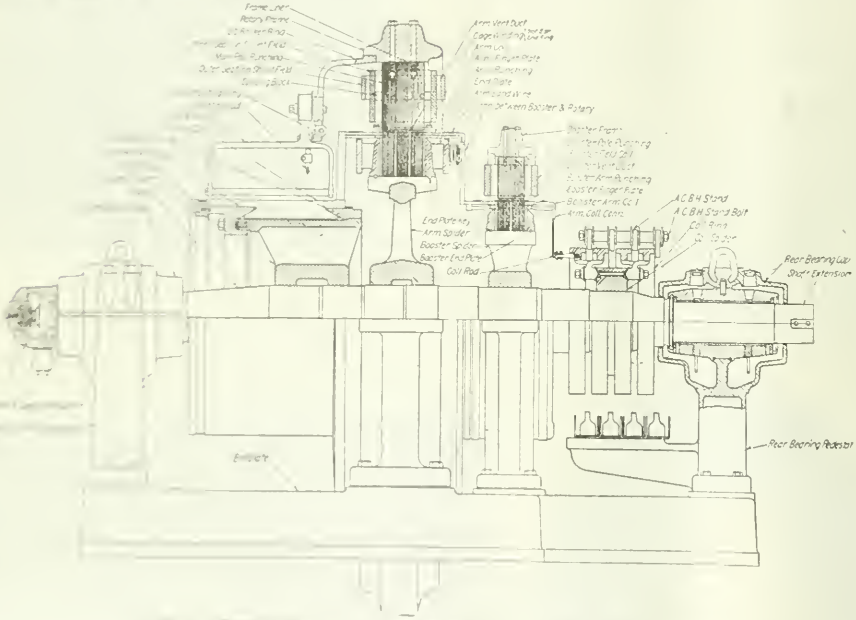


Fig. 4.—Construction of a Synchronous Booster Rotary Converter.

With a low-reading voltmeter read the voltage between the brush and the commutator at four equi-distant points along the width of the brush (round the circumference of the commutator) when the machine is running at normal load and voltage. These voltages can be most conveniently read by inserting in an outside brushholder two special carbon brushes D and E, each of which has a covering of the paper to insulate it from the holder, each brush being used in two positions to give two of the four readings—*i.e.*, brush D for readings 1 and 4 and brush E for readings 2 and 3, as shown in Fig. 5. Readings should be taken from position 1 to 4 in the direction of rotation, the voltmeter leads being one on the brush-holder and the other on the brush.

Take curves under both positive and negative brushes for several brush arms, noting that when running alternating-current—direct-current the positive lead is the moving one when reading the voltages on a positive arm and the negative on a negative arm. When running direct-current—alternating-current the opposite holds.

These readings if plotted as shown in Fig. 5 indicate, for example, in curve " A " over compensation—*i.e.*, excessive commutating field strength; curve " B " correct compensation; curve " C " under compensation.

Where there are only three brushes or less per arm, instead of using special brushes, carbon points attached to the voltmeter leads should be used, one being pressed on the brushholder and other the held on the commutator in the positions 1, 2, 3 and 4. Since the curves are largely affected by the condition of the brush and commutator surfaces a record of them should be made at the time of taking a curve, and if the brushes are at all fitted they should be rebedded before taking any readings.

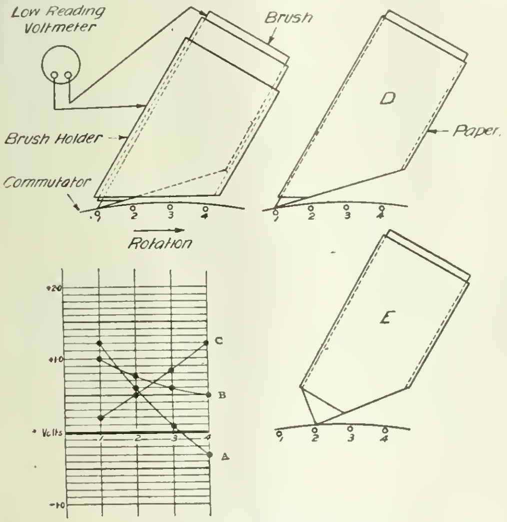


FIG. 5.—ARRANGEMENT FOR DETERMINING PROPER ADJUSTMENT OF COMMUTATING-POLE FIELD.

2. Changes in commutating-pole strength to secure correct compensation can be made by changing the air-gap or by shunting part of the current from the commutating pole winding. Adjustment by changing the air gap is the more usual method. In case of over compensation the air-gap should be increased and in case of under compensation the air-gap should be decreased by means of steel liners.

The measurement of brush curves and the adjustment of the commutating-pole strength should only be undertaken under the supervision of an experienced engineer.

Speed Limit Device.—As a safeguard against over speeds, a speed-limit device (Fig. 6) is attached to the oscillator end of the shaft, consisting of a spring closed switch. When the converter reaches a certain speed above normal, a centrifugal governor mechanism operates the switch and opens the circuit-breakers, thus cutting off the converter from its source of supply. All speed limit devices are set and tested at the works.

To reset the switch it is merely necessary to move the catch lever back to the normal position by hand. This can readily be done at any time, whether the machine is running or not, by means of the lifting lever.

When testing for overspeed the synchronous converter can be run as a motor from the direct-current side. It is important to have complete control of the speed during test. Use a tachometer or any reliable direct-reading speed indicator, but do not use the ordinary revolving dial indicator. The switch should trip at about 10 per cent. above synchronous speed. Bring the speed up slowly and watch for the tripping speed of the plunger.

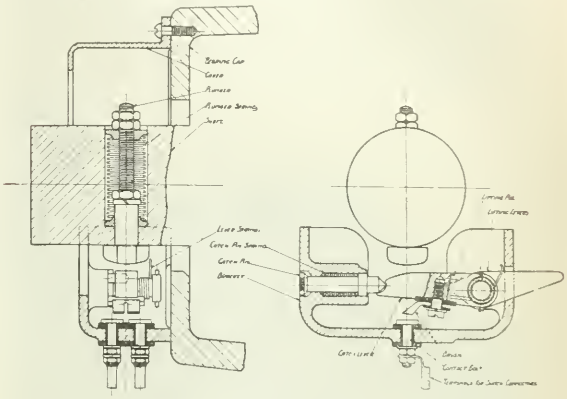


FIG. 6.—DETAILS OF SPEED LIMIT DEVICE.

The tripping speed is raised or lowered by adjusting the two nuts on the end of the plunger, so as to further compress or release the plunger spring. The nuts should be given about one-half turn at each run until the switch trips at the desired speed. Care must be taken that the two nuts are securely locked against each other before running the rotary.

Before starting each test see that the catch lever is in, and press the plunger several times by hand to see that it works freely.

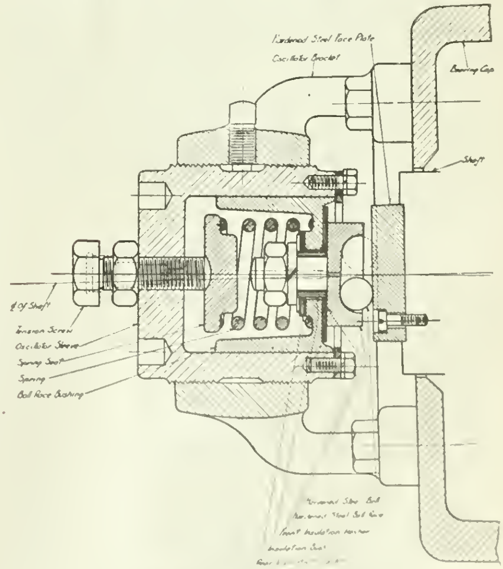
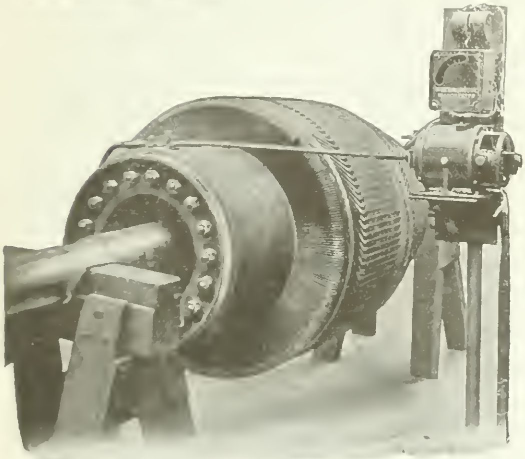


FIG. 7.—DETAILS OF MECHANICAL OSCILLATOR.

The Mechanical Oscillator (Fig. 7) is a self contained device at the end of the shaft to eliminate brush grooves in the commutator due to the armature running in a fixed position. The operating parts consist of a hardened steel ball and a hardened steel plate with a circular ball race, backed by a spring. This is so mounted that the face of the plate is not quite parallel to the face of the end of the shaft. The steel plate is adjusted so that the ball when at its lowest position is in light contact with the race and shaft. As the armature revolves the ball is carried upward and, owing to the convergence of the steel race and shaft face, the spring is compressed. The reaction of the spring forces the armature axially away from its natural position, and allows the ball to drop back to the lowest point of the race. The frame of a self-contained converter is dowelled to the bedplate at the [illegible] in such a position with respect to the armature core that there is a magnetic pull holding the shaft end against the oscillator. Therefore, when the oscillator ball forces the armature away from the oscillator this magnetic attraction returns the armature to its original position and the cycle is repeated. Fig. 7 shows the details of the mechanical oscillator.



The [illegible] Portable Tool for Undercutting Mica Attached to Electric Motor.

Operation.—The armature heating increases rapidly as the power factor is varied from 100 per cent. Thus at 98.5 per cent. power factor the armature loss is 33 per cent. greater than at 100 per cent. power factor in a three-phase converter and more than 40 per cent. greater in a six-phase converter. For this reason rotary converters should not be operated for long periods with heavy loads at power factors differing appreciably from 100 per cent. In compound-wound rotary converters some departure from 100 per cent. power factor is unavoidable. This departure, however, should be made small at the higher loads by proper shunt field adjustment. Shunt-wound converters should be operated at as nearly as possible 100 per cent. power factor whenever heavy load is carried.

When thermometer tests are made after [illegible] in addition to [illegible] the operating temperatures under the [illegible] conditions, particular care should be taken to keep the power factor at the rotary converter terminals 100 per cent. at all times. Failure to observe this precaution makes the tests of no value as a check against the guaranteed temperatures, since these vary so much with variation in the power factor.

With compounding of the proper amount for the converter, the voltage [illegible] by changing the [illegible] current. The power factor may be [illegible] of the shunt field windings. In [illegible] by providing a series field winding [illegible] winding. The direct current [illegible] of the series winding [illegible] the alternating current voltage. [illegible] With lagging wattless currents [illegible] the line voltage [illegible] is practically negligible. Lagging wattless currents are obtained by making the field excitation less than normal, and leading wattless currents, by making the field excitation more than normal. On account of the additional heating at power factors other than unity, a synchronous converter should operate at low lagging power factors at light load (when the additional heating is of no consequence) and at unity or slightly leading power factors at normal loads or at overloads carried for any appreciable time.

When converters carry widely and rapidly fluctuating loads, as in many interurban systems, the series field should be relatively weak, so as to avoid sudden wide variations in voltage and wattless current with sudden changes in load. A drooping voltage at the overload is s also desirable to assist in reducing the current under the extreme load conditions. A compound-wound rotary converter with weak series field, thus approaching a shunt-wound converter in its voltage characteristic, is more stable in operation on rapidly varying loads and when the machine breaker opens on very heavy currents.

With regard to parallel operation on the direct-current side, it is only possible to have exactly proportionate division of load and equal power factor on all converters when all four elements transformer ratio, series ampere-turns, series field resistance and reactance are properly proportioned. Such complete similarity in transformers and converters rarely exists, however, but satisfactory load division can always be obtained, even if one or two of these elements

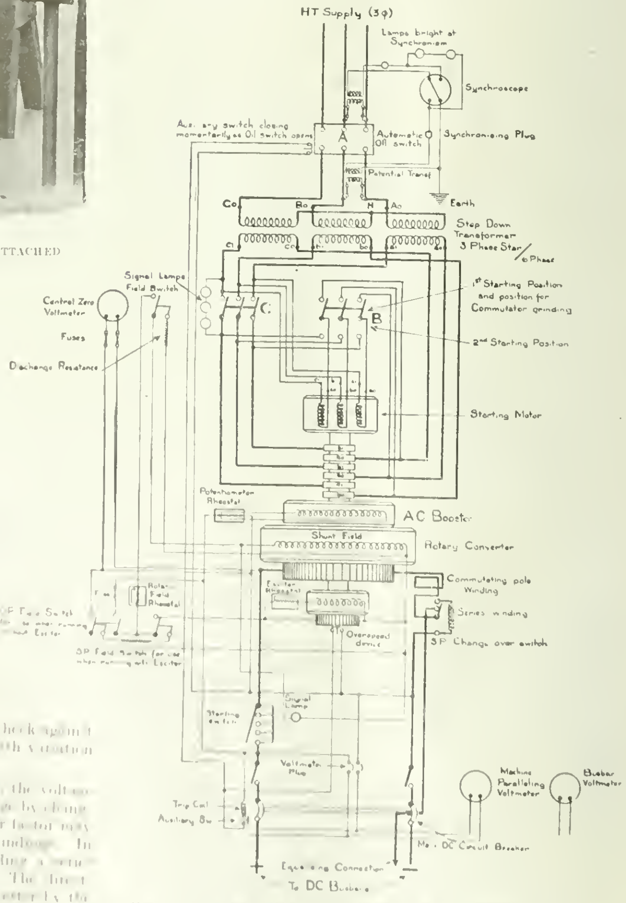


Fig. 9.—Three-phase High-tension to Six-phase Compound-wound Commutating-pole Rotary, with Booster, Exciter and Starting Motor. Starting from Direct-current Side or Alternating-current. Self-synchronising.

are not correctly proportioned, providing compensating adjustments are made in the other elements and slight differences in wattless currents are satisfactory.

It may sometimes appear convenient to connect several converters to the same low-tension alternating-current 'bus-bars and the same direct-current 'bus bars. With these connections, the alternating current and direct-current 'bus bars close the electrical circuit between any pair of converters and the direct-current load division will be determined by the relative voltages generated by the several converters and by the relative resistances of the different parallel paths. Slightly different voltages in different converters will also cause large circulating currents in the closed electrical circuit which may damage the windings and even burn them out. Different converters rarely have the same voltage ratio, and it is very difficult to control the resistances of the various parallel circuits, since the brush contact drops from a large part of these total resistances. The conditions become worse with converters of different ratings or design proportions. For these reasons converters must not be operated in parallel on both the alternating-current and direct-current sides.

With the usual arrangement of separate step-down transformers for each converter the electrical circuits between different converters are interrupted and slight differences between the voltage ratios of different converters can be compensated for by corresponding differences in transformer ratios.

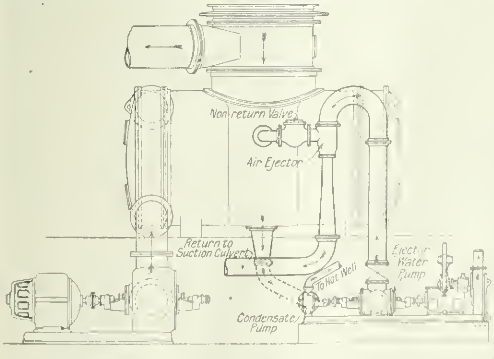
Undercutting Commutator Mica.—All standard commutators have the mica between the bars undercut $\frac{1}{32}$ in. approximately. After grinding or turning, the slots due to the undercutting should be cleaned out and the edges of the bars scraped to remove burrs and well rounded off. It is particularly important that the edges of the bars be well rounded. Failure to do this has caused machines to buck on sudden changes in load or when the circuit-breaker opens.

If it is necessary to re-undercut the mica due to grinding or turning the commutator or due to wear after long operation this may be done with a hack saw blade held between suitable guides or, more conveniently and accurately, with motor-driven circular saws (Fig. 8).

The connections of a three-phase high-tension to six-phase compound-wound commutating pole rotary converter are shown in Fig. 9.

TESTS OF WILLANS & ROBINSON CONDENSERS.

In what follows we give tests of one of the five surface condensing plants supplied by Willans & Robinson to the South-Western Railway Co. for the Durnsford-road power station. We described this station in THE ELECTRICIAN of October 1, 1915, and following issues. It may be remembered that the station contains five identical plants, each of the same capacity, in addition to two small similar plants. The whole of the plants embody the makers' rotary air pump system.



The main feature of this system is that the circulating water is passed through an ejector, which is shown on the accompanying diagram, and which takes the place of the ordinary air pump. A separate condensate pump is provided to withdraw the condensed steam from the surface condenser and to return this to the hot well. An automatic non-return valve is placed between the air ejector and the main condenser body, so as to prevent water being drawn into the condenser in case of failure of the ejector.

There are three common forms of application of the system, known as the "series," the "shunt" and the "separate pump" types respectively. In the case of the "series" type of plant, the whole body of the circulating water is passed through the air ejector before entering the condenser—that is to say, the circulating pump is designed for the normal quantity of water required by the condenser, but allowance is made in calculating the head for the necessary drop across the air ejector.

In the case of the second or "shunt" system, the cooling water for the condenser and the ejector water are delivered in parallel, and the ejector water is returned to the source of supply or to the circulating water suction. In other words, the circulating pump is designed for the normal head required by the lay-out of the plant, with allowance for condenser friction, and the quantity delivered is that needed for the condenser itself plus the necessary water for the air ejector.

The third or "separate pump" type, of which the L. & S.W. installation is an example, differs from the "shunt" system only in that a separate pump is provided for delivering the air ejector water as apart from the main circulating water pump, which supplies the condenser in the ordinary way.

In the present installation both the main circulating pump and the ejector pump draw their water by means of a common suction pipe from the main suction culvert, which runs the full length of the engine room. The water coming from the condenser itself is, of course, heated and passed to the delivery culvert, but the air ejector water is returned to the suction or inlet culvert. It will be noted that in this instance the circulating pump is driven by means of a continuous-current motor, whereas the ejector pump and condensate extraction pump are driven by a small steam turbine.

It will be noticed that the vacuum obtained is substantially above the guaranteed figure, and the difference between the circulating water outlet and the vacuum temperatures is very small. The plant had been in service for a considerable period at the date of the test.

The tests were carried out on August 20, 1916, in the presence of the representatives of the consulting engineers, Messrs. Kennedy & Donkin, and of Mr. Herbert Jones, chief electrical engineer to the London & South-Western Railway Co.

Table.—*Results of Tests at the Durnsford-road Power House of the London & South-Western Railway.*

Trial number	1.	2.	Guarantees.
Duration of test	60 min.	60 min.	...
Load, lbs. of steam per hour	68,176	68,389	68,000
Vacuum at steam inlet to condenser, corrected to 30″ barometer	28·73″	28·76″	28·5
Corresponding steam temperature	86·6° F.	86° F.	92° F.
Condensate temperature	82° F.	82·5° F.	87° F.
Difference between condensate and vacuum temperatures	4·6° F.	3·5° F.	5° F.
Circulating water inlet temperature	58·5° F.	58·5° F.	65° F.
Circulating water outlet temperature	80·8° F.	81·1° F.	83° F.
Difference between circulating water outlet and vacuum temperature	5·8° F.	4·9° F.	9° F.
Cooling water, gallons per hour	318,000	317,600	396,600

Cristobal Coaling Plant.—The new Panama Canal coaling plant at Cristobal is now in regular operation for commercial use, though not all of the work of the contractors has been completed. The unloader equipment now in use is able to care for discharging the colliers, and the two of the four re-loader towers which have been taken over for operation are able to supply coal to vessels as rapidly as required. In fact, the re-loaders usually supply the coal faster than required, for the work of trimming in bunkers in most of the ships requires considerably more time than is needed for the delivery of the coal to the hatches or on deck. One of the Elders & Fyffes ships, which has a large open hatch amidships over self-trimming bunkers, received recently 1,250 tons in three hours; but where time is lost in trimming the coal in bunkers a ship may need eight hours to take her supply. The re-loaders were designed primarily for rapid delivery of coal to barges and colliers with large and conveniently placed hatches. In order to adapt them better to the delivery of coal to the run of merchant ships, with all sorts of hatches and coaling ports, the construction of portable pipe chutes will probably be authorised. These can be affixed to the discharge chutes of the re-loaders and swung round to various positions to deliver the coal to ports inaccessible to the ordinary re-loader chutes. This will simplify both delivery and trimming in many cases

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SMOKE ABATEMENT AND ELECTRIFICATION.

The importance of reducing the smoke nuisance in any large city requires very little emphasis in these days in view of the large amount of investigation that has taken place on this subject. Considerable progress is now being made, and we are glad that electrical energy should be playing a large part in the mitigation of this evil. There is no question, for example, that the adoption of the electric drive by any factory, thus rendering unnecessary an isolated steam plant, leads not only to a reduction in the use of coal, but such coal as is necessary is used under much better conditions from the point of view of smokeless combustion.

As a rule, we do not associate electric traction with the abatement of smoke, but during the last few years there has been an agitation at Chicago from this point of view, and it has been sought to compel the railway companies in that city to adopt electrification on account of the better conditions this would bring about. In 1911 a committee was appointed to consider the whole matter, but a curious feature of the proceedings appears to have been that the committee did not work in conjunction with the railway companies. Actually the chief interest in the project finally is the way in which the proposals emphasise the magnitude of the railway system in a large city like Chicago, a point of view which is brought out excellently by Mr. W. F. M. Goss in an address to the Western Society of Engineers (U.S.A.).

One of the first points to be decided in such a railway scheme is the possibility of using the third rail and the relative advantages of the overhead system. With regard to the former it may be said that the total mileage considered was 3,988 miles of track, and of this amount a large percentage is due to yard tracks where the third-rail is at a disadvantage from the point of view of the movement of trainmen. The interruption of the third-rail at points and crossings must also be considered. In Chicago the number of gaps of this kind would be 737, aggregating about 16 miles in length. Including shorter gaps over which a train would coast, there would be approximately 4,000 gaps, giving a total of 56 miles. Further, there are about 75 miles of track in Chicago which, owing to the physical conditions, could not be equipped with any known form of contact system. On the other hand, if an overhead system is adopted the question of suitable height comes under consideration, and bridges present a certain amount of difficulty. In Chicago there are 222 overhead structures which would permit of only a small clearance.

If an alternating current system at 11,000 volts were used it is estimated that the total capital expenditure would be £17,000,000; but on account of improvements which would normally not yet be put in hand, but would certainly be accelerated by the present scheme, the sum rises to £34,800,000, even after allowing for some credits. In regard to operating expenses, there would be a reduction of £740,000 per annum, but there would be an increase on account of new transformer stations, amounting to £300,000 per annum, and an increase of £90,000 on account of steam operation, thus giving a net decrease of £350,000 per annum. On the other hand, the interest on capital would amount to £1,750,000 per annum, and depreciation would be £1,560,000. It would be necessary to meet these charges by increased revenue.

From the point of view of smoke abatement it appears that there might be a reduction of 7½ per cent. due to the elimination of the steam locomotive, and an increase of something over 2 per cent. due to the new electric power station, so that the net reduction would amount to about 5 per cent. The moral to be drawn, it would seem, is that the offender first to be tackled from the point of view of smoke abatement is not the steam locomotive, and that it is generally a mistake to force the growth of any movement artificially. If electrification of steam railroads is to become general, as we believe it will, this will come about in the normal course of things owing to commercial advantages. In due time the handling of traffic in Chicago will probably become too difficult for steam working. In fact, it is estimated that the number of passengers, which amounted to 11 millions in 1912, will rise to 15½ millions in 1922. This being the case, it is not unlikely that the railway companies will see the desirability of electrifying some of their suburban lines in due course, and that they will adopt electric traction because it suits their purpose better, but this is altogether a different proposition to attempting, as a means of smoke abatement, to force electrification on a whole network of railways serving a large city.

END-RINGS.

BY R. ROBERTS.

Summary.—Following upon the work of Mr. R. Livingstone, who first attacked this problem, which occurs a great deal in electrical machinery, the Author attempts by proofs of similarity to find a method for calculating deflections and stresses in end-rings of all sections. By means of curves and an extreme example he shows how simplified formulæ may be used without grave error.

An end-ring is a ring that is acted upon by forces or moments which tend to turn it about its axis of section; in other words, a ring acted upon by forces tending to turn it inside out. Such a ring is a structure commonly used in the construction of electrical machines as armature, rotor or stator end-plates, also as commutator end-rings; and frequently it is of importance to know the maximum stresses and deflections that may be expected to occur.

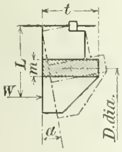

FIG. 1.

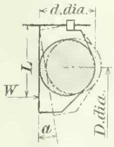

FIG. 2.

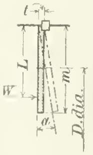

FIG. 3.

Mr. R. Livingstone ("The Mechanical Design and Construction of Generators," by R. Livingstone, 1911) suggested certain formulæ for distinct sections of rings, as shown in Figs. 1, 2 and 3, which may be designated cylinder ring, circular ring and flat ring respectively; but did not foreshadow any general formulæ that might be used for other or irregular sections. His results may, however, be put into convenient form involving the use of "moments of inertia," and "moduli of section." Thus, for a cylinder ring he gives the formulæ

$$\delta=\frac{3WlD}{2\pi Et^2m}\,\cdot \quad \ldots\ldots\ldots \quad (1)$$

$$=\frac{3MDt}{2\pi EI_1 12},$$

and since $\delta=\frac{1}{2}t\sin\alpha$,

$$\sin\alpha=\frac{3MDt2}{24EI_1t\pi}$$

$$=\frac{MD}{4\pi EI_1}\,\cdot \quad \ldots\ldots\ldots \quad (2)$$

Similarly, for the "circular" ring, he obtains

$$\delta=\frac{8WlD}{\pi^2d^3E},\quad \ldots\ldots\ldots \quad (3)$$

which may be expressed, since $\delta=d\alpha/2$ and $I=\pi d^4/64$,

$$\alpha=\frac{8MD2}{\pi^2d^4E}$$

$$=\frac{MD}{4\pi EI_1}\,\cdot \quad \ldots\ldots\ldots \quad (4)$$

For the case of the flat ring, where the thickness t is negligible compared to the depth m, he gives the expression

$$M=\frac{\pi\sin\alpha(1-\cos\alpha)Etm^3}{3D},\quad \ldots\ldots \quad (5)$$

which may be expressed as

$$\text{Sin}\,\alpha(1-\cos\alpha)=\frac{3DM}{12\pi EI_2}$$

$$=\frac{MD}{4\pi EI_2}\,\cdot \quad \ldots\ldots \quad (6)$$

Similarly the maximum stresses may, by substitution, be given for a cylinder ring and circular ring as

$$\text{Max. stress}=\frac{M}{2\pi Z_1},\quad \ldots\ldots\ldots \quad (7)$$

where Z_1=modulus of section about an axis normal to major axis of ring.

In a flat ring, however, the maximum stress may be deduced to the formulæ

$$\text{Max. stress}=\frac{M}{2\pi Z_2\sin\alpha},\quad \ldots\ldots \quad (8)$$

where Z_2=modulus of section about an axis parallel to the major axis of ring.

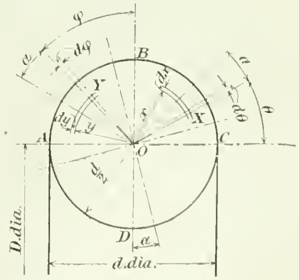

FIG. 4.

By comparing the three cases quoted it will be noticed that the results contain the same constants and nearly the same terms for the deflection. Equation (4), from a general physical aspect, must be wrong; otherwise the moment is always positive, irrespective of the amount of deflection α, a fact which is not born out by a simple experiment, indicating that the moment reaches a maximum value, becomes zero when $\alpha=180$ deg., and then becomes negative, so that we should expect the correct formulæ to be something like

$$\text{Sin}\,\alpha=\frac{MD}{4\pi EI_1}\,\cdot \quad \ldots\ldots\ldots \quad (9)$$

This can be proved for a circular section of ring by a more minute mathematical treatment than was given by Mr. Livingstone.

In Fig. 4 it will be seen that stresses in quadrant COB will produce moments dissimilar in quantity to stresses due to the same amount of movement in quadrant BOA. Quadrants COB and AOD will behave similarly in this respect, and stresses in quadrant BOA will give equal moments to those in quadrant

DOC. To find a true value for the sum of the moments reacting from a deflection of ring we must treat each quadrant separately.

Thus, in quadrant COB at point X:—

Increase in diameter $= 2x\{\sin(\theta+\alpha)-\sin\theta\}$.

Stress at this point due to deflection α

$$= \frac{2xE}{D}\{\sin(\theta+\alpha)-\sin\theta\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Radial pull due to this stress in section $x.\,dx.\,d\theta$

$$= \frac{4\pi xEx}{D}\{\sin(\theta+\alpha)-\sin\theta\}\,dx.\,d\theta.$$

Moment about centre of section due to this pull

$$= \frac{4\pi E}{D}x^3.\,dx.\cos(\theta+\alpha)\{\sin(\theta+\alpha)-\sin\theta\}\,d\theta. \quad (11)$$

The total sum of moments in quadrant COB:—

$$\int_{\substack{x=0\\ \theta=0}}^{\substack{x=r\\ \theta=\pi/2}} M = \int_{\substack{x=0\\ \theta=0}}^{\substack{x=d/2\\ \theta=\pi/2}} \frac{4\pi E}{D}x^3.\,dx.\cos(\theta+\alpha)(\sin(\theta+\alpha)-\sin\theta)\,d\theta$$

$$= \frac{\pi Ed^4}{32D}\left\{\cos\alpha(\cos\alpha-1)+\sin\alpha\left(\frac{\pi}{2}-\sin\alpha\right)\right\}. \quad . \quad (12)$$

Similarly in quadrant BOA we obtain:—

$$\int_{\substack{y=0\\ \phi=0}}^{\substack{y=d/2\\ \phi=\pi/2}} M = \int_{\substack{y=0\\ \phi=0}}^{\substack{y=d/2\\ \phi=\pi/2}} \frac{4\pi E}{D}y^3dy\sin(\phi+\alpha)\{\cos\alpha-\cos(\phi+\alpha)\}\,d\phi$$

$$= \frac{\pi Ed^4}{32D}\left\{\cos\alpha(1-\cos\alpha)+\sin\alpha\left(\frac{\pi}{2}+\sin\alpha\right)\right\} \quad (13)$$

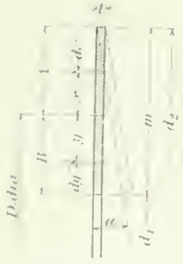

Fig. 5.

The moment for the total section is equal to twice the sum of expressions (12) and (13)

$$= \frac{2\pi Ed^4}{32D}\Big(\cos^2\alpha-\cos\alpha+\frac{\pi}{2}\sin\alpha-\sin^2\alpha+\cos\alpha-\cos^2\alpha$$

$$+\frac{\pi}{2}\sin\alpha+\sin^2\alpha\Big) = \frac{2\pi Ed^4}{32D}\pi\sin\alpha \quad (14)$$

$$\sin\alpha = \frac{MD\,64}{4\pi E\,\pi d^4} = \frac{MD}{4\pi EI_1}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Which agrees with the expected expression (9), where I_1 is the moment of inertia of the section about an axis normal to the [illegible] axis of the ring.

From equation (10) we obtain the expression for the maximum stress $= M/2\pi Z$, which is the same as (7).

In a flat ring as shown in Fig. 5, where thickness t is very small, the neutral axis will not necessarily coincide with the mean diameter of the ring.

The change in length of a small point distant Y from neutral axis due to the deflection of section through the angle α $= 2\pi Y(1-\cos\alpha)$.

The stress [illegible]

$$\frac{2\pi Y(1-\cos\alpha)}{D-2Y}E$$

The radial pull due to this stress on section $t.dy$

$$= 4\pi\frac{Y(1-\cos\alpha)}{(D-2Y)}E.\,t.\,dy$$

The moment about neutral axis

$$= 4\pi^2 y\frac{(1-\cos\alpha)}{(D-2Y)}\sin\alpha E.\,t.\,dy. \quad . \quad . \quad (1$$

$$\int_0^B M = \int_0^B 4\pi\sin\alpha(1-\cos\alpha)Et\frac{y^2dy}{(D-2y)}$$

$$= -\pi\frac{\sin\alpha\,(1-\cos\alpha)\,Et}{2}(D^2\log(D-2B)$$

$$+D^2\log D+2B^2+2DB). \quad . \quad (17$$

Similarly, for the outer section of ring we obtain

$$\int_0^A M = \frac{\pi\sin\alpha(1-\cos\alpha)\,Et}{2}(D^2\log(D+2A)$$

$$-D^2\log D+2A^2-2DA). \quad . \quad (18$$

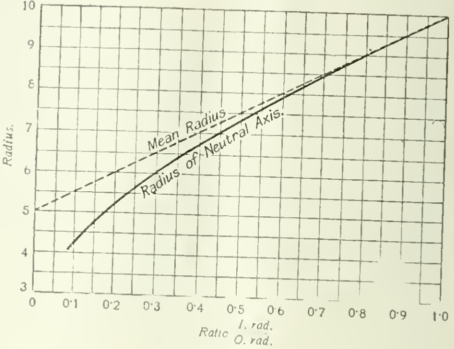

Fig. 6.

The total sum of moments in the ring is equal to the sum of expression (17) and (18). Since the moments in one part must equal the sum of the moments in other part, we can, by equating expressions (17) and (18), obtain an expression for the diameter "D" of the neutral axis. Dividing both sides by $\frac{\pi\sin\alpha(1-\cos\alpha)\,Et}{2}$ we obtain

$$-D^2\log(D-2B)+D^2\log D-2B^2-2DB$$

$$=D^2\log(D+2A)-D^2\log D+2A^2-2DA.$$

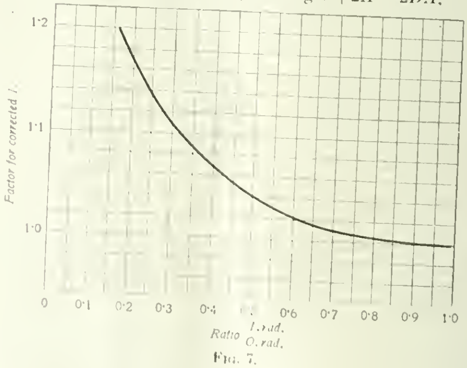

Fig. 7.

and putting "B" and "A" in terms of D and d_1 and d_2 we finally obtain

$$D^2(2\log D-\log d_1-\log d_2-3)-2D(d_1+d_2)$$

$$-\tfrac{1}{2}(d_1^2+d_2^2)=0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

from which values for "D" may be found for different values of d_1 and d_2.

Fig. 6 is a curve which gives the position of the neutral axis for varying ratios of inside to outside radii of rings. The mean radius is shown dotted. It will be noticed that for practical cases where the inside radius of ring is very seldom less than half the outside, that the radius to the neutral axis does not vary very much from the mean radius.

The effect of the true neutral radius is to increase the moment of inertia I_2 in equation (6).

Fig. 7 shows the amount of this increase for varying ratios of inside to outside radius of ring. Similarly, the maximum stress is increased by the amount given on curve Fig. 8, and occurs on the inside periphery of ring.

Fig. 9 is a cylinder ring section similar to Fig. 1. Let "X" be a point distant x in an axial direction from centre of section. Then

Change in diameter of ring at this point $=2x \sin a$.

$$\text{Stress at this point} = \frac{2x \sin aE}{D} \quad . \quad . \quad . \qquad (20)$$

$$\text{Radial pull for section } m,\, dx = \frac{2x \sin aE}{D} = m,\, dx,\, 2\pi.$$

$$\text{Moment about centre of section} = \frac{4\pi m \sin aE.\, x.\, dx.\, x \cos a}{D}.$$

Sum of moments in whole section

$$= 2\int_0^{t/2} \frac{4\pi m \sin aEx^2.\, dx.\, \cos a}{D}$$

$$= \frac{8\pi m \sin aE}{D} \frac{t^3}{24} \cos a$$

$$= \frac{4\pi E \sin a \cos a}{D} \frac{mt^3}{12}$$

$$= \frac{4\pi EI_1 \sin a \cos a}{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (21)$$

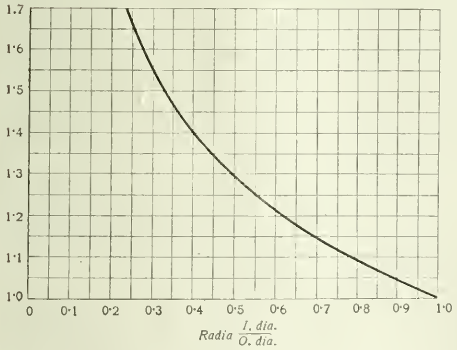

Fig. 8.

This is different from the derived formulæ (2) by the factor $\cos a$. Where a is small the error occasioned thereby is naturally small.

From equation (20) and (21) we may obtain an expression for the maximum stress viz.,

$$\text{Stress max.} = \frac{M}{2\pi \cos aZ_1} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (22)$$

Having investigated the behaviour of fibres in the section relative to two axes, we should expect to be able to obtain a correct expression for the whole section that would satisfy any form of section.

Thus, by adding expressions (21) and (5), we obtain

$$M = \frac{4\pi E \sin a}{D} \{I_1 \cos a + kI_2(1 - \cos a)\} \quad . \quad . \quad . \quad . \qquad (23)$$

This should be correct for cases where $I_1 = I_2$, as in the case of a circular ring in Figs. 2 and 4.

Putting $I_1 = I_2$ and $k = 4$, we have

$$M = \frac{4\pi EI_1 \sin a}{D} \{\cos a + 1 - \cos a\}$$

$$= \frac{4\pi EI_1 \sin a}{D},$$

which agrees with equation (15).

The factor K as given in Fig. 7 can be applied only where the section is rectangular, and will not be applicable to irregular or circular sections. That the position of the neutral axis, or of fibres that are not stressed at all, does not coincide with the centre of gravity of section is manifest; but the error that will be incurred as a rule in practice with irregular sections is small and of little moment.

To find the maximum stress in any irregular section is not so simple unless the section be rectangular. For instance, if we were simply to add expressions (7) and (8) we might add together stresses which do not necessarily occur at the same point. With a square section we obtain

$$\text{Max. stress} = \frac{M}{2\pi Z(\sin a + \cos a)},$$

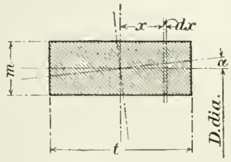

Fig. 9.

and putting in the correcting factor for stress from Fig. 8 we have

$$\text{Max. stress} = \frac{M}{2\pi Z\left(\frac{\sin a}{C} + \cos a\right)},$$

which will occur at a corner on the inside periphery of the ring. The maximum stress in an irregular section can usually be found with sufficient accuracy in practice by use of equation (22)

The absolute determination of deflection and stress is seldom necessary in practice where any value within 10 per cent. of the absolute being quite near enough. This can, as a rule, be obtained by the use of equations (2) and (7). If, however, an accurate result be desired, this can most easily be obtained by use of curves. Equation (23) may, by ignoring the factor in Fig. 7, be expressed as

$$\frac{\text{Sin } 2a}{2} + Q\left(\sin a - \frac{\sin 2a}{2}\right) = \frac{MD}{4\pi EI_1}, \quad . \quad . \quad . \qquad (24)$$

where $Q =$ ratio I_2/I_1. In curve Fig. 10 the values of the left-hand side of equation are plotted against the angle of deflection

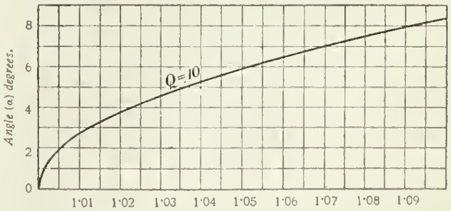

Fig. 10.

in terms of ratio to $\sin a$ for $Q = 10$. Thus, for a deflection of 5 deg. when $Q = 10$

$$\text{Sin } 5° = \frac{MD}{1{\cdot}035,\, 4\pi EI_1}.$$

If Q were 20 $\qquad \text{Sin } 5° = \dfrac{MD}{1{\cdot}07\; 4\pi EI_1}$ (approximately).

It will be noticed that even large values for Q make only a small difference to the result, which shows that the error would be small in practice if we neglected entirely the second moment of inertia I_2.

In practice there are several cases where theory is not complete enough to agree with practice. For instance, stator end-rings are supposed to hold the stampings in place by a pressure of 100 lb. per square inch. The author has met many cases of well-built stators where the average pressure was no more than 10 lb. to 20 lb. per square inch. Another apparent anomaly is the expansion stress in commutators This stress does occur, but not to the extent that is given by the ordinary methods of calculation that neglect the end-ring deflection of strain.

ELECTRIC COOKING AND HEATING.*

BY A. F. BERRY.

For cooking and heating, whatever method be put forward, the two questions that have to be answered to the satisfaction of the would-be user are: "What is it worth to me?" and "What will it cost to install and use?"

In answering the first question as to the worth, for instance, of an electric fire, the customer will take into account first of all his personal benefits, such as any monetary and labour savings, convenience and the capacity for rapidly and cheerfully warming an apartment, consideration being given also to the appearance as well as to the comfort and companionship to be derived from the installation of said electric fire. In connection with "What does it cost?" the customer will have in mind three things only—the initial outlay involved, the cost of maintenance and repairs, and the size of the bill for electricity consumed. As the thoughts of each one of us are largely controlled by habit, we may usefully consider our innate [illegible] regarding fires. For some thousands of years wood and coal were the only fuel our forefathers knew. For warming living apartments and for the preparation of food we naturally accept, therefore, the combustion of fuel in the dwelling place as something to be taken for granted without question, in the same way that the majority of us take for granted the sequence of the seasons, &c. Our reasons for using coal for heating and cooking, unless we make an effort, or someone makes an effort for us, to disturb our mental state, remain just the same as those of our grandparents. They used coal and wood because their grandparents used coal and wood—they had no alternative—and so back through the ages. Although very few, other than "penny-in-the-slot" consumers of gas, have an idea of what coal or gas costs to cook their Sunday dinner, anyone will almost immediately ask for the cost of electric cooking to be compared with that of gas or coal. It seems to me, therefore, that in any discussion with a customer as to the relative costs of fuel one should preface one's remarks with the statement of fact that the actual cost of cooking, for instance, is similar whether one uses coal or the gas or electricity derived from coal. This must be so within certain limits, as the customer for a commodity, whether the commodity be coal, gas or electricity, determines ultimately the price at which it shall be purchased. For if after allowing for certain advantages in the way of increased cleanliness and convenience, a customer finds a charge for a commodity unreasonable, its use is discontinued. Consequently it will be found that the actual "fuel-for-cooking" costs in a given district are similar in that district, whether coal or either of its derivatives is made use of. It has often struck me as extraordinary how very few of us realise where the coal that comes into a house is distributed; that is to say, the relative proportions absorbed in the kitchen and various other rooms. My own experience, which has been confirmed by that of many others who have taken the trouble to look into the matter, is that out of every 10 tons brought into a house some 8 of them are required for the kitchen. It [illegible] that 1 ton burned at the generating station of an [illegible] suffices to do the cooking that ordinarily requires [illegible] of coal in a private house. It is not necessary to labour the question of the relative costs of handling 10 times the quantity of coal, [illegible] the quantity of ashes, dirt, &c. It must be remembered that [illegible] works have their coal delivered by the train load [illegible] are employed for handling it efficiently [illegible] from the trucks through the boilers to the ash heap [illegible]. Coal for the private dwelling houses, &c., [illegible] the quantity from individual truck loads [illegible] from coal cellars to coal scuttles, [illegible] where it is burned; then [illegible] back to cinder sifters, and so on, [illegible], due to imperfect combustion, [illegible] or through them into the air [illegible].

[illegible] that of coal [illegible] the [illegible] the great bulk of our [illegible] I refer to the waste of meat. It is [illegible] joints [illegible] out of [illegible] were employed. I was [illegible] to discover, after a [illegible] Mrs. Beeton [illegible] quarter to one third in [illegible] of a joint. By [illegible] to avoid some [illegible] important. It soon [illegible] the oven and its heat [illegible] mies for themselves, and at the same time prepare food in a manner immeasurably superior to what had previously been possible. It was repeatedly and conclusively proved that with ordinary households the cost of cooking a joint of, say, 10 lbs. with gas, coal or electricity was of the order 2d., taking coal at £1 per ton, gas at 3s. per 1,000 cub. ft., and electricity at 1d. per unit. The advantage in favour of one or other method of cooking due to specially good handling of a cooker might be of the order of one farthing. I found that it was quite easy, however, with "Tricity" cooking to put upon the table from a joint of less than 8 lbs. the same amount of food that had required a joint of 10 lbs. when the older methods of cooking were employed. The saving here is of the order of 2s., in ordinary times, and with present meat prices, is of the order of 3s. During the past 10 years I have discussed this matter of economy, due to electric cooking, with some thousands of individuals. I have invariably found that every living soul has initially been interested merely in the saving of the farthing, that is to say, in the relative fuel costs. The reason is quite obvious. Scarcely anyone took the trouble to weigh joints before and after cooking—I never met an individual who did so—therefore, all were either unconscious of the waste that occurred, or took it for granted that it was unavoidable.

A large number of individuals have sent in to me from time to time figures showing the savings effected by the introduction of "Tricity" cookers in their establishments. The majority of the figures relate to private houses, but some relate to canteen and school equipments. It is clear that the butchers' bills in private houses that used to be over £50 per annum are reduced to £40 per annum; that a plate of meat in a munition workers' canteen is reduced in the ratio of 5d. to 4d., that the weight of meat used in a term in a school of 100 is reduced in the ratio of 2,400 lbs. to 1,950 lbs., when the older methods of cooking are discarded and "Tricity" cookers are fully employed. It will be seen that the retention of the old methods of cooking means that approximately 25 per cent. more meat is being purchased than need be. There is an economy also in making jam, marmalade, &c. I found, for instance, that the additional weight of marmalade when made on an electric hotplate instead of on the coal fire was of sufficient value to pay for the total cost of cooking anyway many times over.

The reliability of electricity for cooking purposes should be one of the first considerations. I think, however, the remembrance of early troubles accounts in a great measure for the apathy of some electrical engineers towards electric cooking.

You will, perhaps, forgive me when I say that my experience has been that ordinary users of electric cookers are even more enthusiastic regarding them than many supply engineers and contractors.

The improvement in detail apparatus, such as fuses, indicators, contacts, terminals and switches have all helped to make electric cooking the solid proposition it now is.

The use of indicators to show when hot plates, &c., are "on" is a great help in the direction of economy. I have brought the latest in combined fuses and indicators in model form, as your honorary secretary thought you would be interested to see it. It combines in most cheap and practical form the fuse and indicating device we have found it necessary to provide. This is only one detail of many that have been brought up to a high state of perfection. If you will consider that in this small apparatus you combine a pilot lamp and fuse you will appreciate how much more robust, more easily replaceable and economical, both in consumption and space, electrical accessories have become.

I am not going to burden you with a lot of theoretical considerations regarding the measurement of the actual efficiency of the various types of oven, &c. I would like to impress upon you, however, that electric cooking is here to stay, and that the sooner the whole electrical fraternity makes the utmost use of it the better will it be for themselves and for the community.

Pray do not let anyone retain the impression that electric cooking is for the rich. I have personally been more than interested to find that the "Tricity" cooker is the friend of the artisan's wife. It goes to the palace and cottage too.

Turning to electric heating, I am not going to take you through the various phases of development. The electric lamp radiator is with us still and is undoubtedly popular. It is an unfortunate fact that many of those who use a four lamp radiator expect to get from it much more heat than they are entitled to. I venture to predict that when the lamps are so made that their filaments are run at such a temperature that the shorter wave lengths of their radiant emissions pass through their clear glass surrounds readily and the filaments are screened from direct vision by suitable reflectors, then we shall find that our dwellings are warmed and lighted in a manner approaching most nearly that in which we receive light and warmth from the sun. This method of lighting and heating will be as near perfection as possible if we can also arrange, as I hope shortly to show that we can, to destroy the monotony of the lamp radiator as well as increase its efficiency.

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* [illegible] Supervising [illegible]

The importance of good radiating effect from an electric fire and its capacity to hold your attention is considerable. You may have noticed that the only time a lamp radiator interests you sufficiently to hold your attention is at the moment of being switched on. A good log fire or a clearly burning coal fire interests you all the time. They are conducive to steady thinking, and the contemplative frame of mind that bring calm and the solution of one's little problems. For many years I and those who are working with me have endeavoured to introduce into electric fires more comfort and some features of interest that will hold one's attention sufficiently to make "sitting in front of the fire" a most agreeable occupation.

To-night I am able to show you for the first time what is generally considered by those who have seen it privately an effect of great value. As you are aware, a great deal of the life of a fire is indirectly due to the different refrangibilities of the various vapours and heated air through which you see the burning fuel, and also to the varying degrees of redness caused by the play of air upon the fuel. I have endeavoured to combine these effects naturally in the "Tricity" Flame Fire which you see before you. The result gives a breadth of effect, and simulates in a perfectly natural manner the appearance of a coal fire at its hottest. I had not intended to show samples of fires to-night, but your worthy honorary secretary kindly offered to arrange for wires to be run, as he thought you would wish to see this effect. You are all of you aware from the working of the model electric fires in your showrooms how considerable the development has been in the direction of electric heating. You are also beginning to realise the extreme interest that the public can be led to take in this comparatively new application of electricity. It is, a great mistake, and has been made by many, to install heaters that are too small. The next thing I wish to point out is that an electric fire must have a big radiant surface if it is to give a sense of comfort. It must also be sufficiently hot and powerful and attractive to draw one towards it and then drive you back from it.

Another feature that should be borne in mind is that ordinary convector types of heater, and I am afraid some other types, have been designed in such a way that they would be most useful to us if we were flies and could sit with our feet on the ceiling. Warmth is wanted low down in the room, not high up.

The fourth point that I wish to make is that electric fires should be designed to look like electric fires. The earlier samples were either made to resemble obsolete fires or else appeared to bear no resemblance to anything at all.

It must not be expected that the economy alone of electric heating for rooms will force it upon householders in the way that electric cooking will do. The actual coal consumption of a private house for the various living rooms is small compared with that used in the kitchen. The economy in the consumption of coal, therefore, is very little worth. It is on the score of general convenience, cleanliness and comfort that electric fires are making their way into the homes of the people. It is difficult to say how far the consumption of electricity can be reduced and the comfort of the individual maintained. I have come to the conclusion that for personal comfort the heating effect of one fortieth part of a unit applied directly to the hands and feet of a warmly clothed individual would suffice to keep one warm when at work during very cold weather. It would appear that we may in time hope for something less than 100 times this amount, namely, 2½ units to be made sufficient to warm a room efficiently.

CORRESPONDENCE.

THE AUDION-FLEMING VALVE LITIGATION.

TO THE EDITORS OF THE ELECTRICIAN.

The letter from the De Forest Radio Telephone & Telegraph Co., appearing in your issue of October 6th, under the heading of "The Audion-Fleming Valve Litigation," has been brought to the attention of Dr. J. A. Fleming, who makes the following remarks thereon :-

However undesirable it may be to engage in journalistic controversy on a case which may still be considered to be sub judice as long as there is the possibility of an appeal, yet nevertheless the letter from the De Forest Radio Telephone & Telegraph Co. seems to demand some brief reply to correct statements which will otherwise leave a misleading impression.

The judgment of Judge Mayer on which they comment was the decision in a suit brought by the Marconi Wireless Telegraph Co. of America as plaintiffs against the De Forest Radio Telephone & Telegraph Co. as defendants for infringement of claims in the Fleming U.S. Patent No. 803,684, generally known as the valve patent, and there were counter claims under a group of De Forest patents.

The case was supported by an abundance of scientific evidence on both sides, and the judge who heard the case was in a better position than anyone else can be to evaluate and sift that testimony. Hence the best answer to any criticisms in particular is the judgment taken as a whole, but as its full publication might take up too much space I will simply briefly summarise the effects of it.

The first efforts of the defendants were directed to endeavouring to prove that the so-called De Forest Audion Detector was the natural descendant and outcome of a De Forest U.S. Patent No. 979,275, the application for which preceded by a few days the effective date of application of the Fleming patent. This De Forest patent was concerned with the employment of a Bunsen burner flame as a receiving device in wireless telegraphy.

Judge Mayer said :—

> This burner detector of De Forest has never been commercially used, and thus has not made any impression on the art. A mere inspection of the device in operation will show that this flickering flame is unpractical. The most that can be said is that it may contain the germ of an idea, which, in this rapidly progressing art, may hereafter be utilised in some way. While, therefore, it is not necessary to declare this patent and its three subsidiaries invalid, they may be eliminated from this case for all practical purposes.

But whilst De Forest was thus groping about in the dark endeavouring by the aid of his bunsen burner to find a new receiver, he suddenly became aware, from the publication of my patent and Royal Society Paper on my incandescent lamp detector, that something much better had been done.

Judge Mayer says :—

> Having read Fleming's article he began to experiment with the incandescent lamp. He probably doubted its efficiency at first, but within a very short space of time—perhaps a week, perhaps a month—he changed his mind, and discovering that Fleming was right wrote his solicitor after he had filed his application for No. 824,637, that the "new receiver is the best yet." Thereafter he used the language of the incandescent lamp, and in an address on October 20, 1906, before the American Institute of Electrical Engineers, really described fundamentally the Fleming lamp detector, although using phraseology which has since become Audion vocabulary.

Nothing could more clearly show the judge's opinion that at this date De Forest appropriated knowledge that he had derived from me, and henceforth set himself by the use of mystifying language and fanciful explanations to make the world belive his audion was something quite different from the Fleming valve. In support of this he neglected no opportunity of depreciating my work, but Judge Mayer says :—

> The contribution of Fleming was clearly invention, and is entitled to liberal interpretation and consideration.

and, again :—

> Fleming's invention was likewise a contribution of value, and is to be treated liberally and not defeated either by unconfirmed theory or by association in apparatus where later developments have taught how other useful adjuncts can be employed.

Hence, whilst giving De Forest credit for certain improvements, the upshot of the judgment is that these cannot be exercised apart from the Fleming master patent, and that claims 1 and 37 of this latter patent are valid, and are infringed by the defendant company in their audion.

GODFREY C. ISAACS, Managing Director,
Marconi's Wireless Telegaph Co. (Ltd.)

THE PROPOSED GOODS CLEARING HOUSE.

TO THE EDITORS OF THE ELECTRICIAN.

In these heavy days we need a little of the comic to cheer us up. Mr. Roy Horniman has recently had a correspondence with a railway manager, with a view to eliciting from him the objections to the adoption of the clearing house system, which Mr. Horniman estimates in his book, "How to Make the Railways Pay for the War," would save the country at least £174,000,000 per annum. You will appreciate that, if Mr.

Horniman is anywhere near accuracy, the objections would need to be very weighty.

The railway manager enters the fray by stipulating that his name is not to be publicly mentioned; but, although this is no doubt a wise precaution from his point of view, it is rather hard on his brother managers, any one of whom may be suspected of the authorship.

It is a relief that our railway manager does not enumerate among his objections the well-worn earthquake, which would inevitably tumble the clearing house into the condition of a fallen Zeppelin, and thus leave London to starve. Nor does he mention that shrewd stroke of lightning which would be sure to strike the clearing house and demolish it. He does not even mention the bomb which would come crashing through the roof, piercing any netting, sand bags and ferro-concrete which might intervene. He no doubt disdains these objections as being too obvious to need repetition.

He strikes at the heart of the matter at once. With an originality which is indeed startling, as coming from a railway manager, he declares that the use of automatic conveyors would need more men to work them than are now required to do the work by hand truck. Mr. Horniman has this magnificent expression of original opinion on the headed paper of the London District Goods Superintendent's Office of a large railway company, and duly signed.

The matter is of the utmost importance. In the light of this discovery, we are compelled to believe that machinery is at the bottom of the whole trouble. Take away the hand truck and make the men carry the goods on their backs and the problem would be solved.

In the presence of this truly wonderful discovery, we cannot help feeling touched by the modesty of its author. It is suggested, but not actually stated, that the clearing-house machinery would require four times as many men to work it as would be required by hand-truck methods. Is it not possible that a like reduction in the number of men could be accomplished by abolition of the hand truck?

I was present yesterday afternoon at the Institution of Civil Engineers and was among a crowd of engineers who were all as benighted in their ignorance as I was myself only yesterday; and Sir John P. Griffith, the lecturer, I now know to have been the worst of the lot. For an hour and a half Sir John gave what was to me, in my then outer darkness on the subject, a most extremely interesting lecture on appliances for handling merchandise at large centres of traffic. He is visiting our works in a few days' time and I am considering whether, strong though he is, the shock of this revelation of the true character of automatic machinery may not be too much for him.

Is there no way, Mr. Editor, whereby this railway manager can be induced to let the world know his identity?

London, Oct. [illegible] A. W. Gattie.

JUVENILE EMPLOYMENT.

TO THE EDITORS OF THE ELECTRICIAN.

Your leading article on Juvenile Employment prompts me to say that those who are interested in the subject of fatigue in industrial work will find a great deal of information in "Fatigue and Efficiency," by Josephine Goldmark. The book is published by the Charities Publication Committee, 105, East 22nd street, New York, and costs $2. Many re[illegible] dealing with fatigue and its consequences. No firm employing many persons can afford [illegible] to be ignorant of the facts recorded in this book. [illegible] to put it on the lowest grounds, to [illegible].

Cambridge, Oct. [illegible] G. F. C. Searle.

COST OF DAYLIGHT versus ELECTRIC LIGHT.

TO THE EDITORS OF THE ELECTRICIAN.

There is so much [illegible] about daylight costing nothing that I think you would give sufficient space in your columns to publish the following letter by Mr. M. Luckiesh, of the National Electric Lamp Association Laboratories, Cleveland, in a recent number of the "Lighting Journal":—

"In lighting discussions, it is not uncommon to hear such statements as this: 'A great virtue of daylight is that it costs nothing.' Outdoors this is usually true, but in the vast field of human activities, where artificial light aids and competes with natural light, such a statement is absurd. From the standpoint of construction, openings such as windows and skylights are not costless. In other words, interest upon a permanent investment as well as a maintenance cost must be charged to the daylighting, and therefore at once it ceases to be free from cost. Furthermore, when the value of land, especially in large cities, is considered, a light court in the middle of a multi-storied building adds to the cost of daylight. In such a case a large area of rental space is sacrificed for the purpose of admitting daylight, and it appears that the cost of daylight would not be inconsiderate. Of course, light courts provide ventilation; but it seems possible that ventilation could be provided without such a great sacrifice of space."

Mazda House, London, Oct. 26. F. W. Willcox.

THE I.E.E. AND THE CITY AND GUILDS OF LONDON INSTITUTE.

TO THE EDITORS OF THE ELECTRICIAN.

Having read with interest the recent correspondence anent the I.E.E. and the London City and Guilds Inst., I take the liberty of offering the students' point of view.

To begin with, I heartily approve of the proposals made by A. P. Lundberg & Sons regarding the relations between the two institutions. The I.E.E. is evidently content to remain as it is, selfishly considering its present members only, and displaying an all too-obvious disregard for its future members, the students of to-day. An immediate and satisfactory reconsideration of the existing state of affairs is especially necessary at the present time, when, in view of the future, the "rising generation" is of paramount importance.

As for the C. & G. Inst., it also is a trifle indifferent in matters electrical. Consequently, the mutual interest of the two institutions, as proposed by A. P. Lundberg & Sons, would be reciprocally beneficial to each, and would at the same time indirectly confer an immense benefit on, and also greatly encourage, the students. It is, in fact, the only way whereby an evanescence of the causes of the many grievances against these two institutions can be brought about.

Since an enumeration of these various grievances would occupy too much space, it will suffice to say that A. P. Lundberg & Sons have called attention to those most in need of consideration—viz., the scanty encouragement of students and the ridiculous list of text-books recommended for the electrical engineering examinations. With regard to the latter, it is evident that the list—which, by the way, contains almost every book recommended in its first compilation—has been ADDED to but never *revised*. The result now is a list of about 50 books, useful and otherwise. What is wanted, therefore, is a better discrimination and a shorter list. To this end, I would propose that the publishers of The Electrician take the matter in hand, and by issuing a "C. & G. Exam. Series," on the same lines as their "Electrician Series," put the C. & G. Inst. to shame. There is not the slightest doubt that it would be extremely popular.

Another point I would like to draw attention to is the C. & G. Inst. regulation "that all intending candidates for examination must make satisfactory attendance at a registered class held previous to the examination." Now, in all sense, such classes should provide efficient preparation for these examinations, yet how many of them do? To quote an instance, a certain college, whose classes are recognised by the C. & G. Inst., gives for the final or honours course a series of lectures on "The Theory and Practice of Alternating-current Machines." Again, during a previous session, it gave for the same class lectures on "The Direct-current Interpole Motor." Is this in accordance with the syllabus of the examination as issued by the C. & G. Inst.? Is it compatible with the requirements of students preparing for this examination, with s various special sections? As a prospective examinee, I say hat it is most decidedly not, and that it displays a regrettable ackness on the part of the C. & G. Inst. in registering such a lass.

Into such matters as these, the C. & G. Inst. would do well o direct a thorough investigation, and by so doing endeavour o eliminate all cause of further complaint.

"MAXWELL."

[We do not agree that the Institution of Electrical Engineers "selfishly considers" its present members only, or that the nstitution displays "an all too-obvious disregard" for its uture members. There are many of the opinion that the Institution disregards its present members. We think that our correspondent is a little difficult to please if he finds fault with a series of lectures on the "Theory and Practice of Alternating-current Machines." Attendance at these lectures, together with about six hours' homework for every hour in the lecture room, would unquestionably go a long way towards ensuring success in the City and Guilds examinations. Although under present conditions we do not propose to add to our activities by issuing a "C. & G. Exam. Series," we feel that students and authors complain with good reason about the list of text books recommended by the City and Guilds of London Institute.—EDS. *E.*]

ON THE RELATION OF IMPORTS TO EXPORTS.

TO THE EDITORS OF THE ELECTRICIAN.

I should like to submit to the consideration of Mr. J. P. Hecht, and others whom it may concern, the following proposition, which I believe to be true: If goods imported into England are paid for by goods exported, then it follows that all Protection can do for us is to take trade from one set of Englishmen and give it to another. I believe the failure to *realise* the fact that goods are only paid for by goods is at the bottom of most of the Protectionist fallacies.

Birmingham, Oct. 31. GEORGE HOOKHAM.

NATIONAL RESEARCH IN THE UNITED STATES.

On October 7th an assurance was given that the National Research Council, recently appointed by the National Academy of Sciences, at the request of President Wilson, to co-ordinate the scientific research of the United States, will have funds to proceed with its plans for placing the United States in the lead of all nations in the application of science to industry or warfare. It was announced that the funds of the Engineering Foundation, a heavily endowed organisation of the four principal engineering societies in the United States, will be placed at the disposal of the Research Council.

Chairman Gano Dunn, of the Engineering Foundation, who made this announcement, said that the financial resources amounted to the income of a $200,000 endowment, together with $5,000 additional yearly, both of which represent gifts by Mr. Ambrose Swasey.

It was also announced that the Council will have at its disposal the services of the secretary of the Engineering Foundation, Dr. Cary T. Hutchinson, who will act also as secretary of the Council. The motive of the engineers, 30,000 of whom are represented in the Foundation, in coming to the aid financially of the researchers, is their acknowledged debt to pure science, as well as a matter of patriotism.

Dr. G. E. Hale, chairman of the Council, and Dr. William H. Welch, President of the National Academy of Sciences, have recently returned from a visit to England and France to learn at first hand what has been the recent organisation of scientific resources in those countries. Dr. Hale remarked:

> Many of us have seen these opportunities for some time, and it is now becoming a matter of common recognition that something must be done. The members of the Council, including leaders in all branches of science, are evincing a remarkable enthusiasm over the service which by concerted effort we hope to render. In our brief visit to England and France, Dr. Welch and I were afforded every opportunity to learn what these two countries, under pressure of war conditions, were doing to enlist the services of their scientists. It is common knowledge that they were much behind Germany in this respect before the war, and, perhaps, it cannot be said they have yet caught up, but what they have accomplished in two years' time under the handicap of war is encouraging to us in contemplating what this vast country might do along similar lines in times of peace. In England all the well-known scientific men are at work, not only to make up for the deficiencies that are felt on account of the war, but looking to the laying of a permanent foundation for co-operation between science and industry, and their respective governments. They are beginning, in fact, at the very root of the matter by revising their school curriculums.
>
> One striking thing is the fact that the new movement has drawn many scientists out of their own sphere—drawn them out of their shell, I might say—and brought their powerful intellects to bear on common problems. In France, the Minister of Public Instruction, M. Painleve, a pure mathematician, is one of the ablest men of the French Cabinet, and the scientific men of France are organised most effectively under his department. One of the French astronomers has recently perfected a device to detect the presence of pieces of shrapnel in the human body; another has invented a range finder for getting the distance of Zeppelins. Thus, the men who study the heavens, men who live, supposedly, in a pretty rarefied atmosphere, can, when the call is made for them, respond to the practical needs of their country.
>
> In England, Prof. Jackson, of King's College, of London, has been conducting a long series of researches to learn how to produce optical glasses for telescopes, microscopes, field-glasses, &c., the best of which prior to the war came almost exclusively from the German subsidised firm of Schott & Co., in Jena. Ultimately, England will be entirely independent of a foreign supply of these glasses.
>
> We also visited, among others, Sir Robert Hadfield, President of the Hadfield Steel Company, of Sheffield, who discovered what is known as manganese steel, and another product known as low hysteresis steel. The latter is used in hundreds of thousands of transformers throughout the world, and in the decreased energy losses and other advantages it has, perhaps, saved America alone in a single year tens of millions of dollars. Sir Robert, we found, was one of those who believe science should not be always directed to immediate useful purposes. "We must have," he said, "the toiler in pure science, who has not in view monetary gain, but is willing to advance the world's knowledge for the sake of knowledge and that alone. These are often the men who discover a little here and a little there, apparently of no particular service at the time, but afterwards proving to be the basis of many of our great advances. It must be the aim of those in high authority not to destroy the pure scientist, but to try and bring his work into more intimate touch with progressive every-day requirements."
>
> That, concluded Dr. Hale, is what we hope to see accomplished in this country. It is certain that the nation that is dominant in the future will be the nation that develops science most effectively.
>
> It is realised that now is the time for this country to go to work on that theory. If it cannot be said that we have enlisted in the National Research Council every man that is a leader in science we are approximating that, for we are adding new men every day. We have a leader already in every chief branch of science.
>
> The National Academy which organised this movement last April, at the request of the President of the United States, did so in pursuance of its duty. The Academy was established by Act of Congress during the Civil War with the stipulation that the services of its members must be available to the national Government without charge. During and since the Civil War the Government has called upon it on some 60 different occasions, the most recent being to conduct a critical geological investigation of the slides in the Panama Canal. President Wilson has now called upon it for this new and important service to the country.
>
> The first thing on our programme is to undertake at once a national register of research, which will include an inventory of equipment for research in all the general, educational, Governmental and privately endowed institutions.
>
> Another important problem which we have already taken up is the determination of the best process for the production of nitric acid. The Government, as is known, has appropriated $20,000,000 for the production of this acid which is invaluable for the manufacture of explosives and for fertilisers, and it has asked our aid in determining the best process. The nitric acid supply, which has come to us almost entirely from the nitrate beds of Chile, though still available, is procurable only at high prices, which have been raised by the war, and in the event of this country ever being at war it would be a serious handicap to have to rely on a nitrate supply that was several thousand miles away. There are now many processes being tried in foreign countries for the manufacture of nitric acid, by taking it from the air and from waste products, and which of these, some of which are scarcely known here, is the best adapted for our purposes will be the object of this research.
>
> Another item will be an exhaustive study into the processes for the manufacture of optical and chemical glasses, which heretofore have come entirely from Germany.

Dr. Hale, who is a director of the Mount Wilson Solar Observatory, called attention also to the personnel of the Council. Medicine, for example, is represented by Dr. William H. Welch, President of the National Academy; by Major-General William C. Gorgas, Surgeon General of the United States Army; Dr. Simon Flexner, director of the Rockefeller Medical Institute; and Dr. Victor C. Vaughan, past president of the American Medical Society; biological science by Dr. Edwin G. Conklin, Professor of Zoology, Princeton University; chemistry by Dr. A. A. Noyes, of Massachusetts Institute of Technology, and Dr. L. H. Baekeland; physics by Dr. A. A. Michelson, of the University of Chicago; and electricity by Prof. M. I. Pupin, of Columbia University. These branches, with the exception of medicine, are in the realm of pure science. Recognising, however, that the practical applications of the principles which the pure scientists discover rest largely with engineers, there is a strong representation from the great engineering societies. Clemens Herschel, President of the American Society of Civil Engineers; John J. Carty, chief engineer of the American Telephone & Telegraph Co.; Gano Dunn, President of the J. G. White Engineering Corpn.; C. E. Skinner, director of the research laboratory of the Westinghouse Company; and Dr. W. R. Whitney, director of the research laboratory of the General Electric Co., are among those who will represent the engineering side of the Council's work.

The important military aspects will be presented to the Council by Major-General William Crozier, Chief of Ordnance of the U.S. Army; by Lieut.-Colonel George O. Squier, Chief of Aviation of the U.S. Army; and Chief Constructor David W. Taylor, U.S. Navy will represent other phases of the military problem. Other branches of the Government are represented by Dr. S. W. Stratton, director of the National Bureau of Standards; Van H. Manning, director of the Bureau of Mines; Prof. Chas. F. Marvin, Chief of the United States Weather Bureau.

Other members of the Council are Dr. John A. Brashear, of Pittsburgh; Dr. W. F. M. Goss, Dean of Engineering, University of Illinois; Dr. William H. Holmes, curator United States National Museum; Dr W. W. Keen, President American Philosophical Society; Prof. E. C. Pickering, director of the Harvard College Observatory; Mr Charles F. Rand, President United Engineering Society; Prof. Theodore W. Richards, Harvard University; Prof. Millikan, of the University of Chicago; Mr. Ambrose Swasey, of Cleveland; Dr Elihu Thomson, Swampscott, Mass.; Dr. C. R. Van Hise, President of the American Association for the Advancement of Science; Dr. Charles D. Walcott, secretary of the Smithsonian Institution; Dr. J. M. Coulter, Professor of Botany at Princeton University.

DIESEL ENGINE USERS' ASSOCIATION.

The first of the autumn meetings of the Diesel Engine Users' Association after the summer recess was held on October 20th. After the election as members of the Association of several engineers having the control of Diesel engine plant, certain resolutions were passed providing for alterations and additions to the rules. From the end of the current year an entrance fee of one guinea is to be charged to all new members elected.

To meet the demand which has arisen in many quarters for copies of the reports of proceedings and of the general information and data collected by the Association, provision has been made for a class of "subscribers." Such "subscribers," who must be duly accepted by the Committee, would consist of individuals or firms who are not qualified for full membership, and who would be entitled to receive the particulars circulated on payment of a sum of one guinea per annum. They would not be entitled to attend the meetings of the Association except by special invitation of the Committee, neither would they have any voice in the control of the Association. "Subscribers" may at any time send communications to the honorary secretary, and if in the opinion of the Committee they are of sufficient general interest, such communications may be read and discussed at a meeting of the Association.

Air Compressor Explosions and Troubles.

The Committee presented a report on the subject of explosions in air compressors and on the various troubles experienced with air compressors, having special reference to the accident which occurred at the generating station of the Smithfield Markets Electric Supply Co. [illegible] After discussion on certain points this report was [illegible] by the Association, and it is in due course to be printed and circulated among the members.

[illegible] Tar [illegible] Diesel Engines.

Mr. [illegible] in connection with the [illegible] by the Suffolk Electricity Supply Co. [illegible] for the duration of the war of the [illegible] He [illegible] that on economic grounds such [illegible] should [illegible] department [illegible] the [illegible] He was now effecting a saving of about [illegible] per cent. [illegible] partial use of tar oil.

Mr. [illegible] Diesel engine at Worthing. The saving in fuel [illegible] in the manner with about [illegible] per cent. of crude oil [illegible] up to date to about 47 per cent. The only trouble experienced had been in connection with the formation of a deposit which choked the pulverisers. No trouble had been experienced with the exhaust valves or with the needle valves. He also stated that he had tried on another engine a mixture of three parts of tar oil to one of crude oil. The engine had knocked rather heavily; but at three-quarters of full load, and with fairly continuous running no further troubles had been experienced. He, however, did not favour the use of mixtures of tar oil and crude oil. There was some risk of mis-firing, and there was a difficulty in securing complete mixture of the two classe of fuel oil.

Mr. W. A. Turnbull stated that he had worked a Diesel engine on tar oil with a slight alteration to the flame plates, and he had obtained a saving of about 50 per cent. in fuel costs. He had not noticed any corrosive effect by the tar oil on the copper pipes or brass fittings.

Further information of the subject of actual experience in the use of tar oils was given by Messrs. F. W. Strickland, J. Broadhurst and W. Fennell.

Mr. Napier Prentice strongly urged that on national grounds, as well as in their own interests, Diesel engine users should contiue to endeavour to make use of home products of fuel oil to the greatest possible extent in preference to fuel oil imported from abroad.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

12,193 Woodhouse. Insulators for electrical resistances and conductors.
12,404 Datzevitch. Telephone systems.
13,614 Morse & Indo-European Telegraph Co. Electric selective devices.
13,801 Thury. Regulation of dynamo-electric machines in continuous-current supply systems for "series" operation. (16/6/15.)

An exciter is provided whose field is differentially excited by the line current and by a current derived from a source of substantially constant voltage: the exciter is further excited by a compounding coil whose effect depends upon the voltage obtaining across the terminals of the machine to be excited, with or without an adjusting rheostat for the said compounding coil.

13,902 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Thermic telephones. (26/4/15.)
14,043 Parker. Electric bath blanket.
15,471 Hanson & Cox & Co. Apparatus for adjustably holding X-ray tubes.
16,694 Railing & Angold. Electric arc lamps.
17,185 Foster. Thermo-electric couple.
17,330 Newman. (Newman.) Sparking plugs for internal-combustion engines.

1916 Specifications.

1,724 Clarke, Chapman & Co. & Harris. Electric resistances. (4/2/16.) 101,498.

A resistance unit in which the resistance conductor is threaded in rows through holes arranged in parallel rows in a thin insulating base of mica or the like in such wise that similar stitches result parallel to one another, but extending obliquely to the rows of holes.

3,817 Soc. Anon. des Etablissements L. Bleriot. Explosion engines coupled to dynamo-electric machines. (10/4/15. Addition to 11,566/15.) 100,268.
7,100 Automatic Telephone Mfg. Co. Telephone systems. (19/7/15.) 100,941.
8,754 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Means for controlling and regulating electric motors. (28/1/16. Divided application on 1,374/16.) 101,523.

Relates to means for controlling an electric motor comprising a main switch for controlling the continuity of the motor circuit, a plurality of electro-responsive accelerating switches, each having a series operating and a series lock-out winding, and means including a shunt lock-out winding to co-operate with said series lock-out winding for controlling said switch.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 18, 1916.

13,198 Cox. Fuses or cut-outs.
13,[illegible]3 Kapferer & Société Anonyme Astra. Power transmission apparatus.
13,[illegible] R[illegible]. Adapting tungsten for magneto contacts.
13,235 B[illegible]. Incandescent electric lamps. (18/9/15, France.)
13,[illegible]37 Ha[illegible]. Telephone system.
13,[illegible] W[illegible] (Cox). Telegraphy.

September 19, 1916.

13,[illegible] Austin, Cohen & Squier. Electric [illegible]alling.
13,[illegible]77 Austin, Cohen & Squier. Te[illegible]
13,[illegible]79 S[illegible] Protection of electric [illegible]
13,[illegible] Y[illegible] & B.T.-H. Co. Electric [illegible] system.
13,300 M[illegible] C[illegible] (15/12/15, France.)
13,[illegible] B[illegible] & R[illegible] (21/9/15, France.)
13,[illegible]3 [illegible] Radio-telegraphic [illegible] transmitting apparatus.
13,304 Etab[illegible] B[illegible] [illegible] &c., devices. (8/11/15, France.)

September [illegible] 1916.

13,314 C[illegible]
13,33[illegible] [illegible] ware.
13,34[illegible] J[illegible] E[illegible]
13,[illegible]43 J[illegible] M[illegible] &c.
13,[illegible] [illegible] & [illegible] A[illegible] Automatic and semi-automatic [illegible]

September 21, 1916.

[illegible] F[illegible] &c.
[illegible] & B.T.-H. Co. E[illegible]
[illegible]
13,[illegible]41 A[illegible] & C[illegible] (22/9/15, Germany.)

September 22, 1916.

[illegible]
[illegible] E[illegible]
[illegible] W[illegible] & Hea[illegible] battery plates.
[illegible] H[illegible] & W[illegible] [illegible] bolt or bit.
[illegible]
[illegible] A[illegible]
[illegible] W[illegible] & [illegible], Automatic Telephone Co. Automatic [illegible]

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

The Excess Profits Tax.

As already notified in these columns, the electric supply companies of the country are appealing to the Board of Referees on the ground that as a class they are entitled to special consideration on account of the limitations and restrictions under which they are working, and the fact that in the early stages of the undertakings it is impossible to earn an adequate return upon the capital expenditure involved, it being necessary, in fact, at all times to expend money in advance of adequate return. The petitioners claim an increase in the statutory percentage allowed by the Finance (No. 2) Act of 1916. The interlocutory meeting was held recently before Sir Charles Renshaw, chairman of the Board, at which the course of procedure and certain principles were settled. Mr. H. B. Renwick is representing certain London electric supply companies, and a large number of provincial undertakings, and Mr. W. F. Fladgate is representing other London undertakings; together practically the whole industry will be represented. The result will be awaited with great interest by the industry, as a matter of important principle is at stake, and one which cannot but affect the financial position of supply undertakings in the future.

* * * *

The British Empire Producers' Organisation.

This association, which, as our readers will remember, was launched under the patronage of the Rt. Hon. W. M. Hughes, Prime Minister of the Australian Commonwealth, some eight months ago, gave a luncheon in London on Tuesday last to wish God-speed to two oversea members, Messrs. E. Saunders, of South Africa, and H. E. B. Young, of Australia. The function was presided over by Sir Henry Birchenough, K.C.M.G., and was attended by a large number of manufacturers, merchants and traders.

The Rt. Hon. William F. Massey, Prime Minister of New Zealand, was to have been present, but owing to an unexpected call to the Front he was unable to attend. In a letter which was read by Mr. C. Sandbach Parker, chairman of the organisation, he said that we are now entering upon an economic contest with Germany for the recovery of the trade of the world. He thought that each section of the Empire should act for itself, and, speaking for New Zealand, he promised that, during the present generation at any rate, no purchases would be made from any German. There was an immense opening for the development of the resources of the Empire, and even if a self-contained Empire were not possible, with free trade within the Empire, there might be preferential arrangements between the Home Country, and the Colonies and the Allied nations. He stated that arrangements had been made in New Zealand to place 5,000 discharged soldiers on the land, and several hundreds of these men had already taken up their allotments.

Mr. F. R. DAVENPORT, chairman of the B.E.A.M.A., replying to the toast of "Empire Production," said that it was of little use to dwell on the shortsightedness of the past. Now was the time to co-operate, and his Association had set a useful example in joining the British Empire Producers' Organisation, with the object of affiliating producing interests. He appealed for good will as between employer and employed, and urged that manufacturers must not be afraid of high wages, provided they were fully earned. Payment by results was a good plan, and would ensure production at reasonable cost.

Mr. J. A. SEDDON, past president of the Trade Union Congress, made a stirring speech, in which he urged upon employers the claims of labour, and the increasing need which had arisen out of the [illegible] of the war for improved relations between the two parties. The old feud between capital and labour should cease. The war had awakened us to the fact that we had been abusing and not using the Empire, and the present was an unique opportunity for uniting the Empire for the common good of all civilised nations.

* * * *

Idle Machinery.

The Minister of Munitions has set up a Central Clearing-house Organisation for tracing and registering machinery which is idle or about to become idle.

The Organisation will endeavour to ensure that contracts placed by the Ministry are directed towards any unoccupied manufacturing capacity which may exist in the country. It is also desired to place engineering contractors who have suitable facilities for particular supplies in touch with the Ministry and with other Government departments requiring these supplies, and to help contractors who are able to undertake additional or more suitable work now or at a future date to maintain continuous employment of their machinery and labour. Manufacturers possessing idle resources and desiring to be placed in touch with Government contracting departments are invited to communicate with the Central Clearing-house, Ministry of Munitions, Northumberland-street, London, S.W.

* * * *

Industrial Relations after the War.

It is announced that important proposals for the adjustment of industrial differences and for harmonising the relations between employers and employed form the subject matter of negotiations now proceeding between the Parliamentary Committee of the Trade Union Congress and the Employers' Parliamentary Committee.

The Government have been asked to assist, and a deputation to a responsible Minister is being organised. According to report, the proposals under discussion are:—

Membership of a trade union to be compulsory on all workers.

Compulsory 48 hours working week in every occupation.

Compulsory minimum wage of 30s. for all adult workers.

No reduction of present wages or increase in working hours.

Complete recognition by employers of trade unions and of agreements entered into between the unions and employers' associations.

State unemployment pay for men and women out of work.

Settlement by unions of conditions of women's labour after the war.

The movement is a result of a resolution passed at the recent Birmingham Trade Union Conference, and it is hoped to arrive at a settlement which will run for at least three years as an experiment.

* * * *

New Enemy Trading Bill.

A new Bill, entitled the Trading with the Enemy and Export of Prohibited Goods Bill, has been introduced in the House of Commons by Lord Robert Cecil. The Bill seeks to enact that for obtaining any licence, authority or approval for any transaction or matter under or in connection with any Proclamation or Act relating to trading with the enemy, or for obtaining a licence to export any goods the exportation of which without a licence is prohibited under any Proclamation or Order in or of Council, any person who

(*a*) Makes or presents any declaration or statement or representation which is false in any material particular, or (*b*) produces a guarantee certificate or undertaking which is false in any material particular, or has not been given by the person by whom it purports to have been given, or which has been in any way altered or tampered with

shall be liable on summary conviction to a fine not exceeding £500, or alternatively, in the case of goods for export, treble the value of the goods, or to imprisonment with or without hard labour for a term not exceeding three months, or to both such fine and imprisonment, unless he proves that he had taken all reasonable steps to ascertain the truth of the statements made or contained in any document so presented or produced or to satisfy himself of the genuineness of the guarantee certificate or undertaking.

The Bill was read a second time on Tuesday.

* * * *

American Exports.

Judging by the latest returns the export trade of the U.S.A. is still increasing at a rapid rate. In August the foreign trade reached a total of $510,000,000, or $35,000,000 higher than the previous record established in May last, and $15,000,000 above the total for June.

Imports, however, decreased to $199,200,000, or $17,000,000 less than in June, the record month. The favourable trade balance for August was $311,000,000, compared with $119,000,000 for the same period of 1915, and the import balance of $19,000,000 in 1914.

The exports for the year ending August were $1,750,000,000, and the imports $2,[illegible]00,000,000, both totals being far above those for a similar period of any previous year.

Decimal System. In reply to a question, the Premier (Mr. Asquith), states that the question of the introduction of the decimal system of coinage, weights and measures is a very complex one, and he is, therefore, unable at present to hold out any prospect of legislation with regard to it. This reply will be read with regret by the numerous and increasing body of advocates of the metric system in this country.

PARLIAMENTARY INTELLIGENCE.

Siemens Bros. & Co. (Ltd.).—In the House of Commons last week Mr. [illegible] asked whether the enemy owned shares in this company had yet been sold by the Public Trustee; if so, to whom and for what price.

In reply Mr. Pretyman said: I am considering in consultation with our expert advisers the British firms or classes of firms to whom it is desirable in the interests of the electrical industry of the country that the shares of Siemens Bros. & Co. (Ltd.) should be sold. I hope this will very shortly be decided, and the Public Trustee will then be in a position to deal with the shares which have been vested in him.

Registration of Business Names Bill.—This bill was read a second time in the House of Commons on Tuesday.

Prevention of Corruption Bill.—This bill was read a second time in the House of Commons on Tuesday, and committed to a Committee of the whole House.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Oct. 21, 1916, *to* Oct. 27, 1916.

IMPORTS.

[illegible]

EXPORTS.

[illegible]

FOREIGN GOODS [illegible]

[illegible]

[illegible] under the [illegible] is described as [illegible]

BUSINESS NOTICES.

Dissolution of Partnership.—The partnership heretofore subsisting between Roger Stephenson Albert Drewer and Chas. Rodier Curtis, carrying on business as electrical consulting and contracting engineers, at 27, Chancery lane, in the City of Westminster, under the style or firm of Drewer, Stephenson & Co., has been dissolved by mutual consent as from Oct. 14, 1916. Debts due to and owing to the late firm will be received and paid by Albert Drewer and Charles Rodier Curtis, who will continue under the same title.

Patent Development. The owners of British patents Nos. 8,901/1911, 21,281/1912 and 22,723/1903, relating to "Electric furnaces," desire to enter into negotiations for the development of the patents in this country. Applications to Messrs. Abell & Imray, patent agents, 29, Southampton-buildings, London, W.C.

Also the proprietors of patents Nos. 24,702/1908 and 24,708/1908, for "Improvements in and relating to electric fusible cut-outs" and for "Improvements in seal fastenings," desire to enter into arrangements for developing same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

LIQUIDATIONS, &c.

The liquidator (Mr. H. E. Burgess, 33, Carey-street, London, E.C.) of the Electro-Steel Foundries (Ltd.), Booth-street, Darlaston, has been released.

A meeting to receive an account of the winding-up of the Electrical Oil Refinery Co. (Ltd.) (in vol. liq.) will be held at 29, Great St. Helens, London, E.C., on Dec. 4.

ELECTRICITY SUPPLY.

EXTENSIONS.

Belfast.—The Tramways and Electricity Committee has been considering the increased demands upon the electricity department, and the Council are recommended to authorise the committee to take up again the question of the extension of the plant and mains, and to submit a complete scheme, part of which could be put in hand as soon as the necessary Treasury sanction to the expenditure involved could be obtained.

The committee also approved of a circular being sent to the existing users of electricity, thanking them for the manner in which they had met their request last year in reducing their demands between 4 o'clock and 5.30 p.m. during November and December, and asking them to make a similar reduction this year.

Bradford. The Guardians are to extend the electric mains for lighting the whole of the laundry and garage block.

Dewsbury.—Last week the Electricity and Tramways Committee reported that the electrical engineer (Mr. R. H. Campion) had prepared estimates, amounting to £35,800, based on pre-war prices, for the extension of the electricity works, the principal items being:

Two 2,000 kw. turbo-alternators and condensers, £14,000; two 500 kw. rotary converters, £4,000; two 250 kw. ditto, £1,250; switchboard, £1,600; cables, £8,400.

Mr. Campion also stated that when the load exceeded 2,000 kw. there would be an extra boiler required at a cost of £3,000, an additional cooling tower £2,000 and coal conveyor £1,500.

In compliance with the request of the L.G. Board, the borough surveyor (Mr. H. [illegible]) has prepared a return of the works proposed to be executed after the war. The return includes £12,300 on the electricity works and £2,100 for tramways extensions.

London County Council. The Finance Committee reported on Tuesday that they had made a loan of £3,728 to Battersea Borough Council for electricity supply purposes, £1,260 for buildings, £2,308 for plant and £160 for mains; and of £650 to Hammersmith Council for purchase of a site.

The Highways Committee stated that they had terminated as from Mar. 31, 1916, the agreements, dated Jan. 20, and Dec. 7, 1914, with the London Electric Supply Corpn. (Ltd.) for the supply by the company of electrical energy to the tramway sub-station at Lewisham. In connection with the supply and that provided by the company to Camberwell and New Cross sub-stations, they had agreed to the price to be paid per unit as from April 1, 1916, to be increased proportionately to the increase in the cost of coal above 20s. a ton.

Stalybridge. The Stalybridge, Hyde, Dukinfield and Mossley Joint Tramways and Electricity Board has decided to increase the capacity of the Tame Valley station from 9,000 kw. to 12,000 kw.

Walsall. The new electricity generating station at Birchills was formally opened on Tuesday by the chairman of the Electricity Committee (Coun. B. Hayward).

West Bromwich. The Electricity Committee has had under consideration the present method of dealing with removal of ashes, and it has been decided to erect a runway in the boiler house on which the body of a side-tip wagon could be carried. This would be filled with ashes in the boiler house, placed on truck outside and carried on a light railway to the ash mounds, thus obviating any re-handling.

The Committee has also decided, subject to the usual sanction, to purchase six second-hand side-tip wagons and 400 yds. of light railway with two switches for £155.

The sales of current during the quarter ended Sept. 30 amounted to £6,796, compared with £5,876 in the corresponding period of 1915.

GENERAL.

Birmingham.—There was another failure in the supply of electric current on Friday last.

It appears that soon after 6 a.m. there was an accident to the switchgear at Nechells power station, and a workman named Cadman was slightly burned on the head and neck. The supply of current was shut off from Nechells station to a number of important consumers, and the demand upon the Summer-lane station became too heavy. After a time the supply to some of the works was cut off, so as to enable the tramcars to be run until the workers in the factories and business people had been conveyed to their destinations. Then the current was cut off the trams, and, temporary repairs having been made to the switchgear, the supply of electricity was gradually restored to the factories. The tramcars were stopped from 10 minutes past nine until a quarter to one, when the factories ceased work for the dinner-hour. This enabled the trams to recommence running, and the service was continued until shortly before three o'clock. It was hoped the difficulties due to the accident would be overcome by that time, but this was not the case, and the tramcars remained stationary until the evening, when, the day's work in the factories having finished, the cars were once more in a position to resume their journeys.

Othe. failures of the electric supply have since occurred.

Heywood.—The Electricity Committee is in negotiation with the Roe Acre Dyeing & Felting Co. for a supply of e.h.t. energy for their premises.

Linking-up in Yorkshire.—At Leeds on the 25th ult., there was a meeting of representatives of municipal and company owned electricity supply undertakings in Yorkshire, in order to give further consideration to the proposals of the Board of Trade for the interconnection and joint working of the undertakings.

For the working of the scheme a joint committee of the Municipal Electrical Association and the Association of Electric Power Companies had already divided the country into areas, one of which was Yorkshire, and had suggested the establishment in each of a local committee to consider from a technical standpoint the question as it applies to the particular area. There are 40 electricity undertakings in the county (30 of which are municipally managed), and representatives from 38 of these were present at the meeting. Mr. Thomas Roles (the Bradford City Electrical Engineer) presided. The meeting decided upon the formation of a county committee to obtain the necessary information, upon which they will report to a later meeting. The committee was appointed as follows: Mr. E. Cross (Rotherham), Mr. S. E. Fedden (Sheffield), Mr. C. N. Hefford (Leeds), Mr. Jewell (Yorkshire (W. Riding) Electric Tramways, Wakefield), Mr. S. D. Jones (Batley), Mr. H. A. Neville (Wakefield), Mr. E. S. Rayner (Doncaster, representing also Barnsley), Mr. T. Roles (Bradford), Mr. H. Webber (Keighley), Mr. Geo. Wilkinson (Harrogate), Mr. W. B. Woodhouse (West Yorkshire Electric Power Co.), with Mr. W. M. Rogerson (Halifax) as secretary.

The Leeds and Bradford Corporation Electricity Committees have stated their willingness to consider the practicability of the scheme in the West Riding area. The linking-up suggestion is not a war-time measure, but is looked to as a method of promoting economy under post-war reconstruction conditions.

London Municipal Loans.—London County Council has informed the Metropolitan Borough Councils that the rate of interest charged by the Council on loans to local authorities is to be raised from 5 to 5½ per cent.

Oldham.—The Council have unanimously elected Councillor Charles Hardman, chairman of the Electricity Committee, as alderman for St. Paul's Ward.

Troon.—Negotiations are proceeding for a supply of electrical energy from Kilmarnock to several consumers in the Wood, Troon, by means of an over head line.

Walthamstow.—Two days pay is to be granted to the employés at the electricity works in lieu of the Whitsuntide and August Bank Holidays.

Application has been made for sanction to a loan to supply electric current to a local factory.

Wimbledon.—In view of the desirability of obtaining powers to supply electrical energy in the parish of Cuddington, the Electric Lighting Committee has instructed the Town Clerk to ask the Board of Trade whether they consider there is a prima facie case for the proposed application for a provisional order.

The borough electrical engineer has been directed to keep the Committee informed of any action taken in regard to the interconnection of electric supply undertakings which might affect Wimbledon.

Two electric radiators for heating the Council chamber are to be fixed at an estimated cost of £15.

Wolverhampton.—An additional war bonus of 3s. per week is to be paid as from May 1 last to all employés of the Council of the classes represented by the Amalgamated Society of Gas, Municipal and General Workers and the Amalgamated Association of Tramway and Vehicle Workers.

TRACTION NOTES.

Bolton.—Ald. J. Miles, J.P., chairman of the Tramways Committee, has been appointed a vice-president of the Municipal Tramways Association.

Croydon.—As it is not possible to get new rails until some time next year, it has been resolved, having regard to the condition of the tramway track in a portion of Selhurst-road, to take up rails from the Whitehorse-road section and utilise same in constructing a double line between Selhurst New-road and Selhurst Railway Bridge. The estimated cost of the work when it was believed new rails could be obtained was £2,156.

East Ham.—The inter-running tramway agreement with West Ham being about to expire, it has been arranged that, pending the execution of a new agreement, the present through running arrangement shall be continued between the L.C.C., West Ham and East Ham Corporations and Leyton Urban Council.

Women conductors are to be engaged at 30s. per week net.

Edinburgh.—The report of Mr. A. H. Campbell (city engineer, Edinburgh), Mr. J. A. Brodie (city engineer, Liverpool) and Mr. J. B. Hamilton (Leeds) on the local tramway system has now been issued. The report is 59 pages and the following are the chief points and recommendations in it:—

The report points out that Edinburgh possesses unique advantages for the development of a tramway system of the most approved kind, capable of serving the city and its suburbs in a way which cable traction cannot adequately or economically do. An efficient tramway service for the city would assist the city's progress in its commercial, social and health relations, and present-day appearances and prospects of the city and its neighbourhood indicate the probabilities of a good commercial future for the city as the natural centre of an area in course of industrial development. For these and other reasons the tramway system of the city should be considered with due relation to its wider sphere of operation, for only thus can it realise its full function and attain its own maximum of prosperity. It is the general practice of the great municipal tramway systems of the country to extend their services into the suburban areas outwith the artificial boundaries of a city, and to promote through-running with other tramway systems, and they recommend the overhead electric system as the most reliable, convenient and economical system which can be provided to fulfil adequately all the demands of the city and its suburban areas.

The recommendations are:—

1. That it is not advisable to continue the cable teamway system for the city or for any part of the city after the expiry of the lease in 1919.

2. That "it is practicable to arrange for a system of traction other than the cable being installed so as to be operated on the expiry of the present lease."

3. That, subject to note preceding, the only alternative system of traction which can be made available at June 1919, and which we can confidently advise, is the electric overhead system.

4. That, independent of the existing tramway conditions of the city, the electric overhead system of traction offers the best, most reliable, convenient and economical solution of the transit requirements of the city and suburbs.

5. That in the detailed treatment of the overhead equipment, special care should and can be given to the preservation of the amenities of the city.

6. That we have in our summary of estimates restricted "the central parts of the city" to Princes Street, and for this street we suggest that the tramway should be laid along the south side of the roadway.

7. That as regards this "central part of the city," whilst temporarily it must be equipped with the overhead system (unless diverted), the conduit system may be constructed subsequently should the Corporation so desire.

8. That it is desirable that facilities for through-running between the tramways of the city and the neighbouring tramway undertakings should be provided.

9. That, "keeping in view the proper development of the undertaking in relation to future extensions," we think that the tramway system should be extended by a total route length of 8¼ miles.

10. That we think that the influence of the motor bus traffic upon the future of street transit in the city should be considered by the Committee with a view to co-ordination and the avoidance of waste.

11. That the electric current should preferably be obtained from the Corporation's new power station at Portobello.

12. That it will be necessary at an early date to initiate arrangements with respect to the provision of suitable rolling stock and additional depot accommodation.

13. That if the Corporation decide to continue the cable system after the expiry of lease it will be necessary :—(*a*) To initiate arrangements for the provision of new rolling stock (suitable for conversion and adaptation to other form of traction at a later date) ; (*b*) To provide additional depot accommodation ; (*c*) To restrict the programme of extensions to routes capable of being worked by "self-propelled" cars, and running along and over the existing cable lines ; and (*d*) To arrange for the cables which will be doing duty at the close of the lease being available thereafter.

14. That it is desirable in the event either (1) of electric being installed or (2) of the cable being continued, that an electric battery tramcar and a "self-propelled" tramcar should be acquired with a view to running in series with other cars, provided arrangements can be made for their trial.

Estimates of cost of installation and of working, with resultant annual surplus or deficit upon each system, are set out in tables, and the following summary is given, the year of working assumed being 1919–20 :—

—	Revenue	Operating costs.	Capital expd. (new debt).	Int. & red. charges of new debt.	Annual balance.
1 [illegible]	£322,908	£228,034	£256,312	£26,655	+ £68,219
2 [illegible] ex[illegible] "self-propelled" [illegible]	334,4[illegible]	238,130	342,55[illegible]	35,[illegible]88	+ 61,690
3 Electric [illegible] No. 2	340,[illegible]	207,112	836,750	66,747	+ 67,049
3a As No. 3 [illegible] P[illegible]	340,[illegible]	211,112	924,250	72,747	+ 57,000
4 E[illegible] ex[illegible]	356,[illegible]	217,007	936,500	73,663	+ 66,236
4a As No. 4 [illegible] P[illegible]	356,908	221,007	995,000	65,665	+ 58,000
5 E[illegible] ex[illegible]	328,908	21[illegible],639	1,335,750	99,305	+ 17,964
6 [illegible] 4	33[illegible]	283,334	[illegible]02,000	82,318	— 15,652

The capital expenditure under No. 1 is chiefly for new rolling stock. The result under No. 2 is affected by local conditions, and does not correctly reflect operation by "self-propelled" cars. Under schemes 3 to 5 the capital cost of the conversion, reconstruction and extensions of electric systems are included, and charged against gross surplus before striking net balance available. Under No. 6 the direct deficit plus indirect charges amounts in all to about £39,125 per annum.

The report states that the installation of the overhead system during the currency of the lease can be accomplished by the adoption of the twin overhead wire, [illegible] in railless traction at Leeds and Bradford, and as adopted by the London County Council in one of their latest extensions from Woolwich to Eltham. The wires and their supports might be erected during the period intervening between now and 1919 without interfering with the cable car service, and charged with current by electric [illegible]. The electric current would by preference be obtained from the new power station at Portobello. It was assumed that in the period [illegible] there would be time to complete the works and [illegible] at the new [illegible] station there. It is suggested that having regard to the [illegible] of Princes Street, the four overhead wires and [illegible] with cross span wires should so remain for the [illegible] period [illegible] and proposals are submitted for dealing with Princes Street.

The [illegible] of the cables at the close of the lease need not be viewed with [illegible]. Apart from the reasonable anticipation of a substantial annual surplus derivable from a change of traction to overhead electric and thereby the permanent solving of the tramway problem for at least a generation to come, there are valuable assets represented in the balance of [illegible] capital in the tramway rails, the concrete foundation, paving setts, the four power stations and the land they occupy, the engines and boilers, &c.

Ilford.—The tramway manager's salary has been increased from £[illegible] to £[illegible] a year.

The [illegible] has reported that, owing to the restricted lighting arrangements, an increased number of bad and foreign coins had been received in payment of fares. Having regard to the prevailing conditions it has been decided not to hold the employés responsible for the [illegible] by this practice.

London County Council.—On Tuesday it was agreed to refer the application of certain grades of men employed in the rolling stock section of the [illegible] for alteration in their conditions of labour to the [illegible] Conciliation Board.

Nottingham.—[illegible] of labour, &c., the tramway [illegible] running at 9.30 p.m.

Railway Administration.—[illegible] the chairmanship of the [illegible] a Paper before the Reading No. 1 [illegible] and the following resolution was passed :—

[illegible] Mr. [illegible] of Commerce [illegible] the [illegible] Peter [illegible] with full [illegible] on earth, and to [illegible]

Wolverhampton. For providing a more efficient means of transit over the tramways system for breakdown work, repairs, testing and supervision, the manager has been authorised to purchase an electric lorry and car at a cost of £370 and £217. 10s. respectively.

EMPIRE NOTES.

Australasia.—Crookwell (N.S.W.) Shire Council is applying for authority to establish electricity supply works.

A licence has been granted to the Town Board of Featherston (N.Z.) to borrow £3,000 for installing electricity supply works.

The Electrical Department of the N.Z. Government is considering the selection of a site for an electric power station in the North Island.

Brunswick (Victoria) Council has decided to borrow £5,000 for extensions of electric lighting in the town.

The New Zealand Public Works Statement for 1916 states that the results attained by the Government scheme for the development of hydro-electric power from Lake Coleridge, which has been in continuous operation for a complete year, have justified the Government's anticipations. Three units of generating machinery were originally installed, with a total capacity of 6,000 H.P. Twelve months ago the demand for current warranted the installation of a fourth unit of 2,000 H.P., and a fifth unit, comprising pipe-line, turbine and generator of 4,000 H.P. is now required. During the year the maximum load reached 1,770 H.P. At the end of the year the plant was earning sufficient to cover working expenses. Contracts to the extent of 8,000 H.P. have been entered into, and when the power under these contracts is estimated that the plant will be earning sufficient to pay interest in full as well as working expenses. The power has, up to the present, been utilised mainly for public (lighting, &c.), domestic and certain industrial purposes : arrangements are now in hand for utilising the current for tramways and for the operation of machinery in the principal meat-works, flour-mills, tanneries, dairy factories and the established industries in and around Christchurch. Feeder lines have been extended to Belfast, and arrangements are being made for a further extension in that direction to Kaiapoi. The Department of Public Works is in touch with manufacturers with a view to introducing new processes or improving existing ones where such possibilities are opened up by the large supply of electric power available. It is probable that one result will be the establishment of new electro-chemical industries, and possibly the manufacture of steel

Canada.—In order to meet the increasing demand for hydro power the Ontario Hydro-Electric Commission has decided to double the capacity of the Toronto station to instal new switchgear and other equipment at the Dundas power house, to duplicate the Dundas to Toronto transmission line, and to place additional equipment at Niagara Falls in order to handle the extra 50,000 H.P. recently secured from the Canadian Niagara Power Co.

The work will be commenced at once. The improvements and extensions will cost about £260,000. The power plants at Eugenia Falls, Big Chute, Wasdells, Orilia and Swift Current will be linked up by the construction of approximately 40 miles of line at an additional expense of £22,000.

One of the most valuable discoveries in the territory now being opened up by the Pacific Great Eastern Railway has been that of a large deposit of fine quality diatomaceous earth at Quesnel, British Columbia. Owing to its porous nature this infusorial earth has been used as a holder of nitro-glycerine in the manufacture of dynamite ; it is also used in the preparation of artificial fertilisers, in the manufacture of water glass, cements, tiles, artificial stone and pigments, and as an insulation for electrical purposes.

The Canadian Pacific Railway Co. has prepared plans for wharves which they intend to construct at Vancouver, at a cost of £300,000. The plans are in connection with those which the City Corporation intends to carry out at the port. Vancouver will expend £1,000,000 on wharf extension in the immediate future.

India.—"Indian Engineering" contradicts a rumour to the effect that India is threatened with a fan famine, although it expects an upward tendency in the price of fans.

Definite progress has been made with the electrification of the pumping plant at [illegible], so far as the Bangalore City side of the scheme is concerned. The motors and pumps have been ordered.

MISCELLANEOUS NOTES.

Electrolytic Treatment of Zinc. At the recent meeting of the [illegible] & General Exploration Co. (1916), Ltd., the chairman (the Hon. John A. de Grey) said that they had secured an interest in the British Electrolytic Zinc Ore Co. The board attached considerable importance to the investment, which had been secured on very favourable terms.

The industry was new to the country and it presented great possibilities. The treatment of zinc ores by the [illegible] electric process had been tested, and its commercial value established by continuous working of a plant in America for nine months. The British Electrolytic Zinc Co. held the British patents and 84 per cent. of all the foreign patents except the American. The world's consumption was 1,000,000 tons a year, and Germany had been the principal producer. If they exerted themselves they would have a new and profitable business within their grasp. Zinc produced by the electrolytic process was purer than fire-smelted zinc and commanded a far higher price on the market.

Increased Cost of Printing.—We are informed by the Master Printers and Allied Trades Association of London that master printers throughout the country have recognised the need for increased wages to their staffs to compensate for the increased cost of living, and have in many districts accorded further increases in wages or allowances for the duration of the war and some period afterwards, and are now face to face with an enormous advance in the cost of printing.

It is estimated that the annual wage bill of the printing trade in London alone, exclusive of the daily newspapers, has been increased by the advances by no less than £250,000 per annum, and the amount for the whole country must be considerable. The Special Costing Committee of the Federation of Master Printers of the United Kingdom of Great Britain and Ireland, that deals with such questions, has considered the effect of these and other increases in the cost of printing, and it is found that since the outbreak of war the costs involved in printing (taking into consideration the latest figures available) have increased at least 25 per cent. This calculation of 25 per cent. does not include any provision for the extra cost of paper and other materials used in the printing trade which extra cost reaches in some cases as high as 200 per cent.

Enemy Firms Wound Up.—Claims against Charles H. Blume are to be sent to the Controller, Mr. J. W. Barratt, 19A, Coleman-street, London, E.C., by Nov. 16.

Claims against the United Carborundum & Electrite Works (Ltd.), are to be sent to Mr. Chas. Eves, 62, New Broad-street, London, E.C., by Nov. 27.

Exports to China.—The "London Gazette" of Oct. 27 contains a further list of firms and persons in China to whom goods may be consigned from the United Kingdom.

Inquest.—At Brierley Hill on the 26th ult. an inquest was held on a boy named John Hill, who was killed at the Earl of Dudley's Old Level works, Brierley Hill, on the 23rd ult.

Evidence was given that the boy had been employed at the works for about 12 months as a door boy. They knocked off at 8.30 p.m. for supper which they had by the side of the guillotine, about 70 yds. away from an electric lamp pole. After supper deceased and other boys had a game of "tick." Deceased was running after another boy when he was heard to shout. He was seen holding an electric lamp pole and the electrician was asked to put the lamp out. Two men applied artificial respiration without result. Deceased got his two clogs fastened to the wires attached to the pole, and his hands were also clutching a wire.

Mr. THOMAS MANDERS, assistant electrician, stated that when he heard of the incident he immediately switched the current off and went to deceased's assistance. He applied artificial respiration for about 25 minutes until the doctor arrived. The voltage was 100 and the main voltage 200 alternating current.

H.M. INSPECTOR: Why did you give up artificial respiration so soon? People have been brought round after two hours, and this was not a strong voltage.

WITNESS: I would have kept on until now but the doctor came and took charge of the case. The doctor made an injection. He added that he cleaned the lamp on the previous Friday, and it was then all right. After the accident he found that the insulation had been torn off.

Mr. JAMES FOTHERGILL BUCKLEY, chief electrical engineer at the works, stated that the Home Office regulations considered a voltage of 125 alternating current was safe. The voltage in the present case was only 100. Upon examining the lamp he found the insulation was torn off, thus causing the steel wire running down the pole to become alive.

The jury returned a verdict of "accidental death."

Restoration of Lapsed Patent.—An order was made on Oct. 19 restoring Letters Patent No. 13,719/1908, granted to J. C. B. Ingleby for "Improvements in or relating to squirrel-cage rotors for induction motors and alternators."

Tribunal Cases.—At Bermondsey (London) Mr. W. E. J. Heenan (borough electrical engineer) applied for the exemption of a boiler cleaner and repairer.

Mr. HEENAN stated that the man was in the employment of the Council before the outbreak of war, and joined the Expeditionary Forces at the outset, serving about 14 months in France, and was discharged as a time expired man in February. They could not get men to do that kind of work. They had 11 boilers, and 700 joints had to be made on each boiler. Over 80 per cent. of their electricity was supplied to factories and workshops. He had applied for a badge for the man, but it had been refused.

Six months' temporary exemption was granted.

At Reigate last week the Corporation appealed for Mr. Morgan, a shift engineer at the Council's electricity works.

The Military also appealed against the local Tribunal's decision to grant exemption until Jan. 1, and gave notice that it was not in the national interest that a young man of 29 should remain in civil employment, although he was in a certified trade.

The Town Clerk assured the Tribunal that the Corporation had done its best to obtain a substitute, but was unsuccessful.

The Tribunal decided that Mr. Morgan must go, but the local decision of exemption until Jan. 1 was upheld and made final.

TENDERS INVITED.

Boilers, Stokers and Cooling Towers.

The Generating Station Committee of the SLALYBRIDGE, HYDE, MOSSLEY and DUKINFIELD Tramways and Electricity Board invite tenders for the supply and erection of Water-tube Boilers, Mechanical Stokers and Cooling Towers. Specifications, &c., from the engineer-in-chief, Mr. Robert Blackmore. *See advertisement.*

Telephone and Telegraph Material, &c.

Tenders are invited up to Dec. 22 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 192;

Tenders are invited (up to Nov. 15) by the Postmaster-General's Dept., State of South Australia, for the supply and erection at the telephone exchanges of Glenelg and Brighton, of Automatic Switchboards and all associated apparatus (schedule No. 426). Tender forms from Commonwealth Offices, 72, Victoria-street, London, S.W.

SLIGO, LEITRIM & NORTHERN COUNTIES' RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Electric Telegraph Material, Wire, Rubber Goods, &c. Forms of tender from the Secretary, Enniskillen.

Tramcars.

ROTHERHAM Tramways Committee require tenders by Nov. 16 for supply of Six Electric Double deck Top-covered Tramcars. Particulars from the General Manager.

Steam Disinfector.

MANCHESTER Tramways Committee require tenders by 10 a.m. Nov. 14 for the supply and erection of a Steam Disinfector. Specifications, &c., from the General Manager.

Electrical Stores, Lamps, &c.

The SOUTH AFRICAN RAILWAYS ADMINISTRATION require tenders by noon Nov. 13 for the supply during 1917 of 71,778 Tungsten Wire-drawn filament Lamps; 19,741 Solid Wire-drawn Tungsten filament Lamps; and 2,412 Carbon Filament Lamps. (Contract 733). Specification and form of tender from the secretary to the Tender Board, Johannesburg.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Jan. 8 for (*a*) 33,000 volt Switchgear; (*b*) Conduit and Fittings; (*c*) Fuses; (*d*) Insulators; (*e*) Insulator Straps and Bolts; (*f*) Lamp Holders; (*g*) Mica; (*h*) Switches; and (*i*) Wire Flexible, &c. Specification of (*a*) and particulars with regard to other items may be obtained at the Town Hall, Sydney.

The GT. NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m. Nov. 23 for six or 12 months' supply of Telegraph Material, Castings, Ironmongery, Rubber Goods, Oils, &c. Forms of tender from Stores Supt., 80, Guild-street, Aberdeen.

The Postmaster-General, ALEXANDRIA (Egypt), will receive tenders until noon Nov. 15 for one year's supply of Lamps, Electric Fans, &c. Specifications, &c., from the Egyptian Government Representative (Sir A. L. Webb), Queen Anne's Chambers, Broadway, Westminster, S.W.

CHATHAM Borough Surveyor's Dept. require tenders by 10 a.m. Nov. 15 for 12 months' supply of Electric Lamps, Ironmongery, Paints, &c. Specifications, &c., from the Borough Surveyor.

Carbon Brushes and Cut-outs.

Johannesburg Municipal Council require tenders by noon Nov. 27 for the supply of 12 gross of Carbon Brushes for Electric Motors. (Contract No. 178.)

JOHANNESBURG (Transvaal) Council also require tenders by noon Nov. 27 for the supply of 1,000 sets of Single Pole Ironclad House Service Cut-outs (Contract 187).

Specifications from the Municipal Offices.

Valves, Pipes, &c.

MANCHESTER Electricity Committee require tenders by 10 a.m. Nov. 8 for supply of Valves for steam and water pipe ranges (specification 64); Low-pressure Steam and Feed Pipes and Alterations to existing pipework (specification 65); and supply of Hydraulic Wagon Tipper (specification 66). Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Rotary Converters and Switchgear.

NEWPORT Corporation require tenders by 10 a.m. Nov. 6 for the supply of Rotary Converters and Switchgear. Specifications, &c., from the Borough Electrical Engineer.

Tramway Construction, Materials, Stores, &c.

WALSALL Corporation require tenders by Nov. 1 for the supply of Trolley Wheels, Castings, Oils, &c., for their tramways department. Forms of tender from the Tramways Manager.

The Direccion General de Obras Públicas, Ministerio de Fomento, MADRID, requires tenders by noon Nov. 24 for the Construction and Working for 60 years of an Electric Tramway in Saragossa. An option on the concession is held by the Sociedad Los Tranvias de Zaragoza.

JOHANNESBURG (Transvaal) Council require tenders by noon Nov. 20 for supply of 500 or 1,000 Trolley Wheels for their tramways department (Contract 181). Specification, &c., from the Municipal Offices.

BRADFORD Corporation require tenders by Nov. 11 for 12 months' (or one month's) supply of Stores to tramways department, including Lamp Fittings, Insulating Material, Controller Contacts, Indiarubber, Vulcanite, Paints, &c. Schedule, &c., from the Tramways Offices, 7, Hall Ings, Bradford.

Coal Transporter Plant.

Tenders are invited for the supply, delivery and erection in MELBOURNE, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Pty. (Ltd.), Billiter-square buildings, London, E.C. Tenders by noon Dec. 11.

TENDERS RECEIVED AND ACCEPTED.

WOLVERHAMPTON.—The Electricity Committee have accepted the following tenders :—

Ferranti Limited and Reyrolle & Co., extra-high-tension switchgear at £270. 7s. 8d. and £170. 10s. respectively ; Herbert Morris (Ltd.), crane rails, sole plates, &c., £136 ; A. Reyrolle & Co., 5,000 kw. generator switch panel, £550 ; Gibbons Bros., steel work on roof of boiler house, £90.

The Tramways Committee recommend the acceptance of the tender of E. Allen & Co. for supply of special steel track work at £338.

LONDON COUNTY COUNCIL.—The following tenders were accepted on Tuesday :—

British Westinghouse Electric & Mfg. Co., alteration of existing l.t. wiring and the provision of a portion of the switchgear for the third additional turbo-generator at the Greenwich generating station, £2,694, Morgan Crucible Co., carbon brushes (class T 5, items Nos. 1 and 2), £246. 10s. ; Chloride Electrical Storage Co., battery for use in connection with electrically-propelled fire appliances, £251. 12s.

MANCHESTER.—The Corporation has accepted the tender of the Manchester Electrical Maintenance Co. for wiring the Harpurhey High School for Girls ; and that of E. M. Evans & Co. for a telephone installation for the Libraries Committee.

PAISLEY.—The following tenders have been received by the Corporation for a h.t. switchboard :—

Siemens Bros. Dynamo Works (*accepted*), £2,693 ; British Thomson-Houston Co., £2,862 ; British Westinghouse Electric & Mfg. Co., £2,858.

HALIFAX.—The Corporation has accepted the tender of Drakes (Ltd.), for supply of steel air duct, dampers and trestle for a turbo-alternator, £116. 10s.

PLYMOUTH.—The Council has accepted the following tenders : Brush Electrical Engineering Co., eight tramcars and trucks, £545 each ; British Westinghouse Elec. & Mfg. Co., electrical equipment of eight cars, £431 per car.

SYDNEY (N.S.W.)—The Council has accepted the tenders of the Brush Electrical Engineering Co. for 10,000 550-volt transformers, £660 ; and Dalgety & Co., for two 2-ton Detroit Edison A8 battery vehicles, £1,450 each.

WALTHAMSTOW.—The Urban Council has accepted the tender of Venner Time Switches (Ltd.) for the supply of 152 time switches for public lamps.

GLASGOW.—The Corporation has accepted the tender of Edgar Allen & Co. for special tramway track work.

ILFORD.—The Urban Council has accepted the tender of Crompton & Co. (at £67. 11s.) for a 12 H.P. motor and starting panel.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—Mr. [illegible] on Tuesday, said that notwith[illegible] the traffic receipts for the year ended [illegible] over the preceding year, the total [illegible] per car-mile. The number of passen[illegible] nearly a million, and both [illegible] the figures of any previous [illegible] £10,883, nearly all in con[illegible] the request of the Council [illegible] had [illegible] anticipated at an early [illegible] by the fact that their [illegible] 1931 when the Council [illegible] undertaking computed in the [illegible] from various [illegible] 1931 onwards. The [illegible] based upon [illegible] satisfactory at the [illegible] Although they [illegible] receipts, the [illegible] and land tax [illegible] year. The [illegible] New Zealand [illegible] heavily and [illegible] were made [illegible] in New Zealand, yet every shareholder, whether resident in New Zealand or in the United Kingdom had to pay income tax on his share of the profits either directly or indirectly in both countries. They had no desire to avoid paying their contribution towards whatever taxation the defence of the Empire might necessitate, but it was manifestly inequitable that under the present system of double income tax within the Empire they should be called on to make two contributions towards the war expenditure, while the bulk of the community were only making one. The logical sequence to the closer consolidation of the various portions of the Empire was that profits created within the Empire should be only taxed once, where the profits were created. The injustice was so glaring, and its injurious effect on British trade and commerce, and the development of the resources of the Dominions so serious that they might feel sure it would not be long continued. The net result of the year's working was that, including £1,655 brought forward, the balance available was £[illegible]. The dividend on the preference shares required £9,000 ; they were placing £10,000 to reserve ; they were paying the same dividend (1s. 7d. per share for the year) on the ordinary shares, the carry forward being £[illegible].

BARCELONA TRACTION, LIGHT & POWER CO. (LTD.)—The surplus earnings in 1915, after providing for the interest on the prior lien A bonds amounted to £290,270, against £266,750, which Dr. Parshall estimated would have been realised if the works had re-started at the date he contemplated, in accordance with his programme and the prices ruling at the date of his report. The board consider the enterprises which the company controls in Spain are developing in a sound and satisfactory manner and if no unforeseen difficulties arise during the present year the results should, notwithstanding delays and adverse conditions, show a very satisfactory increase over 1915.

CAPE ELECTRIC TRAMWAYS (LTD.)—The report for the year ended June 30 states that the profit was £72,497. 15s. 1d., and after providing for debenture interest, redemption of debentures, and taking into account the balance from last year, a net credit balance of £31,404. 4s. remains. From this amount the reserve fund has been credited with £5,000, leaving £26,404. 4s. Of this sum the directors recommend payment of a dividend in respect of the past year of 3¼ per cent. on the ordinary share capital, leaving £7,983. 7s. 6d. to be carried forward. During the year the tramways carried 22,477,366 passengers, earning £212,791. 17s. 10d., against 21,680,070 passengers and £206,122. 19s. 4d. in 1914-15. The traffic receipts again show a small improvement, but this is more than set off by the higher cost of operation. The London expenses have also grown owing to the excess profits duty and increased income tax charges. Mr. J. A. Barkley, the general manager at Cape Town, resigned his post in November last owing to ill-health, and the company has been fortunate in securing the services of Mr. Walter F. Long, formerly the municipal electrical engineer at Cape Town who entered upon his duties at the beginning of February last. Shortly after Mr. Long's appointment labour trouble broke out which culminated in April in a most unjustifiable strike on the part of a considerable number of motormen and conductors. The strike lasted about four weeks, and during the whole of the time, with but few exceptions, the system was kept running full time. Eventually many of the employés who had joined the movement returned to work on the terms laid down by the company, and the strike collapsed.

CENTRAL ARGENTINE RAILWAY CO.—The report for the year ended June 30 states that on the 24th August last the electrified line between Buenos Ayres and Tigre (via Victoria) was successfully opened to public service by the President of the Republic. At the meeting last week the chairman (Sir Joseph W. Todd, Bart.) stated that of the £1,000,000 spent to June 30 last was due to new locomotives and coaching stock, the electrification of part of their suburban lines, &c.

DICK, KERR & CO. (LTD.)—The chairman (Mr. C. T. Cayley) stated at the meeting last week that the work undertaken by the company had been of greater magnitude than the directors anticipated last year. The profit earned during the year, added to £18,346 from 1915, was £79,296. They had acquired a controlling interest in the shares of Messrs. Willans & Robinson, though it was not proposed to make any alteration in the present directorate and management of that company. The chairman paid a tribute to the way in which the staff had worked, and said that the time lost by the workers at the Preston works from all causes over a period of 12 months was under 1·4 per cent. Given reasonable protection of a permanent nature against unfair competition from outside the Empire, there was every reason to look forward with confidence to the future. The report and balance-sheet was adopted, and dividends of 6 per cent. on the preference and ordinary share capital were declared.

DRAKE & GORHAM (LTD.)—The directors' report for the year ended June 30 states that, after payment of all charges, including bonuses due to staff, allowances to those who have joined the national forces and making provision for contingencies, the net profit is £8,527. 7s. 1d. (against £3,817 in 1915), which, with £1,623. 2s. 6d. brought forward, makes a total of £10,150. 9s. 7d., compared with £5,748. It is proposed to pay a dividend at rate of 4 per cent. per annum (£5,000), to write down goodwill by £3,000 and to carry forward £2,150. 9s. 7d. The returns show that the net profits, although below the pre-war average, are more than twice those contained in the last balance-sheet, and that there has been a considerable increase in turnover. Contracts in connection with Naval and Military requirements constitute a large portion of the company's operations. A power station of about 4,500 H.P., erected by the company, is practically complete and will shortly be put to work. The wholesale department has further expanded and shows satisfactory results. The output from the company's works has largely increased and extensions of the branch are under consideration. The department dealing with electric vehicles propelled by Edison batteries has made good progress. Up to the present 90 men have joined the National Forces, and the difficulty of obtaining necessary labour is increasing. To June 30 £1,732. 13s. 7d. (including directors' fees) had been paid to absentees. Heavy taxation makes it increasingly difficult to finance the extensions which should be made to provide for trade after the war.

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the year ended June 30, 1916, states that the revenue amounted to £982,247. 16s. 3d. and the working expenses to £362,295. 7s. 10d. After providing £32,747 for debenture stock interest and £138,396. 15s. 8d. for income tax and excess profits duty, there remains a balance of £448,808. 12s. 9d.; to this is added £85,880. 0s. 5d. brought forward, making a total of £534,688. 13s. 2d. Three interim dividends, amounting to £93,568. 10s., have been paid, £100,000 has been applied towards the further reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £100,000 transferred to general reserve fund, £30,000 to land and buildings depreciation fund, and £100,000 to the provision on account of investment fluctuations. The directors now recommend the declaration of a final dividend of 3s. per share, making with the interim dividends a total of 6 per cent. for the year, also the payment of a bonus of ½ per cent., or 1s. per share, both tax free, which together will amount to £72,775. 10s., leaving £38,344. 13s. 2d. to be carried forward. The dividend and bonus are payable on the 9th inst. The shareholders will be asked at the forthcoming general meeting to approve the payment of the directors' remuneration free of income tax.

The register of transfers are closed from the 31st October to the 8th November inclusive.

NEW COMPANIES, &c.

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NEW COMPANIES.

GREENE & SHERRATT (LTD.) (145,063).—Reg. Oct. 12, capital £1,000 in 800 preference shares of £1 each and 4,000 ordinary shares of 1s. each, to carry on the business of brass finishers, metal workers, mechanical, electrical and sanitary engineers, &c. Private company. First directors are W. Greene and J. T. Sherratt. Reg. office: 84, Hatton Garden, E.C.

RUSSO-BRITISH CHAMBER OF COMMERCE IN THE UNITED KINGDOM (INC.)—Reg. Oct. 23 as an association limited by guarantee, not formed for purpose of profit, the word "limited" being omitted from title by licence of the Board of Trade. For the purpose of registration the number of members is declared not to exceed 2,000, each being liable for £3 in the event of winding up. The general objects are for the promotion of commerce between the British and Russian Empires, the collection and dissemination of statistics, the promotion of the interests of Russian subjects in the British Empire and vice versa, and arbitration in settling commercial disputes between British and Russian subjects. There are to be separate British and Russian sections. The management is vested in an Executive Council, to consist of (1) the patron or patrons, the honorary president, the four hon. vice-presidents, the president, the vice-president and the chairman and vice-chairman of the British and Russian sections, all ex officio members; and (2) eight British and eight Russian elected members. Until the first general meeting the subscribers are to form the Council. The hon. president is to be the Russian Ambassador for the time being, and the four hon. vice-presidents are to be the Russian Consul-General in London, the Russian Commercial Attaché in London, and the president of the Association of Chambers of Commerce of the U.K., or their nominees or substitutes, and one other to be elected at the annual meeting. The president and vice-president are to be elected by the Executive Council, provided that if the president is of British nationality the vice-president must be Russian, and vice versa. There is also to be a General Council, to consist of the Russian State Consular Officers in the U.K. and such other honorary or subscribing members as the Council shall elect. Secretary: D. Ghambashidze; and reg. office: International Buildings, Kingsway, W.C.

UNIVERSAL ELECTRIC SUPPLY CO. (LTD.) (145,102.)—Reg. Oct. 17, capital £3,000 in £1 shares (600 6 per cent. cumulative preferred), to take over the business of a dealer in electrical novelties carried on as the "Universal Electric Supply Co. Private company. First directors are A. Lowe and T. Milligan (both permanent) and A. Hitner (general manager). Reg. office, 19, Chapel-walks, Manchester.

VICTORIA GLASS BOTTLE CO. (LTD.) (145,033).—Reg. Oct. 9, Capital £2,000 in £1 shares, to carry on the business of wholesale, import and export glass bottle manufacturers, accumulator jar, lubricator bottle and steam-pressure gauge tubing manufacturers, &c. Private company. First directors are J. Hall, J. W. Hall and W. J. Tootell. Reg. office: 28, Hanover-street, Bolton.

COMPANY INCORPORATED OUTSIDE THE U.K.

ZINC PRODUCERS' ASSOCIATION PROPRIETARY (LTD.) (1,528F.)—Particulars of the Zinc Producers' Association Proprietary (Ltd.) were filed at Somerset House on Oct. 19, pursuant to sec. 274 of the Companies (Consolidation) Act, 1908. The company was registered in Victoria, Australia, on May 20, 1916, with a nominal capital of £100,000 in £1 shares (no shares beyond the first £50,000, and no debentures, to be issued without the consent of the board). The company is to be and remain under British control, and (*a*) no alien can be a director or one of the principal officers of the company, (*b*) no share may be held by or in trust for or under the control of any alien or foreign corporation or any corporation under foreign control, (*c*) no person whose country of origin is now at war with H.M. may hold office in this company or any share or shares therein. "Alien" means any person who is not a British born subject or who was not naturalised in a British possession prior to June 30, 1905, and "foreign corporation" means any corporation other than a corporation established in some part of H.M. Dominions, and having its principal place of business therein. "Corporation under foreign control" includes (*a*) a corporation of which a majority of the directors are aliens, (*b*) a corporation in which such voting power as (in the opinion of the Board of the Zinc Producers' Co.) may give reasonable control is in the hands of aliens or foreign corporations or persons who hold directly or indirectly for them, and (*c*) a corporation the executive of which is a foreign controlled corporation. The number of directors is not to be more than 15. Each of the following companies may nominate one director, viz.: Broken Hill Associated Smelters Proprietary, Amalgamated Zinc (De Bavay's), Broken Hill South Silver Mining Co., Broken Hill Proprietary Block 10 Co., Broken Hill Proprietary Block 14 Co., Junction North Broken Hill Mine, Broken Hill Proprietary Co., Mount Lyell Mining & Railway Co., Sulphide Corpn., British Broken Hill Proprietary Co., and the Zinc Corpn. The Burmah Corpn. is also mentioned as having power to nominate a director if it become a member of the company. There is to be a London Board, an advisory member of which may be appointed by the Imperial Government. The directors at Oct. 18, 1916, were: W. L. Baillieu, W. M. Hyndman, M. Cohen, G. A. Grant, A. Campbell, B. Kelly and J. L. Wharton, all of Melbourne; F. C. Howard and B. A. Moulden, both of Adelaide; D. E. McBryde, North road, Brighton; F. A. Govett, 20, Copthall avenue, E.C.; F. A. Keating, 22, Bishopsgate, E.C.; and W. H. Woodhead, Hyes, Rudgwick, Sussex. The British address is at Pinners Hall, Austin friars, E.C., where W. S. Robinson is authorised to accept service of process and notices on behalf of the company.

CITY NOTES.

MEMORANDA (Nov. 1).—**Bank rate 6 per cent. (since July 13, 1916). Consols** 56⅛. Consols Pay Day, Dec. 1. **Stocks and Shares Ticket Days**, Nov. 14 and 29. Pay Days, Nov. 15 and 30. Price of Silver, 32½d.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—The directors have declared a dividend of 1s. 3d. per share (at rate of 5 per cent. per annum), less tax, for the September quarter.

EDISON SWAN ELECTRIC CO. (LTD.)—Notice is given that a petition has been presented to the Chancery Division of the High Court of Justice to confirm a special resolution of the company for the alteration of the company's objects passed at an extraordinary general meeting on the 3rd July last, and subsequently confirmed at an extraordinary general meeting on the 24th July. The copy of the resolution and the amended memorandum of association are set out in another page. The petition will be heard on Tuesday, the 12th December, by Mr. Justice Neville, and notices of opposition must be given on or before the 5th December next to the solicitors, Messrs. King, Adams, Cotton, Voysey & Macmin, 15, Dowgate-hill, Cannon-street, London, E.C.

LISBON ELECTRIC TRAMWAYS (LTD.).—The directors state that no interim dividend will be paid on the ordinary shares.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—Mr. Alfred Hoare, of Messrs. Hoare & Co., bankers, has been elected on the board of this company in succession to the late Sir Richard B. Martin, Bart.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The board announce and interim dividend at rate of [illegible] per cent. per annum (4s. per share), tax free, payable on Dec. [illegible]

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors will recommend to the shareholders at the approaching meeting the payment of the following dividends for the half-year ended June 30, 1916: 6s. per share on the first and second preference shares and 6d. per share on the ordinary shares (tax free).

METAL PRICES.

Messrs. J. B. Gar[illegible] & Sons, 132, Upper Thames-street, London, E.C., quote under date Oct. 31 the following as the present basis prices of [illegible]

New Metals	Per lb.		Per ton
Solid Drawn Brass Tubes	16½d.	English Lead	Nominal.
Solid Drawn Copper Tubes	19½d.	Antimony	Nominal.
Brazed Copper Tubes	19½d.	Old Metals.	Per ton.
Brazed Brass Tubes	18½d.	Clean Copper Scrap	£112 0 0
Brass Wire	15½d.	Clean Brass Scrap	66 0 0
Copper Wire	1[illegible]d.	Braziery Copper Scrap	89 0 0
R[illegible] B[illegible]	15½d.	Old Lead	26 0 0
B[illegible]	16½d.	Old Zinc	38 0 0
	Per ton.	Hollow Pewter	130 0 0
[illegible] Sheet	£168 0 0	Black Pewter	90 0 0
[illegible]	52 15 0	Gun Metal	88 0 0

Mr. A. J[illegible], Earl-street, Lo[illegible]-road, Southwark, London, S.E., quotes under date Oct. 31 the following approximate prices of Scrap Metals:—

	Per ton.		Per ton.
A[illegible] C[illegible]	£11[illegible] 0 0	Old Lead	£4 under English lead price
[illegible] Brass	[illegible] 0 0	Old Zinc	38 0 0
[illegible]	1[illegible]	Hollow Pewter	132 0 0
Braziery [illegible]	[illegible]	Shaped Black Pewter	90 0 0
[illegible] Metal	90 0 0		

Mr. J[illegible] at the following prices per ton: Plumber's Solder (in bar [illegible]), Tinman's Solder, £97, Blowpipe Solder, £107.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Oct. 31.

Shrs.	Last Dividend	NAME.	Price, Tues., Oct. 31	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
[illegible]	[illegible]	[illegible]	8¼	7 1 2	[illegible] Sept.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Oct. 31	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6¼	6 8 0	Feb, Aug
5	7%	Do. do. Pref.	5 27/32	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72¼	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1 5/32	6 18 5	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6	5 16 8	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	83½	5 19 9	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	76	7 17 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	63	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82½	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	75	5 6 8	Jan, July
St.	4%	City & S. London Deb.	74¾	5 7 0	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2½	5 17 8	Jan, July
St.	4%	Do. 4% Pref.	62	6 9 0	Mar, Sept
St.	4%	Do. 4% Debs.	70	5 14 3	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	22	4 8 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	60	5 16 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	58	6 0 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	60¼	5 16 2	Jan, July
St.	3½%	Do. 3½% Debs.	64¼	5 8 2	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	69	6 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105	5 14 3	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	70⅛	5 14 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2⅞	5 2 7	Apl, Oct
1	6%	Do. 6% Pref.	1 11/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1⅜	5 1 10	Mar
100	5%	Do. Prior Lien Debs.	91	5 9 11	Jan, July
1	6%	Do. 6% Pref.	29/32	6 12 5	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12⅛	7 4 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 5/32	5 16 4	Jan. July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 7 5	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2½	6 0 0	April
100	6%	Do. 6% Prior Lien Debs.	99¼	6 0 9	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	13	7 13 10	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	29/32	6 12 5	Sept.
5	..	Edison, Swan Co. A. £3 pd.	1½	..	Feb, Aug
St.	4%	Do. 4% Deb.	61¼	6 10 7	Jun, Dec
1	7½%	Elec. Construction Ord.	1	7 10 0	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
10	6%	Do. 6% Pref.	9 29/32	6 1 2	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16	6 5 0	Feb, Aug
5	5%	Do. 4½% Cum. Pref.	4 3/16	5 7 6	..
St	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	12¼	8 3 3	Feb, Aug
10	5%	Do. Pref.	7⅛	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38	6 6 4	Mar, July
100	4%	Do. 4% Debs.	95⅛	4 4 1	Jan, July
1	12½%	Vickers Ord.	1⅞	6 13 4	May, Aug
1	5%	Do. 5% Pref.	29/32	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	78¼	5 2 3	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¾	4 10 2	June, Dec
St	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95¾	6 5 4	Fb, My, Aug, N
St.	1½%*	Do. Def. Ord.	22¼	7 5 10	Fb, My, Aug, N
St.	4%	Commercial Cable 4% Debs.	70½	5 13 16	Ja, Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅜	6 5 6	Ja, Ap, Jly, O
St.	8%	Eastern Tel. Co. Ord.	140¼	5 13 2	Ja, My, Jly, O
St.	3½%	Do. 3½% Pref.	64½	5 8 6	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	75⅝	5 5 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77½	5 3 7	Feb, Aug
10	8%	Do. Ord.	13½	5 18 6	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. With Coup. 11	38	5 15 9	Ja, My, Jly
[illegible]	13%	Indo-European	50⅛	6 8 9	May, Nov
1	10%	Marconi Wireless Tel. Co.	2⅝	3 9 7	April
1	7%	Do. 7% Pref	2 13/32	2 18 2	July
10	1%	West India & Panama Ord.	[illegible]	10 6 2	May, Nov
10	6%	Do. 1st Pref.	7 11/16	7 16 1	May, Nov
10	8%	Western Telegh. Co.	14 7/16	5 10 10	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	76½	5 4 7	June, Dec
[illegible]	4½%	Western Union 50-yr. Bds.	99⅛	4 10 10	May, Nov
		Telephones.			
1	[illegible]	Monte Video Teleph. Ord.	[illegible]	7 13 7	Nov
1	[illegible]	Oriental Telephone Ord.	[illegible]	4 7 8	Apl, Oct
[illegible]	[illegible]	Do. [illegible]	[illegible]	5 1 7	Jan, July
[illegible]	4%	T[illegible] Co. of Egypt Db. St.	83	5 8 5	Jan, July
[illegible]	[illegible]	United River Plate Ord	[illegible]	5 19 1	Apl, Oct
[illegible]	[illegible]	Do. [illegible]% Cum. Pref.	[illegible]	5 4 7	Jan, July
[illegible]	4½%	Do. Deb. Stk.	85⅛	5 5 3	Jan, July
		Financial and Investment.			
[illegible]	[illegible]	G[illegible] T[illegible] & Trust	[illegible]	4 17 6	Sp, Dc, Mr, Jn
[illegible]	[illegible]	Do. [illegible]% Pf.	101	5 15 8	Sp, Dc, Mr, Jn
[illegible]	[illegible]	[illegible] Companies' Common	85½	5 17 6	Ja, Apl, Jly, O
[illegible]	4%	Do. $100 Pref.	70	5 14 3	Ja Apl, Jly, O
[illegible]	[illegible]	[illegible] Cable Trust Certs.	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
[illegible]	[illegible]	A[illegible] Elec. Supply 6% Pref.	4 13/16	6 1 6	Mar, Sept
[illegible]	[illegible]	Do. [illegible]% Debs.	94½	5 5 10	Jun, Dec
[illegible]	6%	B[illegible] L. & T. 6% Pref	10[illegible]	5 15 8	..
[illegible]	4½%	Do. 4½% Debs.	83	5 8 5	Jan, July
[illegible]	[illegible]	Calcutta E.S. Corp. Ord	6[illegible]	6 15 10	May, Nov.
[illegible]	[illegible]	Do. [illegible]% Pref	4[illegible]	5 16 9	Mar. Sep

* Pr[illegible]/6 [illegible]. † Ex dividend or interest.

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NOTES.

Science and Industry.

WE hope that the lecture delivered by Mr. JAMES SWINBURNE last week on "Science and Industry" will dispel some of the fallacies usually associated with science and industry by many of those who are asking the people of this country to change their ways. At the same time we do not suppose that everyone will agree with all the author says. Our readers may judge for themselves by turning to another column. Even the Chairman, Lord MOULTON, expressed the opinion that some of the views were "picturesquely wrong," but even so we can well agree with much that was said. For example, in dealing with the respective spheres of academic science and technology, we agree that our universities had better leave the latter subject alone when dealing with the former. By this we do not mean that Cambridge University, for example, should have nothing to do with technology, but that the Cavendish Laboratory will do well to stick to academic science and make no attempt to extend its activities into technical matters. This, we think, must be obvious to all who give any thought to the subject. A much more debatable point, however, is how far a technical college should teach what may be called commercial technology as distinct from the principles underlying technology. For example, how should a student be prepared to take his place in a central station? Very few colleges have serious generating plant of their own, and even if they have a small station the commercial conditions are wanting. As Mr. SWINBURNE says: "Imitations of engineering and chemical workshops have always the drawback that they are only imitations. The elements of time and price do not come in and they are vital." To these might be added what is vulgarly called the "sack." In the imitation works the student has no position to lose. In commercial works this is one of the spurs that makes for efficiency. But to return to the central station. Although it is not possible to have a small central station on commercial lines for the purpose of training, there is no reason why instruction should not be given in all that appertains to combustion, efficiency in steam raising, the testing of boilers and steam plant, the testing of flue gases, and the sampling of fuel. The student is then able to take an intelligent interest in what is going on when he enters an up-to-date power station. The same remarks apply in general terms to other lines of work.

◆

AT the close of the address Lord MOULTON made some interesting remarks, in which he expressed the view that the technical student ought to have the advantage of first-class technological professors, such professorships being held by men who have distinguished themselves in commercial concerns. We fear, however, that this ideal is unattainable. There are several difficulties that would be encountered in realising such a programme. To start with, men of this character would generally be beyond the financial resources of a technical college. Secondly, unlike a professor of academic science who may have a wide knowledge of the greater part of his particular science, the efforts of a commercial technologist are generally far more restricted. For example, a successful station engineer would probably not be well acquainted with the commercial running of an electric railway, and vice versa; nor would a steel maker have an intimate knowledge of the manufacture of sulphuric acid. It would, therefore, be necessary to have several professors. Thirdly, there is the difficulty that any such men, if they became teachers, would soon lose touch with the commercial aspects. We are inclined to think that the only way in which these difficulties can be met is by getting specialists to deliver lectures from time to time, and this method is actually being followed to a considerable extent. No doubt the requirements differ somewhat with the science under consideration. For example, in chemistry, the difference between laboratory and commercial work, as Lord MOULTON put it, is largely a matter of scale; to increase the scale of operation a hundredfold or a thousandfold may introduce difficulties of possibly an insurmountable character. For this reason the laboratory can only carry the students a certain distance, but this is no reason why they should not be instructed in all the principles underlying operations on an industrial scale, and thus be equipped to deal intelligently with the problems that are likely to arise in after life.

Electrically-Driven Floating Cranes.

IN common with most cranes, the tendency is to use electricity as a motive power for the large floating cranes which are used for the fitting-out and repair of ships of heavy tonnage. Elsewhere is given a detailed description of the two 250-ton cranes that have been provided for the Panama Canal. Some idea of the size of these cranes will be gathered from the fact that the contract price was £169,500. The displacement of each pontoon exceeds 3,000 tons. The work was entrusted to the Dentsche Maschinenfabrik A.G., a company which, prior to the war, traded in this country under the title Demag Ltd. It is unfortunate that, after being well ahead of the contract time for delivery, an accident during the official tests on the first crane should cause a delay of some months. Investigation of the accident led to the conclusion that the failure was probably due to the distribution of metal in the heel structure, insufficient strength of latticing, tie-plates and rivets, as well as lack of adequate provision for flexure in addition to direct compression. These subjects are of greater interest to the mechanical engineer than to the electrical engineer, but it should be noted that after trifling alterations to three of the members the second crane was put through the official tests and was accepted by the Canal authorities. Our object in alluding to the accident, which happily was not attended by loss of life, is to direct attention to the scantiness of the literature on the strength of latticing. From the description it will be seen that the mechanical and electrical details are excellent.

Unremunerative Appointments.

In our last issue we called attention to the evil of unremunerative positions in the teaching profession. Unfortunately, such positions are by no means limited to teachers. They are well recognised, for example, in electricity works, and we [illegible] also that they are to be found in the works of many of our manufacturers. This view is supported by a letter which appears this week in our Correspondence columns, the gist of the letter being that the authors, four in number, who are technical designers with several years "live" experience, enjoy an average salary which is well below £150 per annum. In these days we hear much of the living wage, but this should not preclude the possibility of all those who provide designs by which living wages are to be obtained from receiving a reasonable salary. We also hear much about the importance of the selling side of business, but it should surely be remembered that selling is of little avail if the product to be sold is not up to the desired standard. A high standard can only be obtained by high technical ability, and the best technical results cannot be expected if the technical man is rightly discontented with a poor prospect and a salary which can easily be surpassed by those performing manual labour in the shops. It appears to us that the whole position requires careful consideration by those responsible for our manufacturing under[illegible] [illegible]. They will probably plead [illegible]

* * *

Copper Export From the United States.—According to [illegible] ended Sept. 30th [illegible] from the United States [illegible] period of 1915 [illegible]

[illegible]—[illegible]

Electric Furnaces in Sweden.—[illegible]

Sweden. The molten pig is delivered direct to the open-hearth furnaces, heated by the gases from the reduction furnace, and finally the charge is poured into an electric refining furnace, from which steel of remarkably high quality is said to be obtained.

Electrical Vehicles in Simla.—In view of the attention now being given to the development of the electric automobile in this country, it is interesting to note that the matter is also exciting interest in Simla. The Postal Department is to be approached with a view to the trial of such vehicles for the conveyance of mails, and at a recent meeting of the municipality the Committee instructed the electrical engineer to submit specifications for an "electrical jinrickshaw."

Control of Copper Wire.—The Minister of Munitions has issued an order prohibiting the manufacture of any copper wire or any cable containing copper, except for the purposes of any of the following contracts or orders for the time being in existence, namely:—

> (1) A contract or order to which there shall have been allocated by the Priority Branch of the Ministry of Munitions a reference number and priority classification within Classes "A" or "B" of circular L.33 as to control of output issued by the Minister of Munitions on March 31, 1916; or (2) A contract or order with and bearing the reference number and identification letters of any of the following departments, namely: the Admiralty, the War office, the Ministry of Munitions and the Post Office.

The Metric System.—The "Metric System in the Wool Manufacturing Industries" formed the subject of a recent lecture by Prof. A. F. Barker, at the University of Leeds. Prof. Barker is a strong believer in the metric system, and gave many instances of the confusion and discrepancies caused in the textile industries by the existing British units. Among others who emphasised the imperative need for a change in this respect were Mr. Joseph Lowden, chairman of the University's Dept. of Textile Industries, and Mr. J. E. Bedford, President of the Leeds Chamber of Commerce.

Electric Paraffin Vaporisers.—In view of the present restrictions on the use of petrol, any device facilitating the employment of paraffin for motor cars deserves attention. One of the latest American carburetters (the Eynon heavy-oil type) embodies an electric heater. When it is desired to start the car, current is switched on to this heating resistance, vaporising a portion of the paraffin, after which the engine can be started. A spark from the plug ignites the paraffin vapour, causing a flame in the mixing chamber, which in turn heats a series of thin horizontal plates pierced with a number of small holes, through which the fuel is drawn.

Industrial Lighting by Electricity.—In a Paper on the above subject, read before the Junior Institution of Engineers on October 15th, Mr. F. H. Taylor referred to the benefits of proper industrial lighting. Unsatisfactory illumination, it was pointed out, results in (1) an increase in the number of accidents, (2) possible damage to eyesight and health, (3) diminished output of work, and (4) imperfect discipline. Reference was made to the recommendations contained in the Report on lighting in factories and workshops issued by the Home Office Departmental Committee last year, and attention was drawn to the importance of proper facilities for switching control of the lights.

Canada's Giant Telescope.—Much interest is being taken by astronomers in the new 6 ft. reflecting telescope now being erected at the Canadian Government Observatory, British Columbia. Its great size can be imagined when it is stated that its moveable parts weigh 10 tons, and that the dome inside which it is housed is 75 ft. high and 66 ft. in diameter. Special measures are taken to secure free circulation of air currents and a constant and uniform internal temperature, as variations in this respect give rise to alterations in the form of the mirror. The dome revolves by electricity, seven motors being employed. The new observatory is to be erected on Little Saanich Mountain near Victoria, B.C. The difficult task of making the 6 ft. mirror was entrusted to a Belgian firm. It is considered improbable that anything larger will be constructed for several years to come.

Munitions Output. The Ministry of Munitions is desirous of extending the output of casting and stamping fuse bodies and sockets and casting and rolling brass rods for the components. Engineering firms possessing suitable machinery and capable of undertaking such work are requested to communicate at once with the Central Clearing House for Engineering Resources, Ministry of Munitions, 8-9, Northumberland-street, Northumberland-avenue, London, W.C.

Electric Railway Development in Germany.—An article by Lord Monkswell on "Railway Development in Germany," in the "Railway News," discusses the prospects of increased electrification. On all underground railways, in long tunnels and on steep gradients electricity is at an advantage. It has, however, the drawback that whereas an accident to a steam locomotive only stops the particular train, a failure of the electric supply paralyses the whole line. For this reason alone the German military authorities are said to have forbidden the use of electricity on railways anywhere near the European frontiers. Urban and suburban traffic in and near the great centres of population in Germany will no doubt be more and more worked by electricity, but electrification of the main lines is quite another matter.

Portable Power Tools for Ships.—The present pressure in shipbuilding has emphasised the value of portable electric tools. In some cases repairs are now done on board ship that would in the past have been invariably carried out on shore. An interesting case, mentioned in the "Nautical Magazine," is the re-boring in position of a high-pressure cylinder of a main engine. The cylinder was 22½ in. diameter, with a 42 in. stroke. Two men working with a portable electric boring machine rebored the entire length in six hours. The current consumption was only about 37 units, costing 4s. 7½d. The same work by hand would have required seven men, would have taken 42 hours, and at pre-war labour rates would have cost £9. 16s. The total cost with the electric boring machine including the cost of energy, was only 12s. 7½d.

Iron Conductors for Transmission Lines. The shortage of copper in Germany is said to have already led to the substitution of iron for copper conductors on quite a large scale. It is of interest to recall that experiments in this direction have been made in the United States for some years, and even in that country the present high price of copper is no doubt an influential factor. According to the "Electrical World," the United Electric Light & Water Co., of Waterbury, has found that for small loads, iron at 8·25 cents per lb. works out cheaper than copper at 15 cents per lb. The Public Service Co., of Northern Illinois, is using No. 8 iron wire strung on 25 ft. to 30 ft. poles for light work, and the Nebraska Gas & Electric Co., Omaha, operates three iron wire transmission lines, one 7 miles long and another 28 miles long, with satisfactory results.

Wireless on Aeroplanes.—What would seem to be a record in wireless transmission for an aeroplane, according to the "Liverpool Courier," is credited in recent advices to Captain Culver, of the United States Army Aviation Corps, although it is known that some wonderful things in this direction have been done during the war. During a flight from San Diego to Santa Monica, a distance of about 110 miles, Captain Culver is stated to have maintained constant touch with his home station, despatching messages at three minute intervals. The power for the transmission set in this case was provided by a generator fixed on the lower wing section, and driven by a two-bladed propeller. Aërial wires were suspended from the fusilage of the aeroplane, and an insulated counterpoise was hung from the wings to the tail of the machine. In view of the importance of the weight of the wireless apparatus of an aeroplane it is of interest to learn that in this instance the complete set is stated to have weighed less than 10 lb.

Hydro-Electric Power in Spain. According to recently compiled statistics, the hydraulic power available in Spain is estimated at over 5,000,000 H.P. There are 110 large hydro-electric plants exploiting a total power of 281,190 H.P., and a large number of small plants, so that the whole amount of power in use may be reasonably estimated at 300,000 H.P. This total will probably be increased to 500,000 during 1916, when important installations are expected to be completed. The total potential horse-power controlled by the 110 large enterprises referred to is 1,020,790, and consequently 739,300 of their total power remains to be developed. Independent of this amount, numerous paper, spinning and flour mills and other manufacturing plants are run by water power not transformed into electricity. In Catalonia, North-Eastern Spain, the textile industries alone use some 200,000 H.P., about one-half of which is natural water-power. The estimated power of the streams of the Pyrenees running through Catalonia amounts to 1,135,000 H.P., and the concessions have been granted for the exploitation of only 800,000 H.P. The water-power of the rivers of Spain has been estimated as capable of producing horse-power as follows: Ebro and affluents, 1,300,000; Duero, 900,000; Guadalquiver, 750,000; Tajo, 700,000; Guadiano, 370,000; Mino, 250,000; Jucar, 190,000; Segura and affluents, 100,000; and others, 600,000; making a total of 5,160,000 H.P.

Ontario Hydro-Electric Power System.—Owing to the rapid increase in the consumption of electric power the Ontario Hydro-Electric Commission has decided to proceed immediately with plans for the extension of the provincial power-transmission system, which it was intended to postpone until after the war. Sir Adam Beck, chairman of the Commission, announces that the plants in Toronto and Dundas will be doubled, and the transmission line between these points duplicated, involving an expenditure of over £250,000. Preliminary work on the stations is already under way, and plans and specifications for the new transmission line have been completed. At Niagara Falls new switches and other equipment to handle the additional 50,000 H.P. being secured from the Canadian Niagara Power Co. are being installed. The maximum load of Niagara power now ranges between 115,000 H.P. and 120,000 H.P. These extensions will insure an ample supply for the needs of Toronto, and bring the equipment at Niagara Falls and Dundas up to the condition necessary to handle the larger load which will be available at the end of the year. The Commission has also decided to proceed immediately with the work of linking up the four power plants at Eugenia Falls, Big Chute, Wasdell Falls and Swift Current, in the Owen Sound-Collingwood district. This will require the construction of 41 miles of transmission lines. It will give a total supply from these four developments of 15,000 H.P. With the increased production possible at the Big Chute and developments yet to be made on the Saugeen and Severn Rivers the ultimate development of this district will be 25,000 H.P. As the Northern line will be only six miles distant from the Niagara power transmission line at Mount Forest, the two systems can easily be linked together if thought requisite in the future. Sir Adam Beck states that new municipalities are being connected with the system and that the steady increase in consumption is largely due to the manufacture of war munitions.

OBITUARY.

PROF. JOHN FERGUSON.—The death of Emeritus Prof. John Ferguson, who recently retired from the Chair of Chemistry at Glasgow University, occurred at Glasgow on Thursday, Nov. 2. In 1868 he became assistant to the Professor of Chemistry, whom he succeeded six years later.

PROF. H. M. WAYNFORTH.—We regret to record the death, on the 5th inst., at West Dulwich, London, of Prof. Harry Morton Waynforth, Professor of Engineering at King's College, London, in his 49th year.

KILLED IN ACTION.—The following deaths in action or of wounds are reported:—

Capt. Hamilton S. Harris (Sherwood Foresters), who was previously reported missing, is now reported to have been killed on July 1. He was 27 years of age, and was the youngest son of the late Henry Graham Harris (of the late firm of Bramwell & Harris), consulting engineers. He was educated at King's College School, Wimbledon, and was afterwards employed by the Canadian General Electric Co. On the outbreak of war he enlisted in the Queen's Own Rifles of Toronto. His brother, Second-Lieut. H. Lionel Harris, R.E., died of wounds on Dec. 2, 1915.

Lieut. Eric Appleby (R.F.A. has died of wounds received in action. He was at the outbreak of war a student at the University of Liverpool, Faculty of Engineering, and of the Institution of Civil Engineers.

PERSONAL.

The Vice-Chancellor of Cambridge University has appointed Dr. R. T. Glazebrook, C.B., Fellow of Trinity College, director of the National Physical Laboratory, to the office of Reader on Sir Robert Rede's foundation for the ensuing year.

Mr. J. S. Pitkeathley, C.V.O., electrical engineer, Imperial Works, Delhi, India, has been gazetted as temporary Major in the Army.

Naval Electricians.—The following warrant electricians have been promoted to the rank of commissioned electricians:—

Geo. W. Hows, Chas. P. Perry, John B. Clough, Thos. R. Brotheridge, Joseph A. Smith, Ernest C. Offer.

Royal Engineers (T.F.)—The following appointments have been made:—

London Electrical Engineers: R. F. Wood-Smith to be second-lieutenant (on probation).

Tyne Electrical Engineers: Sapper H. E. MacDonald and A. Woods to be second-lieutenants (on probation).

London and Tyne Electrical and Mechanical Company: Staff-Sergt. C. J. Hews to be second-lieutenant (on probation).

APPOINTMENTS VACANT AND FILLED.

A principal and secretary is required for the Technical School, Lurgan. Salary £200. Applications to the Acting Secretary by noon Nov. 24.

A leading firm of accumulator makers advertises for an estimating clerk for their London office.

The Lahore Electric Supply Co. (Ltd.), require a general manager, who must be a member of the Institution of Electrical Engineers. Salary 800 R., rising to 1,000 R. per month. Applications to Messrs. [illegible] Baker & Co. (Ltd.), 4 & 5, Bond-street, Walbrook, London, E.C.

The Government of India require three assistant electrical engineers, two for a factory at Arnwankada and one for a factory at [illegible]pore. Five years' engagement. Salary 280R., rising to 310R., per month. Particulars from the Director General of Stores, India Office, Whitehall, London, S.W.

A professor and assistant are required for the department of physics of the South African School of Mines and Technology, Johannesburg. Salaries £800, rising to £1,000; and £350, rising to £450, respectively. Applications to Messrs. Chalmers, Guthrie & Co. (Ltd.), 9, Idol lane, London, E.C., by Nov. 16.

Mr. T. A. Ripley has been appointed Clerk of Works for the extension of the generating station buildings at Rotherham.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—A general meeting of the members of the Royal Institution was held [illegible] afternoon (the 6th inst.), the Duke of Northumberland, K.G., President, in the chair. Dr. H. E. Armstrong, [illegible], F.R.S., was elected a Manager in place of the late [illegible]. Resolutions of thanks were passed to Mr. [illegible] of £100 and to Mr. John Y. Buchanan [illegible] of £100 to the Fund for the Promotion of [illegible] at Low Temperatures, and of £100 to the [illegible].

Royal Society.—Among the Papers read at the meeting on Nov. [illegible] "[illegible] Elastic Plate," by Prof. [illegible] Relations of the Energy of [illegible]," by C. H. Lees.

Electric Vehicle Committee.—[illegible] have been addressed to [illegible] calling their attention to the [illegible] and to the desirability of [illegible] in this country. Attention is also drawn to the [illegible] firms, such as [illegible], Vickers Limited and others. Attention is also drawn to the fact that such vehicles [illegible] of the modern [illegible], will give an [illegible] made at [illegible].

The Industrial Development Committee of Nottingham.—On Monday, the 13th inst., at 6.30 p.m., Mr. T. C. Elder, of the British Electrical and Allied Manufacturers' Association, will deliver an address on "War and Industrial Revival."

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 10th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Agenda: "Note on the Diffusion of Liquids," by Mr. B. W. Clack; and "On the Regularity in the Distribution of the Satellites of Spectrum Lines; with a Note on the Structure of the Green Line of Mercury and Terms of Correction in Using a Concave Grating," by Prof. H. Nagaoka.

SATURDAY, Nov. 11th.

Association of Mining Electrical Engineers (West of Scotland Branch).

4.30 p.m. At the Royal Technical College, Glasgow. Lecture on "Friction Surfaces," by Mr. John Oswald.

MONDAY, Nov. 13th.

Industrial Development Committee.

6.30 p.m. At the Exchange, Nottingham. Address on "War and Industrial Revival," by Mr. T. C. Elder.

Newcastle Local Section of the Institution of Electrical Engineers.

6.45 p.m. At the Mining Institute, Newcastle. Inaugural Address by Mr. H. W. Clothier.

TUESDAY, Nov. 14th.

Circle of Scientific, Technical and Trade Journalists.

5 p.m. In the Hall of the Institute of Journalists, Tudor-street, E.C. Paper by Mr. B. S. Rowntree (Director of the Welfare Dept., Ministry of Munitions of War), on "The Human Element in Factories."

Scottish Local Section, Institution of Electrical Engineers.

7.30 p.m. At the Rooms, 207, Bath-street, Glasgow. First Ordinary Meeting to be held. The Chairman, Mr. J. K. Stothert, will deliver his Inaugural Address.

Manchester Local Section, Institution of Electrical Engineers.

7.30 p.m. At the Engineers' Club, Manchester. An Address by the Chairman, Mr. A. E. McKenzie.

WEDNESDAY, Nov. 15th.

Royal Society of Arts.

4.30 p.m. At the Royal Society of Arts, John-street, Adelphi, W.C. Opening Address by Dr. Dugald Clerk, F.R.S., on "The Stability of Great Britain."

Birmingham Local Section, Institution of Electrical Engineers.

7 p.m. At the University, Edmund-street, Birmingham. Kelvin Lecture on "Some Aspects of Lord Kelvin's Life and Work," by Dr. A. Russell.

THURSDAY, Nov. 16th.

Greenock Electrical Society.

7.45 p.m. At Masonic Rooms, 22, West Stewart-street, Greenock. "A Criticism of the I.E.E. Rules," by Mr. H. Piggott.

FRIDAY, Nov. 17th.

The Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Report of the Hardness Tests Research Committee.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. Clay, K.D.

Orders for the Week:—

Officer for the Week.—Platoon Commander J. O. Cheadle.

Next for Duty.—Platoon Commander A. Gerard.

Monday, November 13th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.25–8.

Tuesday, November 14th.—School of Arms, 6–7. Miniature Range, 5.30–7.30. Lecture, 7.15, "The Service Rifle," Platoon Commander A. Gerard.

Wednesday, November 15th.—Instruction Class, 6.15. Miniature Range, 5.30–7.30. Platoon Drill, Platoon No. 3.

Thursday, November 16th.—Platoon Drill, Platoons Nos. 5 and 6. Ambulance Class, 6.0. Miniature Range, 5.30–7.30.

Friday, November 17th.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, Platoon No. 9. Signalling Class. Recruits' Drill, 6.25–8.25.

Saturday, November 18th.—N.C.O.'s Class, 2.30, Company Commander Cartell.

Sunday, November 19th.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office) 8.45 a.m. Uniform, haversacks and water bottle. Midday ration to be carried. Railway vouchers will be provided.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

Inspection.—The Corps will be inspected on November 25th by Sir Desmond O'Callaghan. A full muster is highly important. Parade 2.20. Uniform.

WORKS ORGANISATION.*

BY A. D. C. PARSONS, B.A., EDWIN L. ORDE, AND G. H. TWEDDELL.

(*Continued from page 147.*)

In this Paper the question of works organisation is divided into three main parts, covering: (1) Manufacturing, (2) Costing, and (3) Selling, of the works product. In our last issue was given the part covering manufacturing.

PART II.—THE FINANCIAL ORGANISATION OF FACTORIES.

BY EDWIN L. ORDE.

The evolution of accurate cost accounts seems to have begun at the time when competition began to influence sales, and to prove the superior efficiency of large factories, finding its highest development in factories where machine work can be most largely utilised. The various stages in the evolution are long, and until lately, technically trained engineers have been too apt to look on accountants with kindly tolerance, rather than as valuable allies.

The primary object of all costing systems is to obtain a record of the amount of money spent on labour and material, to ascertain the proportion of the expense of working the factory to be added to these two items and to present (1) The total net cost of every production, and (2) such divisions and sub-divisions of the cost as may be considered by the management most likely to enable a close scrutiny of working processes to be made, and a continuous comparison with corresponding items in the estimates.

Four essentials of a good costing system are:—

1. Accuracy.
2. Simplicity.
3. Rapidity.
4. Elasticity.

This seems sufficiently obvious, but writers on these subjects complain that elaboration of detail is only too apt to increase to a point where the cost of working the system becomes unduly high. The case of Woolwich Arsenal is quoted, where in 1906 over 4 per cent. of the total wage bill was spent on clerical administrative labour.

The total wage bill is not given, but from other figures it may be deduced that it was of the order of £1,500,000.

Time.—Accuracy in recording time is of the first importance and at the same time most difficult to ensure.

When the work is constant and is paid on piece rates, the returns are probably as correct as is necessary, but when a man on time rate is employed on a number of comparatively short operations for various orders, the difficulty of accurate record becomes greater and attempts to meet it probably costly. As a general principle it would seem that foremen should be involved in the time-keeping system to an extent which shall influence them in spreading the work as evenly as possible, so as to avoid the difficulty referred to above, but at the same time shall not interfere to any harmful extent with their real function, the distribution and technical supervision of the work.

Stores.—A great deal of attention has been paid to the store-house by various writers, as it constitutes a possible source of leakage which is difficult to detect unless the cost system is carefully designed and applied. A well arranged system of cards seems to offer the best solution and to give the clerical department complete information in a form which is readily accessible. In the designing and application of the system there should always be the closest possible collaboration between the accountants' department and the technical management.

In fluctuating markets the storehouse requires considerable attention, for the adjustment of the rates at which various articles should be issued must exercise an important effect on the cost of the product and on future estimates. As a general rule it seems that the market rate at the date of issue or at the nearest date that can conveniently be ascertained should be taken, and any profit or loss dealt with in the stores account. Unless this is done direct comparison between the market rates and the cost of the product becomes impossible and future estimates based on these costs are misleading.

Materials.—Materials ordered direct for contracts pass through the ordinary books required by the system in use, and materials for stock through the storehouse or yard and can be suitably recorded on cards.

Estimating.—American methods of costing and estimating possess the attractive feature of rapidity. The best way of obtaining accuracy is to be found in a system which enables results to be recorded before many days have elapsed after the work is finished, and the details are still fresh in the memories of those concerned in it; while the estimating department have the knowledge that the net costs on which their work is based are the result of immediate inquiry and investigation when discrepancies occur and so can be used in a new estimate without any misgivings. Another feature of what may be called the American system of estimating is the employment of technical men as estimaters both of quantities and rates.

The system must be costly if it is really to be efficient, though this will be perhaps recouped in works where there is much estimating to be done, by the accuracy and rapidity which must be attained by such a system in the hands of competent men.

It is said that the inherent weakness of the system of estimating in general use in this country, *i.e.*, the calculation of quantities by technical men and rates by net cost clerks, lies in the difficulty experienced by the net cost clerk in fixing his rates judiciously, owing to his lack of technical experience, and this is urged by the advocates of what has been called the American system.

The writer considers that a judicious blend of the estimating draughtsmen and net cost clerks can often be made which will bring out the best qualities of both departments.

The system of doing the whole of this work by means of a technical staff has an advantage over the net cost clerk system in this respect; that the technical staff, when not actually engaged in estimating, can be occupied in watching net costs as the work progresses, and in devising means whereby they can be compared with the estimates at all stages, so as to keep the management closely in touch with the financial aspect of the operation. This, in the writer's opinion, is the most important point in financial organisation.

A close comparison between the cost of work in progress and the estimate can to some extent be arranged in shipyards by plotting cost progress curves, of which the ordinates represent money, and the abscissæ, time. If the scales are judiciously chosen, the estimate curve can be made to assume so definite a character that any marked difference between it and the actual cost curve, when it is plotted, can be seen, probably one or two weeks before it begins to assume serious proportions.

The ordinary book-keeping systems have been criticised, overhauled, and improved until there is probably little to be done in further improvements except perhaps in minor details, but the full development of a good net cost system and the establishment of a close connection between the net cost estimating and constructive departments on the lines indicated above deserves the careful attention of all those who are concerned with factory organisation.

The best results are likely to be obtained by the closest possible combination between accountants and engineers, for if either is eliminated some essential element of success is sure to be forgotten.

No discussion on the financial organisation of factories, so far as it affects internal work, should disregard the great and vexed question of establishment charges. The closeness of the estimating, and the accuracy of the net cost systems are indicated very clearly by the number of items placed under the head of indirect charges. When there are few, the work is well subdivided and a good measure of accuracy may be counted upon; when there are many, the opposite may be confidently expected.

The basis on which indirect charges should be calculated in costing and estimating has been argued at considerable length by manufacturers, and it has been held that some percentage should be taken of the total cost of labour and material.

The sub-division of charges is a question which probably never will be finally settled, for conditions in engineering works and shipyards are constantly changing, and though elasticity is claimed as an essential of a good costing system, this admirable quality must sometimes fail under new developments, and when changes have to be made. In engineering works where a large amount of the work is done on machine tools, it is probably advisable to charge all such capital cost items under a special heading, and provide for them by fixing a rate for each machine which is added to the cost of all the work which it produces.

The cost of estimating and tendering is an item which should be carefully kept, if only as a record of the unproductive work and a guide as to how and where it has been apportioned, for this brings under review the idiosyncrasies of customers in regard to the demands they make on the estimating staff, compared with the value of the orders given, and may form an important factor in deciding policy.

The perfect cost system should be capable of showing at a glance the cost of work as it proceeds, but unfortunately such a system has yet to be devised.

It may, however, be taken, that in most factories, shipyards, or engine works, some little signals can be set up which will indicate to the management symptoms of the financial health of the place which will be serviceable.

Weekly returns of material and wages showing how they are apportioned; weekly output of various trades, machine time worked, and many similar data can be easily collected and applied as best suits the particular trade or the requirements of the management, but in this as in all detailed costing arrangements the exercise of very wise discretion is required in deciding the extent to which details shall be carried.

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* Abstract of Paper read before the North-East Coast Institution of Engineers and Shipbuilders.

*So far only the internal finance of factories has been considered, but a very large and important question is opened when the finance connected with the disposal of the product comes under discussion. The time seems to have arrived when the whole machinery required for obtaining and fulfilling foreign orders should, where it does not at present exist, be set up at once, and where it does exist, should be put into the best possible working order.

In the writer's view the first great necessity is a banking compnay (subsidised by the Government if need be, or relying on its own resources if these are sufficiently strong) which shall finance manufacturers who find it necessary to grant long credit terms to foreign customers. German success in securing such trade is largely due to this, and her example will no doubt be followed by neutral countries. Similar American institutions are already in existence, and have no doubt done much to foster trade during the war. An institution of this kind has been established in England for the furtherance of trade with Italy. This has a capital of £1,000,000, and for the next ten years a subsidy of £50,000, but for the development of trade with, for instance, Russia, a bank of this kind would have to be on a much larger scale. A capital of £10,000,000 as a foundation is suggested by one Russian writer (M. Alexander Wilner, "Times Russian Supplement," July 29, 1916).

The financing of trade would not be the only function of such a bank, it would also arrange to collect by means of trade and banking connections, all such information as is essential in building up a trade organisation. This would be distributed amongst the potential purchasers and traders as found desirable, and thus lay the foundations of business relations which only require satisfactory productions from the factories to develop them into permanent connections.

The organisation should probably be a combination of banks, merchants, and manufacturers supported by the Government financially if necessary and through international channels whenever and wherever required, but should not be under Government control.

The details of the work to be carried out by such an Institution are numerous, and comprise:—

(a) Translation into the particular language and numeral system of communications between buyers and sellers; in fact, all the literature of the trade.

(b) The dissemination in the proper direction of all such information as may spread full knowledge of the productions of firms involved.

(c) The collection of information regarding the requirements and standing of possible purchasers; and

(d) The training and development of suitable men to act as pioneers of British trade, who shall have sufficient technical knowledge to appreciate possibilities, understand and overcome difficulties, and [illegible] to be entrusted with powers to negotiate contracts if necessary.

[illegible] of trade, essential though it is, has never yet been sufficiently cultivated in this country.

Unless some such measures are taken it is to be feared that this country will lose the best opportunity she has ever had of developing the [illegible] and forming close business relations with our Allies, [illegible] develop into a large and mutually advantageous trade.

(To be concluded.)

ELECTRICALLY-DRIVEN FLOATING CRANES.

The extent to which large vessels of war have been constructed [illegible] of the century has led to the introduction of [illegible] for the fitting out and repair of these vessels. Although at the time it is not permissible to refer to what is [illegible] to give detailed descriptions, it may be of interest to describe what has been done in recent years by our neighbours.

In the past several of the [illegible] shipbuilding firms in the country ordered floating cranes from German firms, not because our engineers were unable to construct such cranes, but because they were either unable to compete in regard to price or to give such quick delivery as their competitors. Although an analysis shows that there is little difference in the cost per ton of cranes by different firms, it is, nevertheless, extremely likely that German firms either deliberately underquoted in order to get information at first hand as to work in progress in out shipyards, or were in a position to under-quote on account of financial assistance received from those likely to benefit by such information. Readers will call to mind that when the "Thunderer" was being constructed by the Thames Ironworks Co. skilled German engineers were engaged at the works on the Thames in erecting the large floating crane which the company had ordered from a German firm, and which was to be used for the fitting-out of the vessel.

If we remember rightly, questions asked in Parliament at the time elicited the familiar type of answer, but in view of the experiences of the last two years it is reasonable to suppose that the information which could be collected without difficulty by trained observers on the spot would be invaluable to the German naval authorities. It is of little consequence to us now, and in the future maybe we shall have the good sense to exclude from our shipyards not only all those of German nationality, but also all those who are not British.

Relatively few firms are in a position to engage in the manufacture of heavy floating cranes, and little technical information has been published concerning such cranes.

Descriptions were given recently in these columns * of two electrically-driven 150-ton cranes, one of the non-revolving bridge type and the other of the revolving type. In this article particulars will be given of a 150-ton crane by the well-known Dutch firm, Messrs. Smulders, of Rotterdam, and of a 250-ton crane by the Deutsche Maschinenfabrik A.G., of Duisburg, Germany.

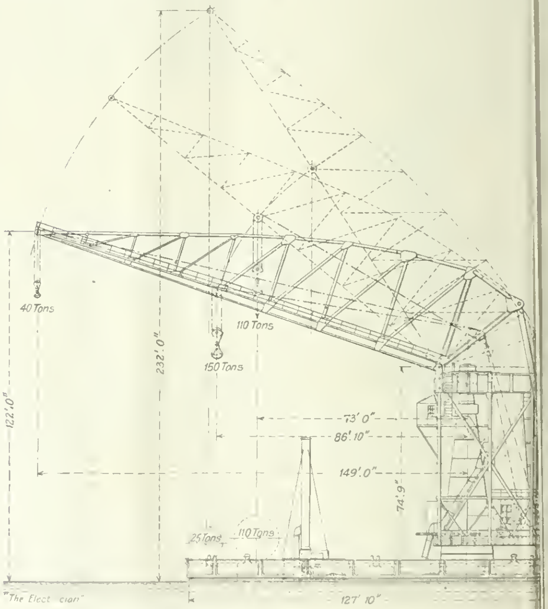

Fig. 1.—150 ton Floating Crane.

150-TON CRANE.

The crane rests upon a conical tower built on the pontoon, as shown in Fig. 1. The tower carries at its apex a platform which supports at one side the jib, and at the other side the counterweight and the various operating mechanisms. The whole is united by a structural steel frame enveloping the tower.

Of the two lifting mechanisms, one is of 150 tons capacity at a radius of 87 ft., and the other is of 40 tons capacity at 149 ft. radius. The weight of the jib is balanced by special counterweights, while the load is balanced by movable counterweights. These counterweights are such that there is practically no list under any condition of loading.

The capacity of the crane and the corresponding figures for the lifting speeds and working radii are:—

150 tons	at a radius of	87 ft.,	and a speed of	2 ft. 8 in. per min.
120 tons	,,	103 ft.,	,,	3 ft. 0 in. ,,
90 tons	,,	72 ft.,	,,	4 ft. 1½ in. ,,
70 tons	,,	87 ft.,	,,	5 ft. 11 in. ,,
40 tons	,,	149 ft.,	,,	13 ft. 8 in. ,,
25 tons	,,	149 ft.,	,,	16 ft. 5 in. ,,

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* This part of the paper was written at the end of July; the writer thinks [illegible] of Lord Farringdon's Committee which [illegible] a resemblance to the rough [illegible] which he outlined.

* The Electrician, July 28, 1916, p. 561.

With loads of from 25 to 110 tons the crane makes one complete revolution in six minutes.

The jib can always be derricked in such a manner as to permit of loads up to 110 tons being deposited on deck. Loads of 120 and 150 tons can only be lifted when the arm is pointing forward in a longitudinal direction as regards the pontoon. When these heavy loads have to be handled the structural-steel framework surrounding the tower is fixed to the deck of the pontoon. The two lifting mechanisms, the slewing and derricking mechanisms and the machinery for moving the counterweights are all electrically-driven. On board are installed the necessary capstans and other apparatus for manœuvring the pontoon. The entire crew for such a crane consists of three men, namely, a driver for directing the operations of the crane from his cabin, one man in the engine room and a fireman.

250-TON CRANES AT PANAMA.

In anticipation of requirements, investigation was made by representatives of the Isthmian Canal Commission with a view to deter-

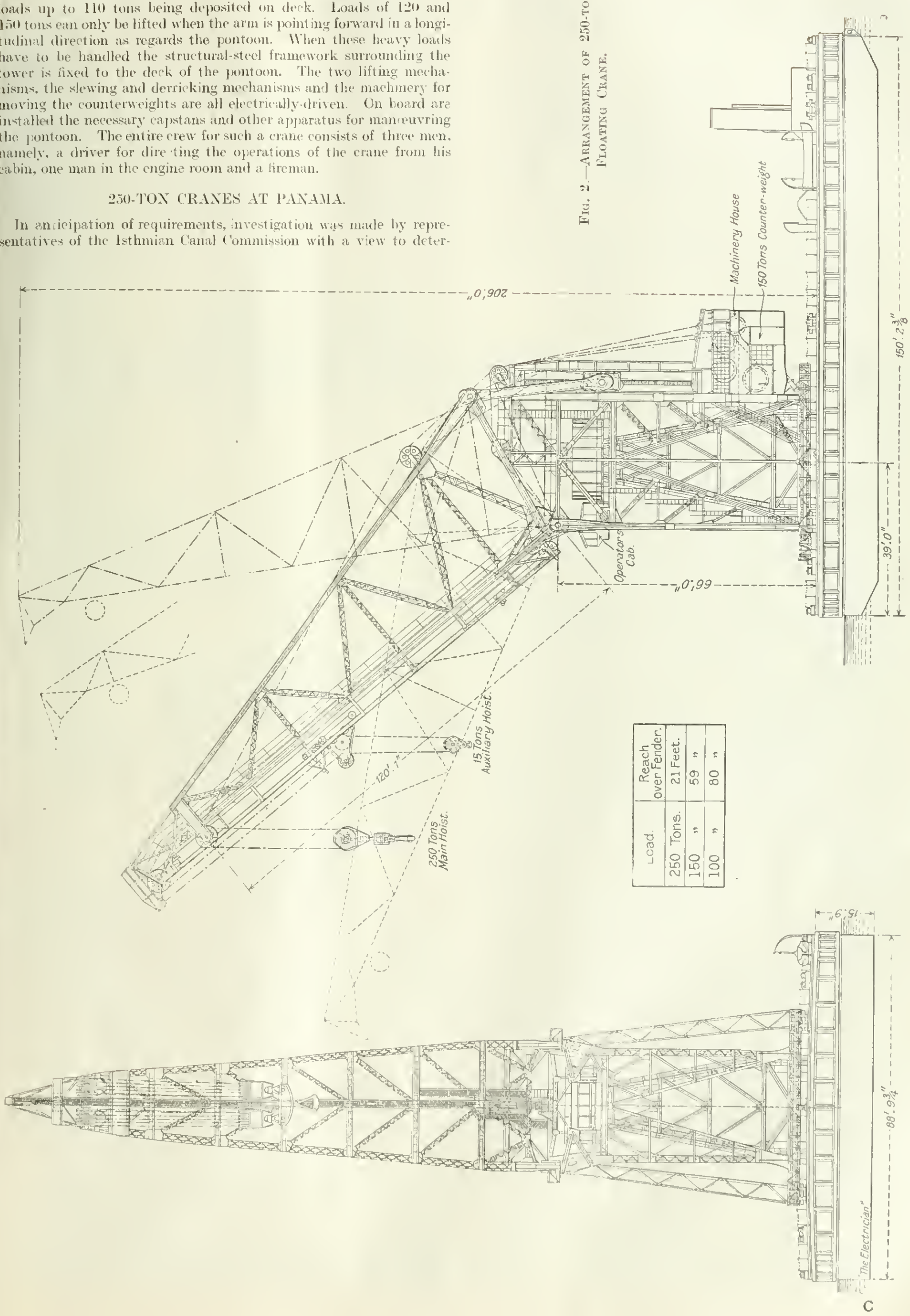

FIG. 2.—ARRANGEMENT OF 250-TON FLOATING CRANE.

Load.	Reach over Fender.
250 Tons.	21 Feet.
150 "	59 "
100 "	80 "

mining the type of crane that would best meet canal requirements. The conclusion was early reached that two floating cranes of the largest size would be necessary. Towards the close of 1912 tenders were invited for the construction and delivery of two floating cranes of 250 tons capacity.

Four sets of tenders were received—one American, one British, one Dutch and one German—as follows:—

American.—Wellman-Seaver Morgan Co.—Two cranes, £290,000. One crane only, £149,000. Time required for delivery, 690 days in either case.

British.—Cowans, Sheldon & Co.—Two cranes, £230,000. One crane only, £115,250. Time required for delivery, 548 days in either case.

Dutch.—Werf Gusto.—Two cranes, £184,000. One crane only, £92,000. No time specified.

German.—Deutsche Maschinenfabrik, A.G.—Two cranes, £164,070. One crane only, £84,035. Time required for delivery, 580 days and 550 days respectively.

Contract was entered into with the German firm, the total contract price of the two cranes being £169,500, the difference of £5,430 from the original estimate being due to minor alterations and to the provision of condensing apparatus for each crane. The cranes have been given the names "Ajax" and "Hercules" respectively.

General Description.—From Figs. 2 and 3 it will be seen that each crane consists essentially of a steel pontoon 150 ft. long, 88 ft. wide and 16 ft. 3 in. average depth, containing a power-generating plant, and supporting the fixed and revolving superstructure. Electric energy is generated at 220 volts continuous-current by engine-driven dynamos, steam being supplied by a coal-fired Scotch marine boiler. All motions of the hooks are controlled by one operator. The pontoon is not self propelling, but is fitted with a powerful steam capstan at each of the four corners for warping the crane into any desired position, and is further fitted with suitable towing bits, cleats, &c., and with two 3,000-lb. anchors handled by steam.

The fixed and revolving superstructure is centred at a point 39 ft. distant from one end of the pontoon and midway of its width. The fixed superstructure consists of a truncated steel-framed pyramid supporting at its top the revolving superstructure. This latter consists of two parts, the "bell" which surrounds the pyramid, and which supports the jib, machinery room and operators' cab, and the jib which is hinged to the bell at its top, and carries the main and auxiliary hoists. Rotation about a vertical axis is obtained by power applied between the bell and pyramid near the foot of the latter. Movement of the jib in a vertical plane is secured by means of two links attached to the jib and to carriages driven by vertical screw spindles, these latter being at the rear of the bell and vertically above the machinery house.

The design of superstructure virtually eliminates all uncertainty as to how the loads are carried. All vertical loads, dead and live, of the revolving superstructure are concentrated at the top of the pyramid. The overturning moment of the live, dead and wind loads of the revolving superstructure is resisted by horizontal forces applied at the top and bottom of the pyramid. The clearances are such that no part of the revolving superstructure, except the jib, overhangs the pontoon in any position, and the heights of superstructure are such that an unhindered passage around it is provided in all positions. An area 20 ft. by 60 ft. on the deck of the pontoon is made sufficiently strong to carry a superimposed load of 2,000 lb. per square foot, this area being intended for the reception of loads up to a total of 300 tons. The cranes can, therefore, carry very heavy and bulky loads on their [illegible] to transport them anywhere on the Canal, [illegible] the use of barges for the purpose.

The [illegible] and auxiliary hoists. The main [illegible] of the jib, and consists of two identical [illegible] of 125 tons. These two blocks can [illegible] whereby they may be [illegible] of 250 tons capacity. Each [illegible] of 2 [illegible] steel wire rope. [illegible] of 15 tons and consists of a [illegible] on a track [illegible] that the auxiliary [illegible] in any position of [illegible] point in a [illegible] completely under [illegible] reach [illegible] of the pontoon to the [illegible]

[illegible]	[illegible]	[illegible] tons	250 tons
[illegible]	[illegible]	[illegible] ft	21 0 ft
[illegible]	[illegible]	62 4 ft	22 3 ft

From any of these reaches the main load can be luffed-in sufficiently far to enable the crane to deposit such load on the deck of the pontoon.

The main hoisting speeds are:—

250 tons	3 ft. 6 in. per min.
125 tons	7 ft. 0 in. per min.
62·5 tons	14 ft. 0 in. per min.

The unloaded blocks are raised or lowered at not less than 20 ft. per minute, and the crane can make one complete revolution in from 5 to 8 minutes, depending on the load and the wind, the lower figure being the most favourable condition without wind. The jib loaded with 100 tons can be luffed-in from its maximum to minimum reach in not more than 17 minutes and luffed-out in not more than 13 minutes. Without load the jib can be fully luffed-in from maximum to minimum reach in not more than 10 minutes, and luffed-out in not more than 8 minutes. The speed of hoisting the fully-loaded auxiliary block is not less than 40 ft. per minute, and the unloaded auxiliary block can be raised or lowered at not less than 80 ft. per minute. The speed of racking the auxiliary hoist along the runway is from 40 ft. to 80 ft. per minute, depending on the angle of inclination of the jib.

Each crane is safely stable in a wind exerting a presssure of 40 lb. per square foot, even with a 300-ton deck load on the pontoon, but it is not intended to operate the cranes in a gale. The pontoon has a freeboard of not less than $3\frac{1}{2}$ ft. when handling maximum capacity loads in any position without deck load; if the deck load be present this freeboard is reduced to not less than 2 ft. The maximum longitudinal inclination of the pontoon does not exceed $2\frac{1}{2}$ deg., and the maximum transverse inclination is less than 5 deg. Ladders, stairs and gangways are provided for convenient communication, inspection and repair. Each crane is equipped with all the necessary signals and means of communication, and is electrically lighted throughout.

Pontoons.—Each pontoon required 980 tons of structural steel and 20 tons of oak as fenders. The fittings, including capstans, anchor winches, anchors and chains, anchor flanges, &c., for each pontoon weigh 53·7 tons. The boiler for each pontoon weighs 41 tons. One hundred and thirty tons of concrete were used in cementing the bottom of each pontoon, and 450 tons for counterweight in the stern. The following is a schedule showing the date of beginning work on each pontoon and the dates when the pontoons left Emden under tow and when they arrived at the Isthmus:—

— —	"Ajax."	"Hercules."
Bottom plates laid	July 29, 1913	Aug. 10, 1913
Launched	Jan. 8, 1914	Feb. 24, 1914
State of completion of hulls when launched:		
Erected	93 per cent.	97 per cent.
Riveted	70 per cent.	78 per cent.
Hulls completed and date of departure from Emden	Apr. 26, 1914	May 30, 1914
Date of arrival	July 8, 1914	July 13, 1914

The weight of the structural steel above the deck of the pontoon for each crane is as follows:—

	Tons.
Tower	120
Bell	300
Jib	123
Total	543

All of this work was manufactured at the Benrath shops of the contractor. Work on the towers and bells started on October 1, 1913, and as the different parts were completed they were shipped to Emden for erection by the contractor. Erection began on December 1, 1913. The jibs, counterweight arm, machinery house, machinery, spare parts, foundry patterns, and erection equipment were shipped from Antwerp direct to the Isthmus in April, 1914. All work not erected at Emden was assembled at the Benrath shops before shipment.

Machinery.—The machinery above deck, including all hoisting, slewing and luffing machinery, weighs about 368 tons. The greater part of this machinery was manufactured at the Benrath shops. About 40 tons of this was erected at Emden, and the rest shipped knocked down to the Isthmus.

Electrical Equipment.—The electrical equipment, consisting of steam engines and generators for the power and electric light units, motors, brake solenoids, switchboards, controllers, electric light installation, and slip ring collectors, was installed and the power plant was thoroughly tested before the pontoons left Emden.

When the pontoons left Germany their general condition was as follows:

Completed.—Pontoons. Power and electric light plants. Power and control wiring within pontoons, and to the collector rings on the towers. All electric light installations for pontoons and crane structures. Towers.

Partially Completed.—Bell, with exception of counterweight arm, machinery house and machinery for same, spindle carriage and spindles.

The jibs, of course, were not erected on the crane structure. The spindle carriages with their cast-iron counterweights and spindles were lashed to the decks of the pontoon for shipment.

The following is a summary of the weight of each crane, complete :—

	Tons.
Pontoon	1,634·4
Electric plant, coal, water, &c.	173·7
Structural steel for superstructure, including tower, bell and jib	543
Machinery	368
Counterweight, motors, controllers, &c.	150·2
Total	2,869·3

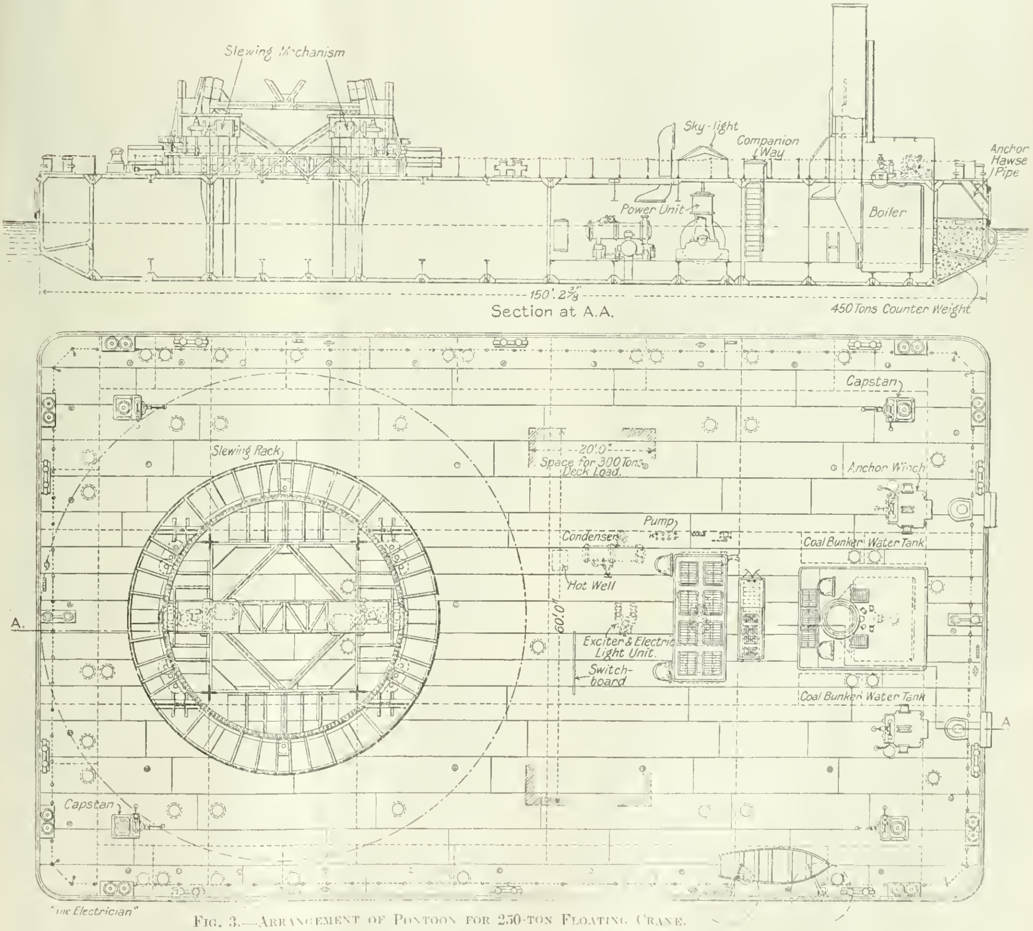

Fig. 3.—Arrangement of Pontoon for 250-ton Floating Crane.

The Deutsche Maschinenfabrik A.G., a company which prior to the war traded in this country under the title Demag (Ltd.), is a combination of the principal crane builders in Germany. The following were the principal sub-contractors :—

Design and Construction of Pontoons. Deutsch-Luxemburgische Bergwerks and Huetten A.G. Abtl. Nordseewerke, at Emden.

Boilers, Piping, Capstans and Anchor Winches. Gebr. Sachsenberg, at Rosslau, Anhalt.

Condenser Equipment.—Firma Velbigan, Dresden.

Power Plant Unit, Electric Light Unit and Installation of Same, Electric Light Wiring in Pontoons and on Crane Structures, Motors and all Control Equipment.—Allgemeine Electricitats Gesellschaft, Berlin.

Steam Engines for Power Plant Unit and Electric Light Unit.—Werft Schichau, Elbing.

Erection. The contract permitted the use of a canal lock for erecting the jibs without charge, except for additional cost of labour, if any. The contractor planned to take advantage of this, and was assigned a building site at the east wall of the middle chamber of Gatun Locks for the erection of the two jibs, and suitable storage and wharf space at Cristobal for work on the cranes proper. The material, other than that for the jibs, arrived at Colon on June 4, 1914, and was unloaded and transported to Cristobal. This material consisted of structural steel for the bell counterweight arm and machinery house, the mechanical and electrical parts of the hoisting and luffing machinery, wire rope, blocks and sheaves.

The work done at Cristobal on each crane before attachment of jib included the following : About 88 tons of structural steel for the bell, counterweight arm, carriage countertrack, machinery foundations, and machinery house were erected and riveted. The screw spindles, spindle carriage, luffing mechanism and hoisting machinery were installed. The remaining work to be done on the power cables and control wiring, that is, the wiring from the collector rings to the machinery house and operators' cabin, was completed. The bell counterweight, consisting of 150 tons of scrap iron, sand and cement, was built about the steel work of the counterweight arm. When the luffing mechanism had been tested and found to operate satisfactorily, the cranes were ready for the attachment of the jibs.

The "Ajax" reached this stage of completion on October 2, 1914, and was towed to Gatun and placed in the lock chamber. On November 4th the "Hercules" followed. The material for the two jibs, which consisted of about 320 tons of structural steel, on arrival was shipped to Gatun, and, after a delay of 12 days, erection was begun. The jibs were erected at right angles to the chamber wall with the pivot end toward the chamber. No part of the jib was permitted to project over the lock chamber wall. The jibs were erected on cribbing of sufficient height, and so placed that the passage of towing locomotives along the lock wall was not interrupted. In order to make the attachment to the crane structure, it was necessary to move the jibs until they projected 15 ft. beyond the lock wall. When completed, each jib was lowered upon four roller supports, so that the lower chords of the jib rested upon them. Two of these supports, each consisting of two 18 in. rollers, were placed at the pivot end of the jib near the edge of the lock wall. The two other supports, which were placed about 60 ft. from the sheave head of the jib, were constructed with one roller only. The lower chords of the jib were fitted on the underside with blocks of elm 10 in. thick and armoured with ⅜ in. steel plate for the full width of the chord. It was found that at the one-roller supports this lining was not sufficient to protect the outstanding legs of the chord angles. When reinforced with a ⅜ in. plate the result was satisfactory. The jib was moved by means of two sets of 7-part block and tackle placed between the head of the jib and deadmen anchored at the lock wall and leading to two hand winches.

When everything was ready, the crane to which the jib was to be attached was brought into the lock chamber, and the water lowered until the pivot jaws of the crane superstructure were level with the pivot holes of the jib. Alignment in a horizontal plane was obtained by shifting the pontoon by means of the mooring lines. The jib was then skidded forward, and the pivot pins were inserted. In order to secure the nice adjustment necessary to line-up the holes for the insertion of the pivot pins, hydraulic jacks, placed upon the roller supports and acting upon the lower chord of the jib, were used. After the jib was thus pivoted, it was raised into place by its own luffing mechanism. To accomplish this, since the jib in its outer position lacks about 30 deg. of reaching a horizontal position, it was necessary to add an extension to the connecting links that transmit the motion from the spindle carriage to the jib. The jib was then derricked up in the usual manner by lowering the spindle carriage. In this position, the jib was secured to the superstructure by special rigging designed for that purpose, and the connecting links released to enable the connections to be removed. When they were removed, the spindle carriage was raised sufficiently, so that the connecting links could be pinned to the jib. The "Ajax" finished this operation on October 16th, and was towed back to Cristobal to receive the lifting ropes and to be adjusted for the acceptance tests. The "Hercules" finished the attachment of the jib on November 8, 1914.

With the contractors' consent, both the "Ajax" and the "Hercules" were docked at Gatun from November 9 to 13, 1914, and their bottoms were cleaned and painted.

On November 14th, by means of a locomotive crane on the lock wall the spindle carriage counterweights were placed on the "Ajax," and it was ready for service. The "Ajax," under the direction of the Mechanical Division of the Canal authorities, and manned by a crew of the contractors' employees, was then used to remove two portions of a sunken barge that were blocking the channel. After successfully removing these obstacles and performing some minor work, the "Ajax" was returned to the contractor at Cristobal on November 25, 1914. The "Hercules" was returned to the contractor on November 16, 1914.

Testing.—The contract required the Canal authorities to provide the weights, slings, lines and unskilled labour necessary for the tests, and to attach and detach the test loads to the hooks. The test load for the main hoist was built up of two concrete blocks in which 15 in. I-beams were embedded and which projected beyond either side. The load was suspended by four 6 in. by 2 in. eyebars, which at their lower ends were pinned to these side girders, and at the upper ends to a shackle through which the 250-ton triangle was passed. The test load [illegible] weighed 100 tons, and by the addition of cast iron blocks [illegible] the load could be gradually increased to the maximum required, namely, 300 tons. The test load for the auxiliary hoist was a steel platform filled with concrete, and suspended [illegible] chain. It weighed 8 tons.

The contractor offered the crane "Ajax" for test on December 1, 1914, [illegible] test load was assembled so that the actual test [illegible] on December 3rd. The test with the 100 ton normal load [illegible] and the speed of the hoisting, luffing and [illegible] contract requirements. On December 7th the test load was increased 20 per cent., as specified by the contract for the increased test, by the addition of steel rail. The 120 ton load was [illegible] and luffed slowly out to the 100 ton radius of [illegible] from the face of the fender. No signs of distress were noticed in any member. The auxiliary hoist trolley was at the inner limit of travel, when [illegible] been at the tip of the jib. The jib was ordered to be luffed in, so that the trolley could be run out. The instant that the controller was [illegible] the luffing position and the brake [illegible] released the brake on the drums, [illegible] the back of the jib and fall of the load, which was only a short distance above the ground, [illegible] the fall of the jib and the recoil of the pontoon. The jib pivot remained intact, [illegible] the jib in its fall [illegible] about the pivot. The head of the jib [illegible] sheaves which support the [illegible] of the test load and buried itself [illegible] in the ground. The extension of the jib beyond the point which serves as an attachment for the crab-trolley sheaves struck the test load, and was completely wrecked. The portal which ties the upper chords together at the second panel point and supports the guide sheaves for the main host remained in place. The connecting links from the jib to cross-head were badly twisted. The back spindle carriage track was sprung outward, and with it the two spindles. The spindles, however, were found to have suffered no injury. The upper chord was sprung and the lower chord twisted. The main hoist blocks and the equaliser bar received injury, more especially the latter, but the block sheaves were intact. One main block triangle was badly bent. Of the upper sheaves at the head of the jib only two of the 10 were broken. The ladders, walks, railing, &c., had been bent. The crab track was badly twisted and bent. The jaws of the revolving superstructure which form the jib pivot were twisted, and the outer cover plate was ripped. The inner part of the crab track penetrated the operator's cab, and damaged the controllers and instruments. The hoisting rope was kinked in places and rendered unfit for use. No one was injured.

Investigation of the accident led to the conclusion that the heel strut was the first to fail, and that the failure was probably due, not to insufficient sectional area to resist the maximum direct compression, but to the distribution of metal in this member and to the insufficient strength of latticing and tie-plates, and of rivets connecting these details to the main members, as well as failure to provide adequately for flexure as well as direct compression. The contractor did not concur in the above-stated cause of failure, and whilst stating he did not know the cause of the accident, expressed such confidence in his design that three days after the accident he offered the "Hercules" for contract tests. The Canal authorities were unwilling to permit this to be done without his first reinforcing certain members of the jib. The reinforcement of three members of each truss of the jib of the "Hercules" was begun on January 11th, and was completed on January 27, 1915.

During the period from December 10, 1914, when the "Hercules" was offered for test, until January 11, 1915, when work in reinforcing the jib was begun, the crane was available for service up to 60 per cent. of its rated capacity. The crane was used by the contractor in removing the jib of the "Ajax." When the reinforcing was finished, the "Hercules" was offered for test. The tests were discontinued on January 29th on account of vibration in the screw spindles at certain positions when operating under load. The contractor was engaged in remedying this matter when on February 16th the Canal authorities required the crane. After 29 days' use the crane was returned to the contractor at Cristobal on March 17th, and the tests were resumed.

The tests were completed satisfactorily on March 27, 1915, and on March 30th the "Hercules" was accepted by the Canal authorities with a few minor exceptions, and turned over to the Mechanical Division for operation. Since taking over the crane, it has been fitted up with living quarters for the crew, a galley and other necessary equipment.

The contractor was entirely responsible for the accident to the "Ajax," and on December 27, 1914, as soon as the extent of the damage could be ascertained, his local representative cabled to his home works for an entire new jib with connecting links, excepting only such minor parts as sheaves, walks, &c., that had escaped damage. New wire rope was ordered for both main and auxiliary hoists and the trolley, a new front for the operator's cabin, and electrical and mechanical parts to replace those which had been damaged in the operator's cabin. In building the new jib the contractor was required to strengthen certain members similar to the reinforcing of the jib of the "Hercules." The new jib was completed at the works of the contractor on April 15, 1915. On May 8th, the structural steel for the jib was shipped from Rotterdam and arrived at Colon on June 10th. The second shipment, including the wire rope and mechanical parts, left Rotterdam in May and arrived at Colon on June 18th. The final shipment, consisting of the electrical parts and the main engine crankshaft, arrived at the Isthmus on June 24th. The contractor erected and riveted the jib in two parts upon the ground at Cristobal, and hoisted them into place on the crane superstructure by the "Hercules."

We are indebted to Messrs. Smulders for particulars of the 150-ton floating crane, and the matter relating to the 250-ton Panama cranes has been drawn from the Annual Reports of the Isthmian Canal Commission and the Panama Canal for 1913, 1914 and 1915. Readers desirous of obtaining further information on the Panama cranes are referred to two articles and editorial comment in "Engineering News."* Both articles were written by Mr. F. H. Cooke, the designing engineer to the Division of Terminal Construction at the Canal. In one of these Mr. Cooke dealt at some length with the contract for the cranes, and in the other the failure of the "Ajax" was discussed authoritatively and exhaustively.

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* May 13, 1915.

DUPLEXING IN THE SQUIER SYSTEM OF TELEGRAPHY.

BY LOUIS COHEN.

The subject of telegraphy has received but little attention from electrical engineers for a good many years past. Methods and apparatus developed in the remote past are still considered good enough in this day, when progress and change are a daily occurrence in all other branches of electrical engineering. Undoubtedly there were a number of causes which operated to hamper the progress of the art, but there can be no question of the fact that the use of direct currents had a great deal to do with it. The recent rapid progress in other branches of electrical engineering, either in methods or apparatus, are mainly in the field of alternating currents, and consequently all these developments found no application in telegraphy.

It was reserved for Col. Squier, by his epoch-making invention, which consists in the use of an unbroken alternating current for telegraphy, to bring also this branch of engineering in the realm of alternating-current practice. The full merit of Col. Squier's invention can hardly be appreciated at the present time. Aside from its great intrinsic value, it is bound to have a highly stimulating effect on the development of the art, and as the system gets into general use rapid progress may be expected. It will be found that many of the phenomena, circuit arrangements and apparatus studied in connection with other branches of electrical engineering, by allowing for suitable modifications, can be made good use of in working out problems in the Squier system of telegraphy.

Duplexing.

In the present method of telegraphy, duplexing is accomplished by the use of a Wheatstone bridge arrangement, in which an artificial cable is used to balance the cable in regard to resistance and capacity. For the case of long-distance submarine signalling the artificial cable constitutes an important element; its design and construction must be executed with great care, and the cost is considerable. In the Squier system, however, methods can be developed by which duplexing is accomplished without requiring the use of an artificial cable, and thus it will be possible to eliminate at least one troublesome factor. Two new methods which suggested themselves to the writer are discussed in the present Paper, and it is hoped that they may receive some attention from cable engineers.

Method I.

The first method proposed for duplexing, in which no artificial cable is required, is shown in Fig. 1. As will be seen, we have an independent transmitting and receiving circuit, marked *I* and *III* respectively, both of which are linked electrically with the cable through transformers M_1 and M_4, and the transmitting and receiving circuits are linked together electrically through the intermediate circuit *II* and the two transformers M_2 and M_3. The operation is as follows: The current generated in transmitting circuit *I* is transmitted through transformer M_1 to cable, the current flowing in the cable induces an E.M.F. in the receiving circuit *III* through the action of transformer M_4; but the transmitting circuit also induces another E.M.F. in the receiving circuit through the intermediate circuit *II*, and it will be shown that the circuit constants can be arranged so that these two E.M.F.s neutralise each other completely—that is, they are of the same magnitude and exactly opposite in phase. To further ensure, however, absolute freedom from electrical disturbances of the transmitter affecting the receiver, which may be due to lack of perfect balance, a loop circuit, L_3C_3, is introduced into the receiving circuit, which is tuned to be in resonance for the frequency of the current of the transmitter, and it will be shown that the loop circuit has the same effect as that of a very high resistance in the circuit in regard to the current of the frequency to which it is tuned. For any other frequency the effective resistance of the loop circuit is practically only the ohmic resistance of the coil. It is obvious, therefore, that with such an arrangement of circuits the local transmitting current will have no effect whatever on the local receiver.

For the signals to be received the conditions are different. Let the current generated at the distant station be of a different frequency from that of the local transmitter, and let the loop circuit L_1C_1 of the local transmitter be tuned to the frequency of the current of the incoming signal; hence the local transmitting circuit acts like a high-resistance secondary, the cable being the primary in this case, and therefore very little current from the incoming signal is induced in it, and none transmitted through intermediate circuit *II* to the receiving circuit. The current, therefore, of the incoming signal flows along the cable and acts only on the receiving circuit through transformer M_4. We have then a condition where the transmitting current acts on the cable without affecting the local receiver, and the incoming signal acts on the receiving circuit without affecting the transmitting circuit. Having a corresponding system of circuits at the other end of the cable, we can realise the condition which makes it possible to have simultaneous sending and receiving. It remains yet to establish the mathematical relations to show more conclusively that the relations outlined above can be realised in practice.

In Fig. 1, let *I* designate the transmitting circuit, *II* an intermediate circuit linking electromagnetically transmitting and receiving circuits, and *III* the receiving circuit. We shall also designate the constants of the circuits and the currents in them by corresponding subscripts. The terminal impedance of the cable and the current in it to be designated by subscript 0. Assuming a sine E.M.F. impressed in the transmitting circuit, we have for the three circuits *I*, *II* and *III* the following three equations:—

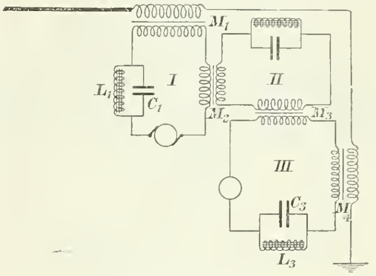

Fig. 1.—Method I. of Duplexing.

$$\left.\begin{aligned} &(a) \quad Z_1I_1+M_1j\omega_1I_0+M_2j\omega_1I_2=E \\ &(b) \quad Z_2I_2+M_2j\omega_1I_1+M_3j\omega_1I_3=0 \\ &(c) \quad Z_3I_3+M_3j\omega_1I_2+M_4j\omega_1I_0=0 \end{aligned}\right\} \quad . \quad . \quad . \quad (1)$$

For the cable itself we have the following equation,

$$Z_0I_0+V_0+M_1j\omega_1I_1+M_4j\omega_2I_3=0 \quad . \quad . \quad (2)$$

where V_0 is the voltage of the cable at the point above the terminal impedance. It can be readily shown, however, that the relation between voltage and current at the terminal of the cable is given by the equation,

$$V_0=\frac{R}{m}I_0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where $m=(1+j)\sqrt{\frac{RC\omega}{2}}$, and R and C are the resistance and capacity of the cable per unit length. Substituting the value of V_0 from (3) into equation (2) we get

$$\left(Z_0+\frac{R}{m}\right)I_0+M_1j\omega_1I_1+M_4j\omega_3I_3=0. \quad . \quad . \quad . \quad (4)$$

Equations (1) and (1) give us four equations from which the values of the currents in the four circuits can be readily determined. For our purpose, however, it will suffice to determine only the values of I_0 and I_3—that is, ascertain the effect of the current in the transmitting circuit in regard to the cable and the receiving circuit.

Eliminating I_1 from (1a) and (1b), and from (1$_b$) and (4), there results in conjunction with equation (1c) the following three equations:—

$$\left.\begin{aligned} &M_1M_2\omega_1^2I_0+(M_2^2\omega_1^2+Z_1Z_2)I_2+Z_1M_3j\omega_1I_3=-EM_2j\omega_1,\\ &M_2j\omega_1\left(Z_0+\frac{R}{m}\right)I_0-Z_2M_1j\omega_1I_2-(M_1M_3\omega_1^2\\ &\qquad\qquad\qquad\qquad -M_2M_4\omega_1^2)I_3=0,\\ &M_4j\omega_1I_0+M_3j\omega_1I_2+Z_3I_3=0. \end{aligned}\right\} \quad (5)$$

Eliminating I_2 from the above equations we obtain two equations in I_0 and I_3 as follows:—

$$\left.\begin{aligned} AI_0+BI_3&=-EZ_2M_1M_2\omega_1^2\\ -DI_0+FI_3&=0 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where

$$\left.\begin{aligned} A&=Z_2M_1^2M_2j\omega_1^3-M_2j\omega_1\left(Z_0+\frac{R}{m}\right)(M_2^2\omega_1^2+Z_1Z_2)\\ B&=-Z_1Z_2M_1M_3\omega_1^2+(M_2^2\omega_1^2+Z_1Z_2)(M_1M_3\omega_1^2\\ &\qquad\qquad -M_2M_4\omega_1^2),\\ D&=M_2M_3\omega_1^2\left(Z_0+\frac{R}{m}\right)+Z_2M_1M_4\omega_1^2\\ F&=M_3j\omega_1(M_1M_3\omega_1^2-M_2M_4\omega_1^2)+Z_2Z_3M_1j\omega_1 \end{aligned}\right\} \quad . \quad . \quad (7)$$

Introducing the value of I_0 from the second equation of (6) into the first equation we get

$$\left(\frac{AF}{D}+B\right)I_3=-EZ_2M_1M_2\omega_1^2. \quad . \quad . \quad . \quad . \quad . \quad (8)$$

or

$$I_3=\frac{-EZ_2M_1M_2\omega_1^2D}{AF+BD} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Now suppose we arrange the constants so that

$$\left.\begin{aligned} M_1&=M_2\\ M_3&=-M_1 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

That is, the secondaries of the transformers M_3 and M_4 are so connected as to induce E.M.F.s of opposite phase in the receiving circuit. Also adjust the values of the constants of the terminal impedance of cable and impedance of the intermediate circuit II as to satisfy the relation

$$Z_2=Z_0+\frac{R}{m},$$

or

$$L_2j\omega_1+R_2=L_0j\omega_1+R_0+\frac{R}{(1-j)\sqrt{\frac{RC\omega_1}{2}}}$$

$$=L_0j\omega_1+R_0+(1+j)\sqrt{\frac{R}{2C\omega_1}}.$$

Equating reals and imaginaries separately we get

$$\left.\begin{aligned} L_2\omega_1&=L_0\omega_1+\sqrt{\frac{R}{2C\omega_1}}\\ R_2&=R_0+\sqrt{\frac{R}{2C\omega_1}} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Substituting the values from (10) and (11) into equations (7) we get

$$\left.\begin{aligned} A&=Z_1M_1j\omega_1(2M_1^2\omega_1^2+Z_1Z_2)\\ B&=M_1M_4\omega_1^2(2M_1^2\omega_1^2+Z_1Z_2)\\ D&=0\\ F&=M_1j\omega_1(2M_1^2\omega_1^2+Z_2Z_3) \end{aligned}\right\} \quad . \quad . \quad . \quad (12)$$

Inasmuch as $D=0$, the value of I_3, the current in the receiving circuit as given by equation (9), is also zero, the condition desired—that is, the current of transmitter does not affect the receiving circuit.

And to ensure against possible disturbances which may be due to lack of perfect balance, or to vary the transformer adjustments so as to the balance desired, the constants given by equations (11), a loop circuit is introduced in the receiving circuit which is adjusted to be in resonance for the frequency of the current of the local transmitter. If we denote by L_3, C_3, R_3 the inductance, capacity and resistance of the loop circuit, the impedance of the circuit is given by the formula

$$Z=\frac{L_3j\omega_1+R_3}{(1-L_3C_3\omega_1^2)+jR_3C_3\omega_1}$$

$$=\frac{R_3}{(1-L_3C_3\omega_1^2)^2+R_3^2C_3^2\omega_1^2}+j\frac{L_3\omega_1-L_3^2C_3\omega_1^3-R_3^2C_3\omega_1}{(1-L_3C_3\omega_1^2)^2+R_3^2C_3^2\omega_1^2} \quad (13)$$

For resonance condition, $1-L_3C_3\omega_3^2=0$, we have

$$Z=\frac{1}{R_3C_3^2\omega_1^2}+\frac{1}{jC_3\omega_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

The effective resistance then of the loop circuit for the angular velocity ω_1 is

$$R_{\text{eff.}}=\frac{1}{R_3C_3^2\omega_1^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

It is a function of the capacity and frequency as well as the actual ohmic resistance, and it may be made very large by making the capacity small.

As an illustration, consider the following constants—

$R_3=50$ ohms, $C_3=10$ mf., $\omega_1=2\pi\times10$

$$R_{\text{eff.}}=\frac{1}{50\times10^{-10}\times4\pi^2\times100}=50{,}000\text{ ohms approx.}$$

Any residual current in the receiving circuit due to lack of perfect balance will be completely wiped out by the high resistance of the loop circuit. For successful operation extreme accuracy in tuning is required, and also the resistance of the inductance coil should be as low as possible.

For the current in the cable we have by equation (6), since $I_3=0$,

$$I_0=\frac{-EZ_2M_1M_2\omega_1^2}{A},$$

$$I_0=\frac{EM_1j\omega_1}{2M_1^2\omega_1^2+Z_1Z_2}. \quad . \quad . \quad . \quad . \quad . \quad (16)$$

To determine the effect of the current of the incoming signal on the receiver it is necessary only to establish the relation between I_0, the current in the cable due to the incoming signal, and the corresponding value of I_3, the current in the receiver. Assuming that the frequency of the current of the incoming signal is $n_2=\omega_2/2\pi$, we have for the three circuits, I, II and III, the following three equations:—

$$\left.\begin{aligned} Z_1I_1+M_2j\omega_2I_2+M_1j\omega_2I_0&=0\\ Z_2I_2+M_1j\omega_2I_1+M_3j\omega_2I_3&=0\\ Z_3I_3+M_2j\omega_2I_2+M_4j\omega_2I_0&=0 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (17)$$

Eliminating I_1 and I_2 from the above three equations, we get a resultant equation giving the relation between I_3 and I_0 as follows:—

$$I_3=\frac{M_4j\omega_2(2M_1^2\omega_2^2+Z_1Z_2)}{Z_1M_3^2\omega_2^2+Z_3(M_1^2\omega_2^2+Z_1Z_2)}I_0. \quad . \quad . \quad . \quad (18)$$

If we introduce a loop circuit in the transmitting circuit which is tuned to the frequency n_2, the impedance of the circuit for that frequency will be very large, and we may accordingly neglect $M_1^2\omega_2^2$ in equation (18) as compared with Z_1Z_2, which simplifies the equation to the following:—

$$I_3=\frac{M_4j\omega_2Z_2}{M_3^2\omega_2^2+Z_2Z_3}I_0. \quad . \quad . \quad . \quad . \quad . \quad (19)$$

We may also, if desired, introduce a loop circuit tuned to the frequency n_2 in the intermediate circuit II, which will make also Z_2 large, and equation (19) will reduce to

$$I_3=\frac{M_4j\omega_2}{Z_3}I_0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

By tuning the receiving circuit as a whole to the frequency n_2, its impedance will be simply the resistance R_3, and we get

$$I_3=\frac{M_4j\omega_2}{R_3}I_0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

It is evident now from the foregoing that the local transmitting current does not affect the receiver, while the current of the incoming signal acts only on the receiving circuits, and none or only very little of its energy is absorbed in the other circuits.

There remains yet to investigate the effect of any possible transient phenomena that may be developed in the system of circuits. It will be recalled that in the Squier system an unbroken alternating current is used, and signalling is accomplished by varying the amplitudes of various half-cycles through a change in the impedance which always takes place at the instants when the current flowing in the circuit has zero value. Now let us suppose that we have a current flowing in a circuit of inductance, capacity and resistance (L, C, R), and a sudden change in circuit conditions is effected which introduces a transient current in the circuit. If we denote by I_v and V_v the transient current and the corresponding condenser voltage, it can be shown that the expressions for I_v and V_v are as follows:—

$$\left.\begin{aligned} I_v&=\varepsilon^{-\alpha t}\{A\cos\beta t+B\sin\beta t\},\\ V_v&=\frac{\varepsilon^{-\alpha t}}{C\sqrt{\alpha^2+\beta^2}}\{A\sin(\beta t-\varphi)-B\cos(\beta t-\varphi)\}\end{aligned}\right\}, \quad (22)$$

where

$$\alpha=\frac{R}{2L}\cdot\beta=\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$$

$$\tan\varphi=\alpha/\beta$$

Now let the steady values of the currents and the corresponding condenser voltages before and after the change be denoted by I_{1s}, I_{2s}, V_{1s} and V_{2s}. We have then

$$\left.\begin{aligned} I_{1s}&=\frac{E}{Z_1}\sin\omega t,\\ I_{2s}&=\frac{E}{Z_2}\sin\omega t,\\ V_{1s}&=\frac{-E}{C\omega Z_1}\cos\omega t,\\ V_{2s}&=\frac{-E}{C\omega Z_2}\cos\omega t.\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (23)$$

Now at the instant when the change occurs we must have

$$\left.\begin{aligned} I_{1s}&=I_{2s}+I_v.\\ V_{1s}&=V_{2s}+V_v.\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

Since the change always takes place at the time when the value of the steady current is zero, we have $I_{1s}=I_{2s}=0$, and, therefore, the value of I_v at $t=0$ is also zero; hence $A=0$. From the second equation of (24) we get at $t=0$:

$$\frac{E}{C\omega Z_1}=\frac{E}{C\omega Z_2}+\frac{B\cos\varphi}{C\sqrt{\alpha^2+\beta^2}},$$

or

$$\Delta I=\frac{\omega B\beta}{(\alpha^2+\beta^2)}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

Neglecting α^2, being small as compared with β^2, we have

$$B=\frac{\beta}{\omega}\Delta I, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

where ΔI represents the difference in current intensities before and after the change of circuit impedance. Substituting the value of B from (26) into (22) we obtain the value of the transient current—

$$I_v=\frac{\beta}{\omega}\Delta I\varepsilon^{-\alpha t}\sin\beta t. \quad . \quad . \quad . \quad . \quad . \quad (27)$$

We have then in addition to the steady alternating current, a free oscillatory current of frequency $\beta/2\pi$. Now, it is seen from equation (11) that the balancing of the receiver in regard to the effect of the local transmitter is a function of the frequency, and we may expect therefore if β differs from ω_1 a lack of perfect balance for the transient current, though the effect would be very small if $L_0\omega_1$ is large compared with $\sqrt{(R/2C\omega_1)}$. To guard, however, against any disturbance in the receiver arising from the above cause, we may do one of two things: either adjust the constants so that the free period of the system as a whole is exactly the same as the period of the impressed E.M.F., or we may introduce an additional loop circuit into the receiving circuit, and adjust it to be in resonance for the frequency of the free oscillatory current, thus wiping out any residual effects due to lack of perfect balance for the transient current.

METHOD II.

Another method for duplexing without the use of an artificial cable is shown schematically in Fig. 2. In this arrangement of circuits the current from transmitter divides at the branch point a, flowing in opposite directions through primaries of transformers M_1 and M_2, thus inducing E.M.F.s of opposite phase in the secondary which is the receiving circuit. As in the previous method, to guard against any disturbance in receiver due to possible lack of perfect-balance, a loop circuit (L_3C_3) is introduced into the receiving circuit, which is tuned to the frequency of the current of the local transmitter. The function of the loop circuit has been discussed before. For the incoming signal, on the other hand, the current flows in the same direction through the primaries of both transformers M_1 and M_2, inducing E.M.F.s of the same phase in the receiving circuit. It is also assumed that the frequencies of the currents of the outgoing and incoming signals are different, so the loop circuit (L_3C_3) does not offer any great impedance to the current of the incoming signal. Having a corresponding system of circuits at the other end of the cable, simultaneous sending and receiving can be readily accomplished. It remains yet to show the mathematical relations between the electrical constants for the condition of perfect balance.

Let Z_0 denote the impedance of the transmitting circuit, Z_1 and Z_2 the impedances of the primaries of the transformers M_1 and M_2 and Z_3 the total impedance of receiving circuit. We shall also designate by the corresponding subscripts the currents in the different circuits. We have then the following three equations:—

$$\left.\begin{aligned} Z_0I_0+Z_1I_1+V_1+M_1j\omega I_3&=E\\ Z_0I_0+Z_2I_2+M_2j\omega I_3&=E\\ Z_3I_3+M_1j\omega I_1+M_2j\omega I_2&=0\end{aligned}\right\}, \quad . \quad . \quad . \quad (28)$$

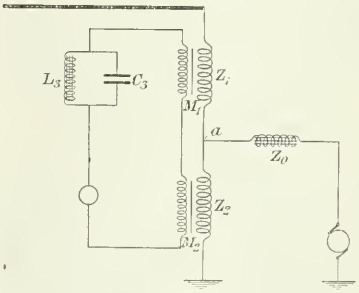

FIG. 2.—METHOD II. OF DUPLEXING.

where V_1 and I_1 is the potential and current at the terminal of the cable. The relation between V_1 and I_1 is given by equation (3)—

$$V_1=\frac{R}{m}I_1=(1-j)\sqrt{\frac{R}{2C\omega}}I_1,$$

where R and C is the resistance and capacity per unit length of cable.

We also have the relation,

$$I_0=I_1+I_2.$$

Substituting the above in equations (28) and rearranging, we get

$$\left.\begin{aligned} \left(Z_0+Z_1+\frac{R}{m}\right)I_1+Z_0I_2+M_1j\omega I_3&=E,\\ Z_0I_1+(Z_0+Z_2)I_2+M_2j\omega I_3&=E,\\ M_1j\omega I_1+M_2j\omega I_2+Z_3I_3&=0.\end{aligned}\right\} \quad . \quad (29)$$

Eliminating I_1 and I_2 from the above equations we get an expression for the value I_3, the current in the receiving circuit, as follows:—

$$I_3=\frac{E\{D(Z_1+R/m)+AM_1j\omega\}}{AF-BD}, \quad . \quad . \quad . \quad . \quad . \quad (30)$$

where

$$\left.\begin{aligned} A&=Z_0^2-(Z_0+Z_2)\left(Z_0+Z_1+\frac{R}{m}\right),\\ B&=Z_0M_1j\omega-M_2j\omega\left(Z_0+Z_1+\frac{R}{m}\right),\\ D&=M_1j\omega(Z_0+Z_2)-Z_0M_2j\omega,\\ F&=-M_1M_2\omega^2-Z_0Z_3.\end{aligned}\right\} \quad . \quad . \quad (31)$$

It is obvious that to make $I_3=0$, the condition for perfect balance, the numerator in the right-hand member of equation (30) must be zero; we must have—

$$D\left(Z_1+\frac{R}{m}\right)+AM_1j\omega=0.$$

Substituting the values of D and A from (31), we get—

$$Z_2M_1j\omega+M_2j\omega\left(Z_1+\frac{R}{m}\right)=0.$$

Since M_1 and M_2 are of opposite sign in their effect on the receiving circuit, we have—

$$\frac{M_1}{M_2}=\frac{Z_1+\frac{R}{m}}{Z_2}, \quad . \; . \; . \; . \; . \; . \; . \; . \quad (32)$$

or

$$\frac{M_1}{M_2}(L_2j\omega-R_2)=L_1j\omega+R_1+(1-j)\sqrt{\frac{R}{2C\omega}}.$$

For the condition of perfect balance in regard to amplitude and phase, we must have the reals and imaginaries in the above equation separately equal to each other. The condition for perfect balance then is given by the following equations—

$$\left.\begin{aligned}\frac{M_1}{M_2}L_2\omega&=L_1\omega-\sqrt{\frac{R}{2C\omega}},\\ \frac{M_1}{M_2}R_2&=R_1+\sqrt{\frac{R}{2C\omega}}.\end{aligned}\right\} \quad . \; . \; . \; . \quad (33)$$

The discussion given before in connection with Method 1. will also apply to the above method.

In conclusion, the writer wishes to express his thanks to Col. G. O. Squier for his valuable and helpful suggestions.

SCIENCE AND INDUSTRY.*

BY J. SWINBURNE, F.R.S.

A lecturer on this subject is expected to discuss the dependence of industry on mathematics, physics, chemistry, bacteriology, botany, and to a less extent a few other branches of science, such as biology, geology, and astronomy; and he is expected to show how the universities can help the industries of this country in two directions. The first is training men in the different branches of science, so that they can go into industrial work and be of the greatest value; the second is helping manufacturers directly by the advice of university professors and by carrying out technical research at college laboratories.

Coal mining involves some geological knowledge. Burning coal to get heat is applied chemistry. It is generally misapplied chemistry, because furnaces are usually not designed to give the mixed heated gases time to finish their reactions before the heat is taken from them. But much more important than this, in burning raw coal we are wasting products which are daily becoming more valuable. The ordinary house fire, for example, is a barbarous apology for a heating device. Navigation depends on astronomy; metallurgy is a branch of applied chemistry; the design of good steam, gas and oil engines demands a competent knowledge of applied thermodynamics. All machinery embodies applied mechanics. In many cases, such as metallurgy, mechanics, the steam engine and the sailing ship, the practice preceded the science; but in most modern developments, as for instance, electrical engineering and fine chemicals, the industry has followed the science, helping in its turn, so that they continue to develop together.

Many branches of industry are the direct application of scientific knowledge or discoveries made without any idea of its practical value. The foundation principle of wireless telegraphy is a good example of this. A few students of Routh's rigid dynamics would have thought of making a gyrostat serve as a compass. Problems of capillarity seemed to have only academic interest, yet Elmore's process for the separation of copper ore and its various modifications [illegible] hundreds of thousands to those concerned [illegible] differences of surface tension. [illegible] the country has its technologist or applied [illegible] understood by those in charge [illegible] of the country.

It [illegible], or even a branch of [illegible] education. I do not understand [illegible] meant to do. It [illegible], without any ulterior advantage. To my non-expert mind, education ought to have four main objects. First, to enable one to earn his living, because if he cannot make his living nothing else is much use. Second, to let one know enough about his health to secure it. It is no use making a living or anything else if, owing to your own ignorance, your health is wrecked and you are prematurely buried. Third, to make one a good citizen. Fourth, to enable one to enjoy his well-earned leisure properly. These principles appear to be wrong, for they do not in the least fit education as commonly inflicted.

All the same, I will assume that under the first head there is a question of university teaching of science, with the object of its connection with industry. The main question is, then, How can universities best fit students to make their living by science in industry? To make the discussion complete, we ought also to discuss the question, How can business men make the best use of universities and of the men trained by them? This last question need not be discussed here, except in so far as the attitude of business men must react on universities attempting to work in conjunction with them.

In discussing its relation to industry, we must understand what we mean by science. Mathematics is the science of quantities and their relations. There are pure and applied mathematics. Pure mathematics is a study by itself. Kelvin called it the quintessence of common sense. The pure mathematician has one part of his brain very highly trained in one direction, and he has a remarkable mental acquirement and a special kind of knowledge and ability; but in a sense he is of no use, and pure mathematics is of no use. Mathematics may be applied to solve problems in astronomy, physics, mechanics, chemistry and statistics. To one devoted to pure mathematics this is a kind of debasement of his subject, and he is apt to look down upon people who use mathematics for such low purposes. The pure mathematician works strenuously, extending the bounds of his subject, and develops a new theorem or invents a new calculus. The astronomer or the physicist follows his work, and utilises his advances to attack his own problems by applying them. We thus have pure mathematics and applied mathematics. Sometimes the same man—Newton, for example—makes advances in both pure and applied mathematics.

In science generally we have the same distinction. Science itself is a complicated fabric of organised knowledge of Nature. The man of science devotes his life to extend this fabric of knowledge in new directions, and perhaps even more to elucidating the relations of the various elements, the object being to make the wonderful fabric complete in all its parts; with their interdependence, as far as it can be, clear to the limits of the mind. In a sense this is of no use; but surely it is the noblest exercise of the human intellect. This is called pure, as opposed to applied, science, because it has no direct ulterior purpose. The term is bad, as pure and applied are not opposed, and all kinds of science are quite pure. Theoretical has been proposed; but in the popular mind theoretical is opposed to practical, while to the technologist nothing is practical unless it is theoretically right. I will, therefore, use the word academic to specify science pursued as an end in itself, without any regard to any external or ulterior use, the object of the pursuit being the attainment of knowledge and the development of the intellect. The word also fits as this kind of science is developed mainly by teachers.

Nearly all great advance in academic science is, and has been, made by professors in universities and colleges and their assistants—or in short by teachers. It might be supposed that a body undertaking the education of young men would choose the man best able to explain matters to students. This is not the practice, however. A university gets the most eminent scientific man available, or chooses a young man who promises to become eminent. He is given every assistance to make himself as famous as possible as a scientific discoverer; and apparently scientific distinction is his sole aim, the education of the students being of no account. This curious arrangement seems to work splendidly. It secures men of great ability, and they do good work, which would hardly be done otherwise at all; and instead of the students being neglected, they get fired with their leader's enthusiasm, and become assistants and co-workers, and eventually carry on the great work themselves.

We have thus academic science; we also have utilised science or technology. The technologist, as such, is not interested in the fabric of organised Nature knowledge, or academic science. He takes bits of the knowledge and uses them in manufacture. Sometimes the technologist is first, and his work is fitted into its place in academic science afterwards. Academic science generally develops it, so that the technologist is helped further forward. The technologist generally studies the branches of science which concern him till he knows more about them than those who have the more balanced knowledge of academic science. But this is not all: he has to look at matters from a different standpoint. He has always to consider prices and costs. He has to make his works pay. An engineer is one who makes for one dollar what any fool can make for two. This obviously American definition, of course, covers the chemical manufacturer, and, in fact, every other manufacturer.

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* Lecture delivered at [illegible] (University of London) on [illegible] 8th, [illegible] which will be published by the [illegible].

Academic science thus does not cover technology. The knowledge is not there in the right form, and it is not in the right proportion, and it is entirely independent of all questions of cost, which are fundamental in technology. Here we have the great difficulty. The science teacher and the general public confuse academic science and technology, and think that the science taught at school or at the university is what is wanted in industry. This is a serious mistake. The teacher especially is apt to assume that academic science includes technology. It has been suggested that Faraday could have made a fortune by devoting his abilities to industry. He was about as well fitted for success on the turf. It is often said that this or that eminent professor could have made untold wealth if he had stooped so low, but he preferred to labour for a higher object. Of course, this is all nonsense; all men work in competition for the approval of their fellow creatures. Some like to earn it by advertisement and other easy methods; but the student of science is satisfied to earn it only by intellectual effort, but all the same that is his real motive. The case of Cavendish is difficult to understand; but, speaking broadly, fame is the reward sought by the man of science, though he does not say so as naively as the poet.

The idea that academic science includes technology does harm in several ways. It prevents the science teacher understanding technology or realising what the manufacturer wants. It leads to his looking down on manufacturers as ignorant people, because they have not his particular kind of knowledge. The standpoint that academic science is all important and technology something outside it and quite inferior is, as far as I understand the position in France, the French Academy view. The standpoint that academic science includes technology, or renders any special knowledge of technology unnecessary, is the Royal Society point of view. A few technologists are fellows of the Royal Society, but it is essentially a non-technical society, and much harm is done by its being put forward to deal with technical or industrial matters. There are technologists among the fellows, but the society is essentially untechnical. There are good technical men at the Bar; but it would be absurd for the Government to apply to the Bar Council for scientific advice. It is not true that industry is unscientific either in France or in England; but it will be much better when they get rid of the Academy attitude over there and we get beyond the Royal Society view.

The question is, What ought universities to do? The obvious answer is that they should drop academic science and cultivate only technology. When a course seems quite obvious, and is not at once followed by competent people, it is generally wrong. If we dropped academic science we would drop technology, too, and lose all. Academic science depends almost entirely on universities, and great technological advance is possible only in conjunction with academic progress. In fact, it is like happiness: you can only get it by striving for something else. The universities of the country cultivate virtue in the form of academic science, and the country gets happiness in the form of industrial success. But while cultivating virtue it is foolish to despise any happiness that may come along as an indirect result.

The spirit of academic science does not necessarily render a man less useful as a technologist. Quite the reverse. As long as it does not lead him to look down on technology, or to think he knows all about it without any special study, it helps him.

Whether it is possible to teach technology satisfactorily in college courses is an open question. A professor of academic science can be in the van of his subject, as he is himself taking part in it. A professor of any branch of technology must be behind his subject, as he has to learn from what is going on in works, which in many cases are not open to him at all. No commercial works wants college professors loose in them, attempting to keep up to date in practical matters. All he could hope to teach satisfactorily would be such matter as can be found in text-books, the text-books being written generally by other teachers, not by practical technologists.

The education of technologists, and especially of engineers, has been discussed from many points of view, and anything I could say would be a personal opinion and therefore of little value unless I gave reasons which made it something more. I hold that the training at the university should be on thoroughly academic lines, because those are the lines on which the teachers are able to go far and well; and the whole of a student's available time is not too long to be devoted to a good groundwork of systematic coherent knowledge on which he can raise any desired superstructure of technology. The point I would insist on again is that he must not confuse the foundation with the superstructure. Though I am advocating the development of academic and not practical science at universities, I am not putting forward another argument, and that is the greater educational value of academic science. That is outside my subject, and I might be told I am not an expert on education. I do not know whether I am or not, as I do not know what an educationalist is, or what the symptoms are. Many think that professors and schoolmasters are experts in education. You might as well say that a shunting engine is an expert in locomotion. It goes back and forwards along the lines for which it is designed. Those who take interest in the community want to get the locomotives off the old lines on to tracks suitable for the times, and such changes can be made by outside influence only against the bitterest conservatism. That education always side tracks into useless absurdity is not due to any inherent wickedness of schoolmasters; it is the result of a kind of evolution, and is unavoidable.

Imagine, for instance, a school absolutely practical and sensible and perfectly in touch with real life. When a set of students grew old enough to leave, the most practical would go into outside life, and a small selection would go into the teaching profession. This selection would not be deficient in ability, but it would be made up of the less practical, and more pedagogical men. In their generation as teachers the school would thus be a little more out of touch with life than before, and the next generation of masters would be the least practical of a batch of students themselves less practical as a whole; and the school would in due course get more and more senseless until it got down to the ordinary state. Educational institutions thus always contain the growing germs of their own ruin, and do so unavoidably. The teacher's position on a pedestal, his contact with the immature mind only, and his immunity from contradiction tend to foster the rapid growth of the germ. Outside influence ought to affect education, but has no power over it. Parents might control it by sending their sons where it is good, and not where it is bad; but they do not care. A father will say: "Tom's education? Oh, yes. My father was at Rugbarrow and the 'Varsity, and so was I, so, of course, Tom goes, too. I had the ordinary education of a gentleman, and I am all right. There's nothing like the regular English public school and 'Varsity education." Closing the matter with this fact, he reconcentrates his attention on the study of "How to Train a Sporting Dog."

Universities do now train men to earn their living by practice in law, and more especially in medicine and surgery. How far our training is good I do not know. A medical man must go through either this course or one of the same kind before he is allowed to practise, so there is nothing to compare it with, to see if it is good. If it is, universities have solved the problem of giving a technical, as opposed to a purely academic course, but this needs the connection with hospitals. Nothing analogous is available in industry. If industrial concerns which are ill financially turned themselves over to the treatment of university professors and students they might come to make big profits, but there is some doubt about it.

Imitations of engineering and chemical workshops have always the drawback that they are only imitations. The elements of time and price do not come in, and they are vital.

Technical schools, unlike universities, have the definite object of training students to make their livings in industry; and they make their course as practical and as little academic as possible. A technical school is sometimes connected with a university; and we cannot in any case consider university training for industry without taking technical colleges into account. It must be admitted that if the best type of science training, even for industrial use, is the academic, the technical colleges are on wrong lines, and as technical colleges are doing splendid work, the idea put forward appears to be wrong. But it is not urged that the academic training is the best in every way; but that on the whole, it is best because, first, the professors are able to effect it best; second, because a student has so little time to spare that it can best be laid out in acquiring a good, sound foundation; thirdly, a well trained mind with the academic can easily acquire the technical outlook, too; and, fourth, because academic science trains the mind to reason rather than to memorise and deals with the facts of nature instead of the ideas or doings of other men just as foolish and illogical as ourselves. More than this, if the universities converted themselves into technical colleges, academic science and with it technology would get moribund. Whether technical colleges are on the best lines is another question. They may be badly designed for training the best class of technologist, while well suited for doing the best for men who have little time, and must be content with an inferior general foundation, and a superstructure which is to a great extent imitation technology.

Recently we have heard a great deal about universities helping in scientific research. Research in academic science has little to do with national industry. All such research is published, and technologists all over the world utilise the results wherever the research is carried on. Research in academic science has no direct effect on national industry; but it has a great influence in rousing scientific enthusiasm, which is most important. But the outcry for scientific research for the benefit of industry is made chiefly by people who have no clear idea of the difference between academic and technical research; or of their circumstances. It is largely due to science teachers backed up by newspaper writers. The idea behind it is that manufacturers are ignorant and unscientific, and science teachers could put them right if allowed the chance. For example, we are told repeatedly that we are wasting coal, first, by burning it in badly-designed furnaces; secondly, by refusing to extract the valuable hydrocarbons and ammonia; and that it will soon be used up at present rates, and England will be ruined. As to the last point: Coal that costs a consumer 10s. a ton is worth only a few pence in the ground to the owner. The rest of the cost is labour, carriage, interest on capital, profits, and so on. The present value of money at industrial interest a hundred years hence is about a hundredth, so that unless coal in the ground is going to be more than 100 times as valuable a century hence it pays better to sell now. If coal is worth 6d. a ton in the ground now, it pays the country better to use it at once than to wait for a century if it will then rise to 50s. But carriage from elsewhere will always keep it below any such fancy figure as £2. 10s. a ton in the ground. Take the question of extracting the hydrocarbons and ammonia. It is ridiculous for science masters to tell technologists to extract valuable constituents. They are quite aware of the waste that goes on, and know that it will be reduced in the future. The technologists know infinitely more about coal distillation than the science masters, and they know what can be done commercially now and what cannot. If the science masters made some discoveries that could be utilised, well and good; but to tell technologists that they are extravagant and ignorant is quite useless.

Can industrial research be carried on in teaching laboratories? During the war excellent work has been done, more especially in connection with such matters as dyes, drugs and glass. In these cases we were merely taking substances that had already been made, and finding out how to make them. Finding out how to produce an existing dye is little in comparison with inventing the dye. The inventor did not know beforehand that there was any possibility of such a dye. After the war a number of undergraduates might be set to experiment on organic substances in the hope they might hit on something new and valuable. Such work would have no educational value, and its commercial result would be small. If one of them produced a new dye that got more brilliant the more it was sunned, who would own the patent?

The vague idea seems to be that manufacturers have a number of definite problems they want solved; but they are too ignorant to solve them. They ought, therefore, to seek the advice of the universities, who would put them right. Manufacturers have no such problems. If you went to a cotton mill, and asked the manager what problem he wanted to have solved, he might say "You had better look round and see for yourself"; or he might say something really quite different. If you went round you would find everything just so. No doubt every part is really capable of improvement, but no improvement suggests itself. Half or more of the merit of an invention is realising that an improvement is wanted in any particular machine or process. One of the greatest difficulties the inventor has is to discover the "long felt want."

Take the question of recovery of hydrocarbons and ammonia from coal; students may carbonise coal in bits of gas barrel. This will not give much information as to the habits of a full-sized gas retort; but it may give some. Then they may distil tar, and fractionate the distillates and investigate them; but everything will be on a small scale except the mess. It is not the least likely undergraduates would find out anything in this way, and teach it to manufacturers; and they would be merely wasting time and learning practically nothing. They might work under a professor; but it is a mistake to suppose every professor of organic chemistry knows the technical problems of tar distilling. Much of the chemistry is very special, and [illegible] uninteresting; but if the professor is going to master not only the general chemistry but the commercial values of all the oils, and the practical nature of all the processes, he will have to give up [illegible] to get time to fill himself up with [illegible] technology.

But even if research on tar distillation, for example, could be carried out satisfactorily in an educational laboratory, it could not be carried on in connection with an industrial distiller, because he would not share it with his competitors unless he was to have a monopoly of the result. If the work is for publication, the tar distiller would not be the least interested, as it concerns his rivals here and abroad as much as him; so he will give neither encouragement nor help. Results which are to be the common property of all, British or foreign, do not appeal to the individual manufacturer.

There is also a confusion between research and invention. It is not the least use forming a research group, and [illegible] of all a committee on to invent. A committee of science professors would be as likely to make an invention as a council of professors of literature to fabricate a lyric. Industrial progress depends on invention, and we are the most inventive people in the world; not because we are the cleverest, but because we are the most individualistic, and the least benumbed by education. Working out dyes, scents and drugs is hardly invention; it is a rather lower type of chemical drudgery, which is above routine analysis, but much below original academic research. The better women chemists might tackle it. Inventions may be divided into two classes—improvements in machines or processes which can be made only by those in close touch with them inside the works; and broad inventions, which are generally made by complete outsiders whose minds are not in conventional grooves. In neither case can the university help.

Nothing is said about the shortcomings of the manufacturer, because I am not addressing him. He will not employ scientifically trained men, and he will not think very much of science generally until he finds that the technically-trained men come to the front. Politicians, journalists, novelists, prelates and other superior people tell them they are going to the dogs. They make no reply, except such as can be gathered from the trade returns of the country. But the talking fraternity do not read trade returns. English manufacturers are, I maintain, the most competent of all. Eventually they may be better and they may employ science more; but to get them to do so science must adapt itself to industrial application.

I remember our chairman putting it that a man finds himself surrounded by a jungle of ignorance. He has not power or time to make roads in all directions with cross roads, alleys and paths everywhere, so as to be acquainted with all the trees in the forest, and still less could he keep the ways all clear, as this means constant use of all of them. The best course is to make a few good roads in main directions, and to keep these in repair. He has then only a short path to make to get to any point. Thus, he ought to have a clear idea of the kinetic theory of gases, that is a very useful main road; the theory of the benzene ring; the principle of chemical action often going so that water is formed; the second law of thermodynamics; the conservation of energy; and the principles of mathematics, to mention a few main roads. Put in other words, this means that the technologist should have a thorough grounding in academic science, technology being added afterwards, and the university will have quite enough to do in supplying the groundwork as it ought to be.

Returning to the contention that education should have four chief aims: First, to enable one to earn his living; second, to enable him to live in good health; third, to make him a good citizen; and, fourth, to fit him to enjoy leisure when he has earned it. I would like to touch on a branch of the third.

Industry does not by any means depend alone on the types of science we have discussed. As a whole, it may be helped by the members of the community knowing something of economics, and acting on their knowledge; and it can be obstructed very effectively by the well-intentioned interference of those who know nothing of economics.

I have not been asked to give this lecture as an economist, so, even if I were an expert on the subject it would be unjustifiable for me to put forward conclusions based on political economy. It is, however, within my limits to say something, not as an expert, but as a student of economics, about the national importance of the subject.

Economics is a curious science. Though it is broadly about wealth, it does not help the individual to become wealthy. To an engineer the skilful application of the knowledge of the various physical sciences, means success in manufacture which is good for him, and being good for him is good for the country. But a study of economics will not help him directly in his business at all; it is useful to him only as helping to make him a sensible citizen. He becomes a unit of sound opinion on labour problems, and on the action of Government in connection with industry. Unless, therefore, a man has the peculiar bent of mind which makes such a subject interesting in itself, he has no motive to lead him to read economics, until he recognises it as a duty he owes to society.

Economics is peculiar in another way. If you ask any so-called educated man something about chemistry or mathematics, and he happens to know nothing of such subjects, he says so. People know when they are totally ignorant in such matters. But a man who is sublimely ignorant of economics is quite unconscious of his blind spot. He will lay down the law on such subjects as the relations of capital and labour, the birth rate, old age pensions, and, especially, international and colonial trade, with a cock certainty, and a wealth of catch words and circumambient balderdash that is almost good enough for a leading article in a daily paper. More than that, he will insist on acting according to his darks, and he is one of the units that determine the acts of the nation.

I will be told that political economy is taught widely at the universities. Something called economics may figure in the timetables and examinations; but it is either not taught at all, or it is not made a live subject. Perhaps, it is put in the wrong group of studies, and taught the wrong kind of student by the wrong kind of professor. I think Bagshot says something of the sort. That it is not taught efficiently is abundantly clear not only by the nonsense talked by what we called educated men on questions involving it, but more especially by the fact that people do not seem to realise that there is any such science. No sensible man would write an article involving a natural science of which he was profoundly ignorant, and if anyone who was not sensible did so, no competent editor would publish his product ; but the high-class magazines the best weekly papers, and, of course, the daily papers, are full of matter based on negative knowledge or nescience of economics. As to politicians, they do not limit their ignorance of science to economics ; they make hay of all sciences and all facts with impartial irresponsibility.

It may be argued that I am putting economics on too high a pedestal ; that economists are always gradually changing their views, and that they are sometimes narrow. Economists do not need me to bolster up their reputation. Every science is progressive. It is possible that if economics were treated properly even abler men might be attracted into it. At present there is little temptation to first-class men to specialise in political economy. The only goal is a university professorship, or the authorship of a treatise which will be read by other professors, or some of them, by a proof reader ; and if I come across a reviewer's copy second-hand, I may cut it.

Not only the industry of the country, but the happiness of our people may depend on economics. At present we have practically the whole of the hand-working classes dissatisfied, and, therefore, unhappy. The social problem is the most important in the world at present. Its solution must depend on economics. Is it not worth while to study economics with such a purpose, instead of trying all sorts of schemes which are economically pernicious ? It may be true that economics has not so far provided any cut-and-dried way out ; but until people realise that the science which ought to shed light on this path exists, and that it ought to be studied and developed, drawing the best intellects to it, there is no hope for any end, or even alleviation of the miseries of civilisation. I would urge that the first step is for the universities to teach economics, in which I include closely related branches of sociology, with the vigour and insight the subject deserves.

After the war, for instance, there will be many internal and international economical questions to settle. Who is going to settle them, and how ?

First, public opinion is being educated. Public opinion is a collection of individual opinions. What we call our opinions are generally unfounded and ignorant prejudices that we wrangle about. When we get interested we hunt up all the arguments that we think will back our opinions up. No one with an opinion examines the matter to see whether his opinion is correct. If anyone has no opinion on hand, he gets one from a newspaper. It is manufactured for him ready made by journalists, novelists, publicists, politicians and everybody but those who know. Later, come committees of all sorts of people whose names are known, but not as economists, and they are supposed to command respect. There will be a sprinkling of business men, because there is a popular delusion that business has to do with economics, and that business men understand economical matters in a peculiarly practical way. In fact, the business man is the most dangerous of all, because he knows no more of the subject than other people ; and he is not only unconscious of his ignorance, but he is, if possible, more certain he knows all about the matter. The opinion of such a body as a chamber of commerce on after-war trade conditions is most dangerous. It will be accepted as authoritative, it will be stated without any alleged reasons, and it will almost certainly be wrong.

Is it going too far to say that the war would never have come if the Germans had any true knowledge of economics ? It is not for me to say. But surely I may say this : The war is either good or bad. If it is a bad thing, a competent general knowledge of economics would have rendered it absurd in the eyes of everybody, and, therefore, impossible.

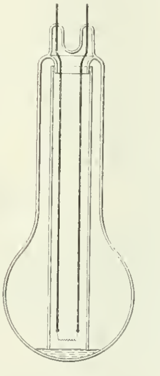
Such a calamity as the war is not broadly somebody else's fault. It is the fault of all of us, but especially the fault of education, of which universities are at the head, in not educating us in such a way that such a catastrophe is out of the question.

Broadly, the great change wanted is in public opinion. Until people consider knowledge of the world we live in and the economical, sociological conditions of our life, as coming first, and the study of the sayings, doings and languages of other men, especially of those that lived when the knowledge of everything except human nature was in its babyhood, as quite secondary, we will no doubt go on with all the miseries of poverty, disease, discontent and war. Those who cannot get their ideas taken up by their contemporaries always think the simplest way is to get the next generation educated so as to adopt them readily. This is hopeless ; education can be improved only by public opinion, and the reactionary tendency already mentioned is so strong that there is no hope of improving public opinion by education, because education has to be improved by public opinion, and it always lags a century or so behind, reacting on and really poisoning the only source of possible regeneration.

A SUPER-EFFICIENCY CARBON-FILAMENT LAMP.

According to the "Electrical World," the Siemens & Halske Co. of Berlin, Germany, has had assigned to it a patent, No. 1,194,643, which discloses a gas-filled carbon-filament lamp with mercury, stated to have a watt-consumption actually less than the metal filament lamps. The inventors are Hans Kreusler, Hans Gerdien and Marcello von Pirani, of Berlin.

It is well known that the metal filaments in lamps operating at extra high temperature are much softer than carbon filaments, so that care has to be taken in arranging the several parts of the metal filament not too closely to each other for obtaining the most favourable effect. If, however, carbon filaments are to be similarly employed they can be so disposed that comparatively large and "concentrated" helices are formed. In addition to this, much shorter or essentially thicker and stronger filaments may be used so that much more freedom is given in the arrangement of the filament as well as in choosing voltages and candle-powers. With carbon filaments it should, therefore, be possible to make lamps for small candle-powers at the ordinary voltages in spite of a comparatively high current load.



The bulb, according to the invention, is preferably filled at the start with an indifferent gas such as nitrogen or argon under a certain pressure, about atmospheric. As soon as the current flows through the incandescent filament, mercury vapour forms in the interior chamber, due to the introduction of mercury together with the gas. The original gas will be pushed entirely or partly away from the interior chamber towards the exterior space of the bulb and the pressure increased. As the pressure on either side of the glass envelope used is the same, the latter may be heated up to a very high temperature without danger of explosion. The outer wall of the bulb will remain relatively cool, and, by reason of this, will be able safely to withstand the comparatively high pressure above atmospheric. The envelope may consist of a tube which at its lower end is closed up by means of mercury and is separated from the remaining part of the bulb.

In this lamp construction, the incandescent body is placed relatively close to the exterior wall of the bulb, but due to the presence of the mercury between the wall of the bulb and the incandescent body the exterior wall can never assume too high a temperature. In the form shown above mercury is placed at the bottom of the bulb and provides a closure at the under part of the envelope between the space of the envelope and that of the glass bulb. In this construction the conductors are prolonged downward for the purpose of having the filament near the surface of the mercury.

BOOKS RECEIVED.

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"Proceedings" of the Institute of Radio Engineers. Edited by A. N. Goldsmith. Vol. IV., No. 5. (New York : Institute of Radio Engineers.) $6.50.

"The Home of To-day." By a Woman Who Keeps One. (London : Chatto & Windus.) Pp. xi. +420. 5s. net.

"Principles of Alternating-current Machinery," by R. R. Lawrence. (London : The Hill Publishing Co.). Pp. xvii.+614. 18s. 9d. net.

"Principles of the Telephone. Part I., Subscriber's Apparatus," by C. M. Jansky, B.S., and D. C. Faber, E.E. (London : The Hill Publishing Co.) Pp. xiii.+160. 6s. 3d. net.

"Telegraphy : A Detailed Exposition of the Telegraph System of the British Post Office," by E. E. Herbert, A.M.Inst.C.E. (London : Whittaker & Co.) Pp. xx.+985. 9s. net. (3rd edition.)

"How to Make Low-pressure Transformers," by Prof. F. E. Austin. (Hanover : F. E. Austin.) Pp. 22. 40 cents. (3rd edition.)

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THE TRANSPORT PROBLEM.

Two books, recently published, deal with a subject which in normal times is important and which, in time of war, is of vital importance. The subject referred to is that of economical and rapid transport. One of the books, by Mr. ROY HORNIMAN, is entitled "How to make the Railways Pay for the War ; or the Transport Problem Solved" ; the other, by Mr. HENRY MURRAY, is entitled "The Railway Swindle." Both books can be recommended to those who are alive to their own interests, as well as to those who have the best interests of their country at heart, and to Government officials, though in regard to Mr. MURRAY's book we prefer to express no opinion on the financial aspects with which he deals ; they are outside our province.

Till we read Mr. HORNIMAN's book we thought that electricity supply stations held the record for low load-factor. Having read the book we feel that an opportunity was lost by the author in not giving the electricity supply station as an example. In such a station, till some 15 years ago at any rate, the bulk of the machinery and the expensive mains were kept standing idle for about 20 hours a day in order to cope with a demand of exceedingly short duration. In the summer months the station was waiting for the winter months. It follows, therefore, that any profit that was made had to be made out of six months' trading ; the trading, even in these six months, being limited to four hours, or thereabouts, per day and to six days per week. In other words, the plant on which the money was invested was only able to earn a dividend for 624 hours per year out of a possible 8,760 hours. The utter hopelessness of attempting to trade under such conditions was early recognised and, as a result, means had to be found for improving the load-factor. But for these means electricity supply would be an expensive hobby to-day.

Absurd as it is to attempt to trade profitably, and without overcharging the customer, by restricting business to three-quarters of an hour per day—and shopkeepers are vigorously protesting against, and are predicting their speedy ruin in consequence of, the recent early closing order which reduces the hours of trading by 10 per cent.—this is in effect what the railway companies claim to be doing. If in the case of railway companies profits are being made then they are being made under the same conditions as those made by some of the electricity supply stations in the early days, namely, by fixing the value of a service rendered at a figure which is out of all proportion to what the cost of rendering such service should be.

At the other end of the load factor scale is the trading company in the enviable position of being able to turn over its entire capital every week. In such a case, if we take the gross profits at the very low figure of 10 per cent., it will be seen that after meeting establishment charges and after making handsome allowances for depreciation and reserve, there must *of necessity* remain a sum for the payment of dividend which may exceed the entire capital of the company. It is inconceivable that the veriest dunce in business could fail to make a profit under such conditions. The business man knows this well enough.

Investments in heavy engineering undertakings are less profitable than investments in, say, butter companies, because in the former, owing to the nature of the work, it is impossible to turn over the capital as quickly as in the latter. To such an extent is capital locked up in engineering enterprises that it is profitable to spend enormous sums of money on single-purpose machines with the object of accelerating the rate of production. It is unnecessary to labour a point that must be common knowledge.

The electricity supply station, as it was in its early days, has been given as an example because it serves to indicate the use made of the appliances provided by the railway companies at the present day for dealing with merchandise. The subject is one of interest even to the meanest member of the community for on it depends the cost of the bare necessities of life. We would go further than this and say that in many cases the methods of handling determine the cost of such necessities.

Stated briefly, Mr. Horniman advocates the substitution of centralised and modern machinery for the present haphazard and unscientific manual methods of handling. He makes out a strong case in favour of the rational system devised by Mr. A. W. Gattie and his associates—a system which, we venture to say, is familiar to most engineers and to all economists. For this reason it is thought to be unnecessary here to describe the system at any length. In our opinion, had the inventor not been an Englishman his Goods Clearing House System would have been adopted in this country six or seven years ago. It has been favourably reported upon by many eminent engineers, actuaries and economists. Had the Goods Clearing House System been adopted it is tolerably certain that the traffic congestion, which has been one of the most lamentable and costly aspects of the war, would not have occurred.

Old-fashioned methods of handling materials and merchandise necessitate the employment of large numbers of unskilled men. There is no place in society for the unskilled, nor are the unskilled entitled to any place in society. We believe that the twentieth century, nay, that Armageddon will see their liberation. The presence of vast hordes of unskilled men is as degrading to the community as it is dangerous. Notwithstanding the expensive character of the machinery employed in industry every employer of labour knows that it is less costly to use such machinery than to employ men who produce nothing.

Apart from the costliness of non-productive labour there is the ever-present menace of what Sir John Purser Griffith in his recent "James Forrest" lecture before the Institution of Civil Engineers referred to as "An army of under-employed, under-clothed, under-fed and badly-housed men, with their dependent families." We have had many warnings in recent years that, sooner or later, this army will rise in rebellion against conditions which result in its being under-employed, under-clothed, under-fed and badly housed.

It is an insult to his Maker to employ man as a mere weight-lifting machine when mechanical appliances exist for doing the work in a highly efficient manner and, at the same time, enable man to be set free for doing man's work in the world. A highly attractive feature of the scheme, so ably described by Mr. Horniman, is that man will be set free for this purpose. In London alone we estimate that close upon a quarter of a million men would be available for purposes of production. If our estimate be a correct one it would appear that the country is capable of yielding several million men; men who, under present conditions, do nothing that is worth the doing.

The irony of the position is brought home to us in these days in a very forcible manner, for with the country at war it is found that the men who produce nothing and who, as we have said, have really no right to live at all, are indispensable to the country. Without fear of contradiction one may say that never before has such a situation arisen in real life. Our readers being electrical engineers need not be reminded that they have been driven into this situation by their high-salaried, supine servants. As electrical engineers they know that they have been successful in the business of electricity supply notwithstanding, and in spite of, the Board of Trade.

The fact that the crane and conveyor makers have been roped in by the Ministry of Munitions leads us to believe that after two years of war some official connected with the Ministry has recognised the influence of modern machinery on the rapid handling of materials, and the influence on production of the rapid handling of materials. Had the shipbuilder, the ironmaster and the engineer neglected to make use of such machinery in time of peace their work would be as congested to-day as are the railways, and but few men would have been available for the Army because the man-power of the country would have been required for the handling of materials in the works. It is to be hoped that in the near future some other official will recognise the advantages of housing this machinery under one roof, for a given district, for the loading and unloading of, say, railway wagons, and that another official will see to it that the arrangements are such that the machines can be fed economically, or, in other words, continuously. When that times comes Mr. Horniman's ideal and ours will be realised.

REVIEWS.

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The Principles of Electrical Engineering and their Application.

By Gisbert Kapp. Vol. I., Principles. (London: Edward Arnold.) Pp. xii.+356. 15s. net.

Prof. Kapp says in his preface that he has found it difficult to recommend to the non-electrical engineer a book in which he may find "all about electrical engineering." The volume under review is the first of two which together are intended to meet this want. It deals with principles the application of which are reserved for the second volume, although, as the author points out, there must be a certain amount of overlapping, since a pedantic separation of application from principles is impossible in a book on any applied science. All engineering students in our technical schools and universities attend some classes in electrical engineering, and are taught the fundamental principles of the subject and their application to practical engineering. This book is intended as a text-book for such students and as a handbook for the general engineer. The manager of a waterworks, the mechanical designer of an electric locomotive, the engineer who specialises in printing machinery, the works manager who buys electric power, and the engineer in charge of an electrically-driven rolling mill are all mentioned in the preface as being likely to require a knowledge of some branch of electrical engineering.

Generally speaking, however, the book is more advanced and theoretical in character than one would expect from this list of prospective readers, as, indeed, the author appears to anticipate when he says "the general engineer should find all he requires here, some may even think more than they require, but this is unavoidable." As an example, one may refer to the two pages devoted to the calculation of the capacity between a sheath and an eccentrically placed core, an excellent thing for the student who intends to become an electrical engineer, but of doubtful utility, except as a mental exercise, to the mechanical or civil engineer.

Turning now to the contents, the opening chapter on conductors introduces Ohm's law, specific resistance, temperature coefficient and thermo E.M.F. Although the centimetre cube is mentioned, Prof. Kapp follows Continental practice in taking the specific resistance ρ per metre length and 1 sq. mm. cross-section. The use of ballast resistances and the question of stability are discussed, as also is the use of various alloys as thermo-couples, and the relative advantages of copper and aluminium as conductors. Chapter II. deals with the various methods of measuring resistance, and Chapter III. with the applications of the potentiometer. Then follows an interesting chapter on "Some Applications of Ohm's Law," including the televoltmeter and the graphical determination of the steps of a motor-starting rheostat. In the next chapter, on the distribution of continuous current, graphical methods are given for determining the voltage variation along mains with distributed and concentrated loads, and also along tramway rails with negative feeders. The three-wire system and balancers are described. Chapter VI. deals with insulation resistance, and proofs are given of the Russell (consistently misspelt Russel) and Kapp-Coales methods of testing three-wire systems. Then follow two chapters on electrostatics, the practical importance of which has increased with the growth of high-tension transmission and radio-telegraphy. Several pages are devoted to the application of the method of images to the approximate calculation of the capacity between a long hollow cylinder and an eccentrically placed core. The same problem is solved accurately further on, allowing for the non-uniform distribution of the charge. Capacity and intersheath grading of cables and condenser bushings are described in order to illustrate the application of electrostatic principles. Chapter IX., on magnets, contains an interesting proof of the law of inverse squares from the ratio of the deflections in the two positions of Gauss. Chapter X., on electro-magnetism, deals with the magnetic field of conductors and coils, the magnetic circuit, *B-H* curves, breaking inductive circuits and the design of lifting magnets. Then follows a chapter headed "Elementary Electro-dynamics," in which, on page 201, the student is introduced for the first time to the force on a conductor carrying a current in a magnetic field, and also, on page 201, to the induction of E.M.F. by the changing magnetic flux, although the breaking of an inductive circuit had been already dealt with in the previous chapter from the point of view of the stored energy. This chapter also includes the calculation of the inductance of parallel wires, concentric cables, toroids, &c., and a discussion of self and mutual inductance, coupling coefficients and time constants. Chapter XII. deals with units and dimensions, and Chapter XIII. with "Electromagnetic Measurements." This latter includes the hot-wire ammeter—which is hardly electromagnetic—galvanometers, fluxmeters, hysteresis loops, and bridge methods of measuring inductance. A separate chapter is devoted entirely to the various methods of testing the magnetic qualities of iron. The study of alternating currents is taken up in the concluding chapter and carried as far as phase meters and the measurement of power in three phase systems.

Although, on the whole, the symbols used throughout the book appear to be well chosen, the author could surely have found for "cross-section" a more suitable symbol than the initial letter of its German equivalent, "querschnitt."

Instead of the usual $\log_{10}r$ and $\log_e r$, the author employs the German symbols *lgr* and *lnr*, which, while certainly preferable from the compositor's point of view, are bewildering to the English reader who feels tempted to cancel the *l* and *n* with the length and number of turns on the other side of the equation; for example, Prof. Kapp would write $\frac{lnr}{lnr'}$, instead of $\frac{lnr}{\log_e r}$.

One is surprised to find Lord Kelvin referred to on page 20 as Thompson, and a galvanometer on page 236 as being of the d'Arsonval pattern. On page 7 *annealed* copper is stated to have a higher specific resistance than the *hard-drawn* variety, while the temperature coefficients of both agree to the third decimal place, viz., 0·00401, although lower down, the Engineering Standards Committee value for *pure* copper at the same temperature is given, viz., 0·00410.

The figure which is stated to illustrate the principle of the "Megger" shows the fixed coils and moving needle of the older ohmmeter.

In calculating the field due to a straight wire on page 177, the mathematics appears to have got very muddled, every equation, except the final one, being wrong; after putting $d(\sin\alpha) = -\sin\alpha\, d\alpha$, it is not surprising that liberties have to be taken with the integration in order to make it give the well-known result $H = 2I/a$.

Although one may take exception to the choice and arrangement of some of the material, in view of the class for whom it is professedly written, there can be no doubt as to the general usefulness of the volume to all students of electrical engineering.

How to make the Railways Pay for the War; or the Transport Problem Solved. By Roy Horniman. (London: G. Routledge & Sons.) Pp. xx.+348. 10s. 6d. net.

The Railway Swindle. By Henry Murray. (London: Grant Richards, Ltd.) Pp. 160. 2s. 6d. net.

We refer to these two books in our leading article this week.

SCIENTIFIC RESEARCH AND OUR FUTURE SOURCES OF ENERGY.*

BY D. ROBERTSON, D.SC.

In the past the industries of this country were able to take a leading position in the world, but now our position is neither so good nor so secure as it was. In comparison with our competitors, do we now produce fewer men of genius than formerly, or does our relatively worse position arise from our making less use of them under the changed conditions?

A century ago the inventive genius, of itself, had a fairly free scope, but in the industrial world of the present day it must be coupled with a much higher degree of scientific knowledge and technical training, and have behind it much greater material resources than formerly if it is to make its influence felt. In the early days of industry the problems to be solved were mainly mechanical, speeds were low, the choice of materials was comparatively small, and the duties put upon them were moderate, while prices were high enough to permit the use of sufficient material to give a good big factor of safety. Only the simplest calculations had to be made, and little scientific knowledge was necessary beyond that acquired in the daily routine of the shops. Consequently, many important advances were made by men having but the slightest theoretical knowledge.

Nowadays, competition requires the utmost to be got out of each ounce of material; higher speeds may cause extra material to be a source of weakness rather than of strength, and introduce phenomena whose control requires the keenest tools that theory can supply.

The field of knowledge may be likened unto a gold field. The first comers acquire the surface veins and nuggets with comparative ease and with the crudest equipment, but as these become exhausted their successors must expend more and more preliminary labour without immediate result, and they must possess more and more knowledge if these labours are not to prove altogether fruitless.

In the field of research we are now far past the first stage. The surface treasures which Nature has placed to tempt our further search have mostly been harvested and the investigator must now be prepared to undergo a long preliminary training before his work is likely to become productive. Consequently, he must have behind him resources sufficiently great to support him during this non-productive period and to provide the ever increasing apparatus and materials necessary for carrying on his work.

We have every reason to be proud of the advances made, and being made, by our own countrymen in the domain of science, but we do not put into this work a sufficient number of men of the right sort, the right training and the right temperament; nor shall we ever get them until we offer them prospects comparable with those open to the other learned professions.

The scientific side at school must have equal prestige with the classical. The scientific man must be as greatly respected by the public at large, as highly honoured, and as well paid as one belonging to any of the other learned professions. Although legislation can help but little in raising science to its rightful status, still it can do something. It might, for instance, encourage the study of science in our public schools, by insisting on a certain minimum of scientific knowledge in future generations of public officials. It might also make the value and number of the scholarships open to science approximately equal to those given for classical studies. This could be done either by a special act diverting part of the present scholarship funds, or by the Government themselves founding a sufficient number of new scholarships.

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* Abstract of Chairman's address before the Western Local Section of the Institution of Electrical Engineers.

By thus making the way to a large number of the lucrative positions lie through a study of science we should very quickly find every school running a real scientific side, and our universities would then be able to pass away from the condition of having to make their scientific alumni pass their first year in learning elementary work which they ought to have had at school.

But we must mainly look to our own men of eminence to bring about a better state of things by continually making the needs of science known in influential quarters. The war has focussed attention on scientific work with an entirely new force. Never again must public opinion be allowed to forget how much they owe to the oftentime obscure worker in the research laboratory. In particular, the notion must be dispelled that scientific men are merely theorists whose ideas can usually be neglected, and who are too ethereal to require any encouragement or any visible means of support, but whose assistance can always be obtained, on those rare occasions when it is useful, without any reward, and, indeed, almost without the trouble of having to ask for it.

One of the great difficulties in the way of scientific men reaping the due reward of their labours arises from the fact that the benefits of their discoveries are seldom immediately tangible, whilst at the same time they are open to the whole of mankind. What reward, for instance, did Faraday reap from the discovery of the electric motor and generator, Clerk, Maxwell and Hertz from radio-telegraphy, or Ramsay, Rayleigh and Dewar from the gas-filled lamp? True, none of these things were invented, in a commercial form at least, by these particular men, but their work opened up the new ground which made the inventions possible. Because of this peculiarity, the highest kind of research work must be supported by mankind at large, which in this country means Parliament and the Exchequer.

The true research worker must possess an infinite patience, a fertile imagination, a wide knowledge of the laws of Nature, and an unbounded faith in the possibility of accomplishing the task on which he is engaged. He must refuse to be diverted from his goal by any reputed impossibility, and if necessary he must be prepared to overthrow accepted ideas when they stand in his way. The advances of the genius are made by accomplishing the impossibilities of his fellows. In 1900 Bremer improved the arc light by doing exactly what everyone would have said was the wrong thing; before Marconi's experiments in 1901 it was perfectly easy to demonstrate that transatlantic radio-telegraphy must for ever be impossible; in 1910 Coolidge succeeded in drawing tungsten into the finest wires that were ever made, in spite of the knowledge among the experts that this metal was far too brittle to be even forged into a rod; in 1913 Langmuir produced the gas-filled lamp when we all knew perfectly well that the best possible vacuum was absolutely necessary for an efficient lamp.

And so it will always be. He is not worthy of the name of pioneer who regards even the laws of gravitation, and of the conservation of energy, mass and momentum as dogmas which may not be attacked and overthrown when they block his way. Research is best dealt with in bulk, so that workers in different fields may come into daily intimate contact. A man with a new idea will develop it more rapidly and carry it further if he discusses it over a pipe with a fellow spirit, even although the latter can do no more than listen to the exposition. If the subject borders on his own in any way, the cross-fertilisation of the sciences produced by such a discussion may lead to enormous results.

The research worker must also come into close touch with the industrial side of his own subject, yet without devoting so much time to it that real research gets squeezed out altogether. The man in the factory meets many problems for whose solution he possesses neither the time nor the knowledge. The scientific man, however willing and competent he may be, would never meet these problems by himself. Keep these two men apart and the problem remains for ever unsolved, but bring their experiences together and progress is sure to follow.

For the success of this co-operation, mutual respect and confidence are required between the manufacturing and scientific sides of industry. This co-operation has been greatly developed with marvellous results in several directions in America, where its realisation has been facilitated by the aggregation of capital into huge trusts. Except in a few of our industries, it is scarcely practical to have that continuous intercourse between the research worker and the factory which is obtained in the well-known American examples, with their real research laboratories attached to, or closely affiliated with, the productive departments. But to some extent the difficulty can be overcome by insisting that the research workers should periodically spend some time in the factory. The duration of these periods must depend on the nature of the work on hand, but they should be as frequent as possible. Even if they amounted to nothing more than a weekly visit to the shops and chats with the managers and foremen, the results would be good, provided the men in the works did actually discuss their difficulties and give the scientific man the benefit of their own knowledge.

Trade secrets, or supposed trade secrets, stand in the way of that good-will on the manufacturer's part without which no such scheme can be really useful. But we must either overcome these difficulties, or else we must organise our industries into corporations large enough to bear the expense of huge research departments directed to their own particular ends. Otherwise we shall in time lose our industries altogether in favour of other countries who may have succeeded in doing one of these things.

Each industry has its own problems which are more or less re-organised by those engaged in it. We could all write out lists of what we think we most want in our own sphere. But I wish to direct your attention to one rather big problem of the utmost importance for the future welfare of our own country. I refer to our supply of energy.

Our annual consumption of coal is about 200 million tons per annum. Since the energy of one ton of coal is almost exactly one kilowatt-year, we are drawing on our energy capital at the rate of about 200 million kilowatts per annum.

We have, of course, other sources of energy of which we are aware and possibly many others still unknown. The energy of disintegration of the atoms is enormous. When this is brought under our control we shall have an ample supply for a few ages more, and may even be able to ward off the approach of the next ice age, which is due in some thousands of years.

Another large store of energy, mainly derived from the kinetic energy of rotation of the earth, is made available to us through the tides. To raise the level of one square mile of sea by one foot involves the expenditure of about 340 kw.-hours. Under ideal conditions of admitting all the water at high tide and releasing it again at low tide, this amount of energy would be available each half tide of, say, 6¼ hours. The tidal power is thus equivalent to about 55 kw. per square mile per (foot rise)^2. Ideal conditions could not be realised, and there would be losses in the turbines, and so we probably err on the high side if we take 10 kw. per square mile per (foot rise)^2 as the maximum we might expect to be able to utilise. This would give 10,000 kw. per square mile with a double tidal amplitude of 31·5 ft., and 500 kw. for one of 7 ft.

The Bristol Channel is by far the most favourable place in this country for the large scale utilisation of the tides, and I think the Firth of Clyde stands next, because of the large area which could be enclosed within a comparatively short dam. We shall not be far out if we take the 10,000-kw. per square mile as applicable to the first and the 500-kw. to the second of these areas.

A dam across the Bristol Channel from Brean Down to Lavernock Point, taking the Flat Holm on the way, would be under 8 miles. It would enclose well over 100 square miles of water, and would give, say, a million kilowatts. One built across below Ilfracombe would be nearly 30 miles long, would enclose quite ten times as much, and might be expected to give us about 10 million kw.

The only possible place for a dam across the Firth of Clyde is the shallow bar somewhere about the Girvan-Kintyre line. It would be in somewhat deeper water than the Bristol Channel ones, would be just over 30 miles long, and would enclose much about the same area as the lower Channel one. But owing to the much smaller tides it would probably give us no more than half a million kilowatts.

I have no doubt that the modern engineer would construct any of these dams within a reasonable time if he were provided with sufficient funds. The capital costs would be very high; I do not know what they would be, but I do not expect that power obtained in that way could compete with our ordinary methods so long as a plentiful supply of coal lasts. Stated in kilowatts they do seem enormous sources of power, but compared with the equivalent of the coal supply which will some day have to be replaced they are quite insignificant. We have, of course, other estuaries which could all be made to contribute their quota, but when all are harnessed we shall still be very far short of the equivalent of our present consumption of coal.

We may next turn our attention to the consideration of our income, which is paid out to us day by day from the sun. The intensity of the sun's radiation as it falls on the earth's atmosphere is somewhere about 5,000,000 kw. per square mile of normal surface, which would mean about 3,000,000 kw. per square mile of land at our latitudes at the equinox noon. Averaging it out throughout the 24 hours and throughout the year, we may call it 1,000,000 kw. per square mile here. Over one-half of this, however, is absorbed by the atmosphere, but what is left is ample for our needs.

For the economical utilisation of the sun's energy on a large scale it will be necessary to keep the size of the power house within reasonable dimensions, and to provide for keeping it running throughout the whole 24 hours. The direct application of the rays for driving a heat engine, which is quite practical on a small scale in tropical countries and has been actually done in Meadi, in Egypt, would thus scarcely meet our needs even if our climate were suitable, which it is not.

Storage of the energy in some intermediate form is thus necessary to enable us to concentrate it and to level up the discrepancies between the curves of supply and demand.

Nature provides us with such storage in several forms. First we have gravitational energy in the shape of water raised from the oceans up into the clouds, and this has the especial merit that it makes some use of the areas covered by water. But the smallness of our island makes our share of this bountiful supply somewhat meagre, and consequently we must look to other forms.

The winds give another means of temporarily storing the energy received from the sun, partly in the kinetic form and partly in the compression of the air. Here again, difficulties arise from the uncertainty of the winds, and from the enormous size which a large power windmill would have. Still, research must not dismiss anything as impossible. The rapid advances in the size of steam and water turbines and of electric generators should teach us not to dismiss wind-power as utterly hopeless.

The last form of storage which I shall consider is chemical energy, to which class indeed our coal itself belongs. The only way in which the solar energy is taken up chemically in nature, so far as I am aware, is through the agency of plant life. Failing other means, *we must grow our fuel.* I therefore offer to our agriculturists the problem of producing a plant having a high calorific value, which shall utilise as high a proportion as possible of the energy falling on the areas devoted to its cultivation and which shall be suitable for use as fuel, either directly or by distilling alcohol or other spirit from it.

At the same time I ask our electro-chemists to find a method of taking up that energy electrically from the plant, or its products, without first converting it into heat so as to avoid the large thermodynamic losses inherent in the heat engine.

Or better still, I ask our chemists to devise some re-action which will occur with the absorption of energy under the action of sunlight, and which can be reversed, under control, with the return of that energy in the electrical form. In short, give us a storage battery which is charged by submitting the active materials to sunlight, and which is discharged in the ordinary way.

As a last resource, in case these should fail, let our ultra-physicists collaborate with the biologists and produce between them a sufficient number of Maxwell's sorting demons to emancipate us from the second law of thermodynamics.

CORRESPONDENCE.

POSSIBLE INFLUENCE OF A RAILWAY ON THE DISTRIBUTION OF THUNDERSTORMS IN A HILL COUNTRY

TO THE EDITORS OF THE ELECTRICIAN.

The enclosed letter from a correspondent in South Africa, about what he has observed in the island of Mauritius and in Natal, seems worthy of reproduction in your columns, because it is of a suggestive nature. Inferior conductivity is often thought to be all that is necessary for some electrostatic purposes, but I have known experiments fail largely because fairly good conductivity was not provided. A Leyden jar standing on a table, for instance, often declines to charge quickly enough. This and other experiences of that kind leads me to think that in a dry climate surface conduction on the earth may be insufficient to supply [illegible] the higher elevations at a sufficient rate [illegible] potential gradient there; so that there would be nothing impossible in the suggestion that a line of rails from coast to summit would tend to diminish the potential gradient in the atmosphere above a hill and diminish it at the coast, especially during the rapid changes incidental to thunderstorms.

I have pointed out to my correspondent, however, that long-continued observation will be necessary before being sure that the effect occurs on a practical scale and really influences the locality of thunderstorms. Also I express a doubt whether insulating fish-plates would be adequate to make rail conduction ineffective for this purpose, unless the rails themselves were insulated from the ground.

Birmingham, Nov. 3. **OLIVER LODGE.**

The following is the letter to which reference is made :—

SIR OLIVER LODGE,

DEAR SIR : . . . . I have in vain tried to find a competent authority in South Africa willing to give a positive answer to the question given below, and I shall be exceedingly obliged if you will kindly let me know if my surmise is correct.

The fact is that I have an idea that the rails of a railway line, starting from the coast level and rising gradually to high altitudes, have an effect on the thunderstorms, and my reasons for thinking so are the following :—

Mauritius, a small island, roughly speaking 30 miles long by 20 in width, is mostly composed of a table land on the coast, rising gradually to a height of about 400 ft. and at a mean distance of about 4 miles from the coast, rising rapidly to another table land, the centre of the island, about 1,200 ft. above the level of the sea. At one time, when the railway encircled the island, the thunderstorms seemed to be equally divided ; but from the moment that a line linked the north coast to the south, passing through the centre of the island at an altitude of about 1,200 ft., the thunderstorms, although frequent in the centre of the island, practically ceased on the coast belt.

In Natal, 40 years ago, before the railway was built, between the coast and the inlands, thunderstorms were extremely frequent and severe from the month of August to the end of April. Since the line to the Transvaal has been built the thunderstorms, although still very frequent in the interior, have practically ceased on the coast. Now this line, starting from the coast, gradually rises to an altitude of nearly 6,000 ft.

The question to my mind is, Is it possible for the two heavy rails to diffuse in the atmosphere at the higher altitude the electric fluid from the ground, and thus cause the disappearance of the storms on the coast ?

Of course, the absence of storms means also the absence of rains, and should it be possible that the rails have the effect I suppose they have it might be possible to control their action by placing at different points insulated fish-plates to break up the current.

I have read that in France, in districts where hailstones used to do great damage to crops, high steel towers have been placed on hills, and that their erection has minimised to a very considerable extent the damage ; this would, I think, bear out my idea that the rails are acting as conductors. . . . Yours faithfully,

L. DUCASSE.

UNREMUNERATIVE EMPLOYMENTS.

TO THE EDITORS OF THE ELECTRICIAN.

I was very pleased to read your Editorial Note urging young men not to accept posts as technical teachers at £150 a year.

The fact of the matter is that technical colleges, whilst making a great deal of noise about their students and " blind alley " employment, forget that their own teachers are in the worst " blind alley " of all.

Just imagine £150 a year and no pension, and certain not to be wanted if he gets out of it, or older, or unwell.

When I was engaged teaching I endeavoured to draw the attention of teachers' associations to this state of matters, but found them as spiritless as a lot of Yahoos. The older and more influential members seemed to have " axes to grind," especially in the presence of superior powers, so they were dumb.

I never regretted giving up teaching and getting back to life again.

Millhill, Nov. 4. **W. H. F. MURDOCH.**

TO THE EDITORS OF THE ELECTRICIAN.

While expressing our appreciation of your remarks on unremunerative salaries in the editorial columns of this week's issue, we regret that your genuine protest did not prevent the advertisement referred to from appearing in your columns.

Unfortunately, lecturers in technical institutions are not the only underpaid victims on the technical side of the profession. Far worse cases exist in the technical staffs of some of our leading manufacturers. Take our case as an example. We are all graduates of universities or equivalent institutions, have had several years " live " experience, and are engaged as technical designers with a well-known manufacturing firm. We do not apologise for startling you when we state that our average salary is well below the £150 of the advertisement in question. Were it not for the present necessary restrictions, we would hail with delight the prospects of securing a post as lecturer at the (to us) princely salary of £150–£175 per annum.

Technical men nowadays are regarded as working for a hobby, and we rue the day when we took up the technical side of the profession as a means of livelihood.

However, we wish the lucky applicant success in his new berth, and offer him the consolation that he is infinitely better off than FOUR TECHNICAL VICTIMS.

The Midlands, Nov. 6.

[No such advertisement appeared in our columns. The fact that the appointment was vacant was announced.—EDS. *E.*]

"SUMMATION WATT" CAPACITY OF FIELD RHEOSTATS, AND THE LIKE.

TO THE EDITORS OF THE ELECTRICIAN.

My attention has been drawn to the reference in Dr. C. C. Garrard's book, "Electrical Switch and Controlling Gear," *re* the "Summation Watt" formula advocated by me as compared with his formula.

Dr. Garrard's formula "square the mean of the maximum and minimum field amperes multiplied by the resistance of rheostat" is only true if the curve plotted between amperes and rheostat ohms is a straight line. Only for extremely short ranges is this true, and the greater the range between maximum and minimum amperes, the greater the inaccuracy of his formula. In the same article to which he refers I showed that with a rheostat resistance of $3\frac{1}{2}$ times that of the field his formula gave a rheostat size 67 per cent. greater than that actually required.

He points out that my formula, viz., "Rheostat ohms. $\times$max. amperes$\times$min. amperes" with "R" very large becomes approximately equal to I max.$\times V$=constant, which he states is absurd. Now the greatest possible current range is obtained in a potentiometer rheostat where I min. is zero. The correct formula for such a potentiometer rheostat is I max. $\times V$ plus the constant watt loss due to resistance being across excitation circuit. However, in an ordinary rheostat the constant watt loss does not exist, therefore the original formula holds good.

In practice a designer may be limited to a relatively small number of resistance units. This is particularly the case if open wire spirals are used. Then to obtain a very large "R" compared with field ohms, a much larger rheostat would be required than one wherein the unit range was not so limited; this, however, is not the fault of the formula but of the facilities at the disposal of the designer, and is no reason for advocating an incorrect formula.

Stretford, Nov. 2. L. BOOTHMAN.

TO THE EDITORS OF THE ELECTRICIAN.

With reference to Mr. Boothman's letter of Nov. 2nd, I would point out that the various formulæ discussed are all empirical; none of them are strictly accurate. When I first saw Mr. Boothman's formula I was impressed by it, and endeavoured to use it; I, however, came up against the difficulties I have mentioned in my book, and therefore reverted to the formula I had previously used. Mr. Boothman has, with considerable ingenuity, worked out different formulæ giving the summation-watt capacity for the various types of rheostats. I venture to think, however, that the simple formula that I have recommended which can be applied to any form of rheostat is the best for all-round practical purposes. It must be borne in mind that the $I_{\text{max.}}$ and the $I_{\text{min.}}$ in the formula are the maximum and minimum currents flowing *in the rheostat itself.*

I am not sure that I follow the argument that Mr. Boothman gives in his letter. Taking, however, his result as given for a potentiometer regulator, he gives

$$\text{Summation-watt capacity} = I_{\max} \times V + \frac{V^2}{R}.$$

Now $I_{\text{max.}}$ is constant independently of the rheostat, V is also constant; Mr. Boothman's formula therefore says that the higher the resistance of a potentiometer regulator the smaller is the summation-watt capacity. Now as I use the term summation-watt capacity I mean a figure of comparison of the size and the cost of the regulator. In this sense I do not think the result, deduced above from Mr. Boothman's formula, is correct. There can be no doubt that there is a certain value of rheostat ohms which gives the most economical form of potentiometer regulator, less and higher ohmic values being both worse. But Mr. Boothman's formula says that the higher the rheostat ohms the less the summation-watt capacity.

I also do not think Mr. Boothman has answered my argument as regards his formula for ordinary shunt regulators. He restates my argument in his letter, but I cannot see that he answers it.

I do not wish to deny the utility of Mr. Boothman's formulæ, and have no doubt that when used properly they give very useful results. I have merely wished to point out that they are not universal, and, in my opinion, must be used with caution.

To sum the matter up, the figure for the summation-watt capacity should only be used for comparing one rheostat with another; the figure has no very precise physical meaning. In my experience the formula I have recommended gives perfectly satisfactory results, and by reason of its simplicity and adaptability to any kind of rheostat is to be preferred to more complicated ones.

Birmingham, Nov. 6. CHARLES C. GARRARD.

THE AIR-GAP FIELD OF THE POLYPHASE INDUCTION MOTOR.

TO THE EDITORS OF THE ELECTRICIAN.

Dr. Chapman is correct in supposing that I had not seen the last paragraphs of his Paper when I wrote my letter. I regret that by an oversight I did not delete the part inquiring as to the degree of saturation when I checked the proof.

With regard to the last paragraph of Dr. Chapman's letter, I did not intend to suggest that the effects of saturation could be treated on the basis of a rectangular field form. I do not pretend to have investigated the effects of saturation in my Paper, but merely, as stated in my letter, inferred, from general considerations, that its effect might be neglected. I was not, however, contemplating such a degree of saturation as is indicated by a figure of 1·4 for the ratio of total ampere-turns to gap ampere-turns; such a high value has been, of course, intentionally selected by Dr. Chapman in order to obtain the minimum values for the air-gap dispersion likely to be met with in practice. The maximum reduction due to saturation appears to be about 15 per cent. of the air-gap dispersion—*i.e.*, perhaps some 4 or 5 per cent. of the total dispersion coefficient. For a more usual degree of saturation—corresponding to, say, 1·2 to 1·25 for the above-mentioned ratio—the reduction, I presume, would probably not exceed half the above amount.

There is one point in Dr. Chapman's method of investigating this question of saturation effects which appears to me to be questionable. The basis of the investigation is a time sine wave-form of M.M.F., whereas is it not actually the *total flux* which approximates more closely to a sine wave-form in time, with a consequent peaked wave-form for the M.M.F.? The general result of a peaked time wave-form of M.M.F. would appear to me to be that the time wave-form of flux opposite the most highly saturated teeth would be flat topped, and that of flux opposite the least saturated teeth peaked. This would tend to make the fundamentals (in time) of these flux waveforms more nearly proportional to the ampere-turns to which they are subjected than is indicated by Dr. Chapman's Fig. 12. But, clearly, the straighter the curve for the amplitude of the fundamentals the more nearly we approach the conditions—so far as the magnitude of the air-gap dispersion is concerned—of no saturation.

Of course, it is impossible to draw conclusions with any certainty from such general considerations; but it would be of interest to have Dr. Chapman's opinion on the point.

With regard to the method I used as compared with Dr. Chapman's, when saturation effects are neglected, the values used for β_m to obtain the figures I gave for $\lambda_1' + \lambda_2'$ were not obtained from formulæ, but were the result of exact calculation (to the four places of decimals given) for each individual case. Dr. Chapman's second objection to the method is more serious. The curves for the mutual induction, however, lie very evenly (neglecting minor irregularities) above and below the horizontal line through the mean of the maximum and minimum values. Further, the variation of the mutual induction passes through nearly six cycles (near synchronism) during one stator current period, and added to this there is a continual progressive change of phase between the variations of the mutual induction and that of the stator current. For these reasons it appears to me that the variations from the mean of the maximum and minimum values cannot have any appreciable resultant effects under normal running conditions. Since these considerations are, however, only of a general nature, it must be admitted that Dr. Chapman is quite justified in his view that the method used by me is not necessarily mathematically more exact than his, though the two methods are in quite sufficient agreement (some 3 to 7 per cent.) for all practical purposes. The figures I gave in my last column, which should strictly have been termed "Percentage reduction in self-induction of stator or rotor due to action of multiple fields," show how extremely small an interaction of the multiple fields would account for the small differences between Dr. Chapman's figures and mine. I should like to ask Dr. Chapman if he is of opinion that the interaction of the multiple fields could not have even the very small values shown there.

If I may trespass just a little further on your space, I would suggest that the definition of the circle or dispersion coefficient as the ratio magnetising current/short-circuit current is preferable on account of its greater simplicity compared with that of magnetising current (short-circuit current − magnetising current), which is Dr. Chapman's (or Behrend's) form in terms of currents. It is also very desirable to have some standard term for that component of the dispersion which Dr. Chapman has called the "air-gap dispersion." The name "zig-zag leakage" is highly objectionable, indicating as it does that there is an actual zig-zag leakage between stator and rotor, which is not the case. This part of the dispersion is due entirely to the main flux which crosses the air-gap, and it was for that reason I termed it the "main dispersion." This name is, however, open to the objection of suggesting that it is the principal component of the dispersion, which in general is not true. Dr. Chapman's term "air-gap dispersion" seems to be much the best.

Bedford, Nov. 2. E. A. BIEDERMANN.

A STUDY OF THE INDUCTANCE OF FOUR-TERMINAL RESISTANCE STANDARDS *

BY FRANCIS B. SILSBEE.

The precise measurement of alternating currents frequently involves the use of standard resistances the inductance of which should be known. When the currents are large the standards used are usually of low resistance, and a very small inductance in such a standard may produce a very considerable phase angle between the voltage drop across the resistance and the current. In the range below 1 ohm the resistances are almost invariably of the four-terminal type, and, therefore, require methods of measurement which are quite distinct from those applicable to higher resistances. The object of this investigation was to develop methods for comparing the phase angles of such four-terminal resistances, and also to construct standards, having a very small known inductance, with which other apparatus could be compared.

If we consider a four-terminal resistance (or, more briefly, a "shunt") which carries a sinusoidal alternating current, we will find that the voltage between the potential terminals is not in general in phase with the current, but may be resolved into two components, one in phase and one in quadrature. The resistance of the shunt is defined as the ratio of the in-phase component to the current, while the reactance is the ratio of the quadrature component of voltage to the current. The angle whose tangent is the ratio of reactance to resistance is the phase angle of the shunt. The inductance is, of course, equal to the reactance divided by 2π times the frequency, while the time-constant is the ratio of the inductance to the resistance. This latter quantity is very nearly constant over the range of commercial frequencies and is a measure of the amount by which a shunt departs from the ideal condition of giving a voltage exactly in phase with the current.

In some of the measurements described below it was necessary to use mutual inductances, and it was found that these did not in general satisfy the ideal condition of giving a secondary voltage in exact quadrature with the primary current, but that the voltage had a small in-phase component. By analogy with the case of the shunt we may define the "resistance" of the mutual inductance as the ratio of this in-phase component of voltage to the primary current. We will further define the "phase defect" as the angle whose tangent is the ratio of the in-phase component of voltage to the quadrature component.

The method for the comparison of the time-constants of two shunts which was found most suitable may be called the current transformer method. It consists essentially of measuring the apparent phase angle of a current transformer by one of the usual null methods, using in succession, as the standard resistance in the primary circuit of the transformer, the two shunts to be compared. The apparent change in the phase angle of the transformer is the difference in the phase angle of the two shunts. A group of about 20 shunts were intercompared by this method and form a basis for future comparisons. A second method involving the use of mutual inductances was tried, and gave results in agreement with the first method, but was found to be much less convenient.

Since the comparison methods just mentioned give only the difference in time-constant of two four-terminal standards, some other measurement is needed to give the actual value of the time-constant of one four-terminal shunt in terms of known quantities. The simplest way to obtain this value is to construct a shunt of such shape that the inductance can be computed from the measured dimensions. This procedure requires that certain assumptions be made as to current distribution, &c., but a careful investigation using three different shapes of shunt showed that these assumptions were completely justified. As a check two other methods of measurement were tried, one involving the use of mutual inductances of known phase defect, and the other using two shunts constructed of identical dimensions, but of materials of different resistivities. These methods gave results in agreement with the computed values, but were less accurate and more laborious. It is believed that the time-constants of the group of shunts, ranging from 0·1 ohm to 0·00025 ohm, at the Bureau of Standards are known to an accuracy of 1 or $2 \cdot 10^{-7}$ seconds. With a frequency of 60 cycles and an uncertainty of $2 \cdot 10^{-7}$ seconds in the time-constant, the phase angle between the voltage and current is uncertain by about 15 seconds of arc.

Further measurements were made on other types of shunt, and also on the effect of stray magnetic fields on the apparent type constants of the shunts. In the design of shunts for use on alternating-current circuits it appears that the liability to err can be minimised by so locating the potential leads that the inductive effects in them completely neutralise the inductance of the resistance material itself and the shunt as a whole is strictly non-inductive. The type in which the resistance material forms one or both of two concentric tubes lends itself very readily to this form of compensation. A study of the phase defects of mutual inductances of large current-carrying capacity showed that this source of error was by no means negligible, and that it was particularly large in cases where the secondary was wound in several layers.

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* Abstract of Scientific Paper No. 281, Bureau of Standards.

LEGAL INTELLIGENCE.

American Wireless Patent Litigation.

We are informed by Dr. Lee de Forest that on Oct. 12 Judge Hand, of the Southern District Court of New York, granted a perpetual injunction against the Marconi Wireless Telegraph Co. of America as a result of the counterclaim in the answer to the suit of that company against the De Forest Radio Telephone & Telegraph Co. and Lee de Forest for alleged infringement of patent. The judgment states that letters patent of the United States No. 841,387, for "Improvements in devices for amplifying feeble electrical currents," issued Jan. 15, 1907, are owned by the De Forest Radio Telephone & Telegraph Co., and are good and valid in law, particularly as to claims 1 and 6 thereof, and that letters patent of the United States No. 879,532, for "Improvements in space telegraphy," issued Feb. 18, 1908, are also owned by said De Forest Radio Telephono & Telegraph Co., and aro good and valid in law, particularly as to claims 2, 3, 6, 14, 18 and 21 thereof; and that the Marconi Wireless Telegraph Co. of America had infringed the said letters patent No. 841,387 and 879,532, and the exclusive rights of the said De Forest Radio Telephone & Telegraph Co. threunder by making, using and selling devices containing and embodying the inventions and improvements set out in the above-mentioned claims. The judge, therefore, issued a perpetual injunction against Marconi Wireless Telegraph Co. of America, their associates, officers, &c., from directly or indirectly making or causing to be made, used or leased, selling or advertising or offering for sale, &c., or disposing of in any manner any devices, structures, appliances, instruments or wireless telegraph apparatus embodying or employing the said inventions and improvements or discoveries of claims 4 and 6 of letters patent No. 841,387 and claims 2, 3, 6, 14, 18 and 21 of letters patent No. 879,532.

In a covering communication, dated Oct. 18, Dr. Lee de Forest protests in somewhat strong language against the terms of the report given in our issue of Sept. 29. That report reached us from Marconi's Wireless Telegraph Co., and was inserted in a slightly abridged form, just as we now insert Judge Hand's judgment granting an injunction against the American Marconi Co. Dr. de Forest states that there is not a vestige of truth in the statement in the report that the Atlantic Communication Co. had purchased his patents for $50,000 or any other sum, and that corporation has no claim or hold whatsoever on his company or its patents. Other statements in Dr. de Forest's letter are expressions of opinion upon the respective merits of the patents in question rather than statements of fact, and are not suitable for reproduction in a purely legal report.

Accidents due to Restricted Lighting.

In the Outer House, Edinburgh, on the 18th ult. (before Lord Anderson and a jury), Mrs. Sarah Jane M'Donald sued Glasgow Corporation for £500 damages in respect of the death of her son (41), her sole support, who was knocked down by a tramcar in Edinburgh-road, Glasgow, on March 5, and died from the injuries received. Pursuer averred that the driver was at fault, and said that the restricted lighting was a reason why drivers should take exceptional care. Fault was denied by defenders, who pleaded contributory negligence.

The jury, after an absence of three-quarters of an hour, found for pursuer, and assessed the damages at £200.

Sequel to an Old Action.

On Monday last Mr. Justice Peterson concluded the hearing of a summons in the action of the British Power, Traction & Lighting Co. (Ltd.) *v.* Hodgson, by which plaintiff company asked that defendant (A. E. Hodgson) might be ordered to pay into Court the sum of £7,562. 13s. 4d in accordance with the certificate of the Master, dated July 20, 1909.

Mr. Hughes, K.C. (for plaintiff), said that defendant was a promoter of the company, chairman of directors, and a managing director, and without the knowledge of his co-directors or other members of the company, entered into contracts which amounted to fraud or fraudulent breach of trust. The action was started in 1903, alleging, amongst other things, that at defendant's suggestion the company paid commissions to a syndicate, whereas defendant was himself the syndicate, and benefited by the commissions so paid, and that he negotiated a contract in France for the company while he had himself a contract on more favourablo terms. Judgment was given for plaintiffs in the action by consent on May 2, 1905, Mr. Hodgson having become a bankrupt in the course of the proceedings. He had now obtained his discharge, and the present summons was issued, alleging that as the finding of the Master was based on a judgment in an action for fraud or fraudulent breach of trust he was not protected by his bankruptcy in respect of the amount found due by the Master's certificate.

Mr. Tomlin, K.C. (for defendant), argued that his client only consented to judgment on the understanding that all charges of fraud were withdrawn, and that plaintiff's rights should be to prove in his bankruptcy for any sum that might be found due under the order. If the judgment was one based on fraud, he said defendant would take steps to have it set aside on the ground of mistake on the part of his legal advisers, as he had all through refused to settle the case unless all charges of fraud were withdrawn.

In reply, Mr. Hughes pointed out that the receiver in bankruptcy had takon no steps before the Master, but the proceedings had been attended by defendant personally.

His Lordship held that the judgment in the action was based on fraud and nothing else, and that, therefore, defendant was not protected by his bankruptcy. He accordingly ordered him to pay the amount found due into Court, and the costs of the action. The order would, however, be stayed pending an appeal and a summons the defendant might issue for further time, in view of his taking proceedings to set aside the order of May, 1905.

J. S. Stubbs. v. British Electrical Federation.

Last week Mr. Pollock. Official Referee, heard this case in which plaintiff (an advertising contractor) claimed a balance of commission upon certain advertising contracts obtained by him for the Federation. He also asked for an account of moneys received on account of advertisements up to the date of the determination of his contract. The terms of plaintiff's contract with defendants were that he was to receive a salary of £400 a year and commission at rate of 5 per cent. upon account up to £4,000 a year, above £4,000 and up to £7,000 4 per cent., above £7,000 and up to £10,000 3 per cent., and over £10,000 2½ per cent. The employment came to an end in 1914, and plaintiff alleged that he had not been paid the full commission as agreed. Since action was commenced the account claimed had been furnished to plaintiff, and the question between the parties was whether contracts made during the 3 years of engagement continued chargeable to commission after the 3 years had expired. Evidence was called on both sides and in the result the Referee found that plaintiff had received all the money due to him, and gave judgment for defendants, with costs.

Telegraphy Patent Extension.

On the 1st inst. Mr. Justice Sargent heard a petition for the prolongation of Creed's Patent, No. 22,653 of 1902, by Mr. F. G. Creed, Mr. W. A. Coulson and Messrs. Creed, Bille & Co. (Ltd.)

Mr. Colefax, K.C. (with him Mr. J. Hunter Gray), said the petitioners asked for an extension of the time of the patent, as, although all due diligence had been observed, and they had not yet been able to develop it properly in a commercial sense. There was no opposition on the part of the public, but the Crown were represented by the Solicitor-General (Sir Geo. Cave, K.C.) and Mr. Austen Cartmell. The object of the patent was to make it possible the printing in Roman characters of a message received at the receiving station in Morse in the form of a tape. When a message was received in the International Morse alphabet it took the form of perforations on the tape, and varying lengths were occupied for each letter. Creed's patent obviated this, and at the same time produced the mesasge in Roman characters. Mr. Creed was the inventor. In 1896, when he was about 24 years of age, he was a telegraphist in the employ of the Central & South American Telegraph Co. He determined to devote himself to the problem of making automatic high-speed telegraphy possible, and with that object in view he gave up his appointment. Wheatstone had invented high-speed telegraphy, but this necessitated the presence of a telegraphist, and this was a highly skilled profession, and Mr. Creed, although himself a skilled telegraphist, set himself the task of doing away with that necessity. Mr. Creed had made several inventions, all of them dealing with this one problem, and all of which were inter-dependent. The patent in question was granted in 1902, and the patentees set to work at once to exploit. They at first supplied two machines to the General Post Office, but on these there was a considerable loss, owing to the cost of materials considerably exceeding the estimate. From 1912 to the present day 81 machines had been sold to newspaper proprietors, cable companies and telegraph administrations, in addition to 33 sold to the Postmaster-General since 1914. This made a total sale of 152 machines since the patent was granted, or an average of about 12 a year. The present company was formed in 1912, Mr. Bille having a somewhat similar invention to that of Mr. Creed, for which he received a consideration in shares in the new company. The company had declared a dividend of 5 per cent. on its shares up to the present.

His Lordship granted an extension of the patent for another seven years, but not to exceed five years after the termination of the present war.

Tube Railway and Compressed Air.

Mr. Alex. Ross, President of the Institution of Civil Engineers, has issued his award in the dispute between the Postmaster-General and the Great Eastern Railway Co. as to the use of compressed air in a portion of the P.O. Tube Railway under the hotel and part of the general offices at Liverpool-street station. The facts were given in our issue of the 20th ult.

In his award the Arbitrator states "that having heard counsel and witnesses for both parties, and having examined that part of Liverpool-street station under which the intended works will be executed, and also the works on each side now being executed by the Postmaster-General, he affirms and awards that it is not necessary to use compressed air in carrying out the works."

Boot v. Tullis, Russell & Co.

This case came before Lord Hunter, in the Edinburgh Court of Session last week. After proof was partly heard by his Lordship a settlement was effected in the action in which Mr. Horace Boot, and the partners of Horace Boot & Partners, consulting engineers, sued defenders for payment of sums amounting to £7,534. Pursuers stated that defenders employed Mr. Boot and his firm as consulting engineers for five years from April 19, 1915, and they entered upon their duties. The sums sued for comprised £350, half-year's salary to Mr. Boot, £248 being 5 per cent. upon cost of new plant supplied to defenders' mills upon specifications prepared by the pursuers, and £6,902 loss and damage for repudiation of the agreement between the parties. Defenders denied that any agreement was concluded between the parties, but stated that if any agreement was made it was invalid.

The terms of the settlement of the action were not disclosed.

In re Electrical Contracts & Maintenance Co. (Ltd.)

On Tuesday Mr. Justice Neville heard a petition to wind up this company. It appeared that the company, which was formed in 1909, was engaged in the manufacture of munitions. In August, 1916, the company gave Messrs. Stoker & Bell, manufacturers' agents, an order for 3 tons of hexagon steel, 1 ton to be delivered at the company's works by Aug. 21 and 2 tons by Sept. 2, and the price was 34s. per cwt., less 2½ per cent.

discount for cash within 14 days of date of invoice. The first ton was delivered on Aug. 21, and the company paid for it, less the discount. The 2 tons were delivered early in September, and the invoice for the price, £68. 14s. 7d., was dated Sept. 13. As the company had not paid within 14 days Messrs. Stoker & Bell on Oct. 2 served on the company a written demand for payment of the £68. 14s. 7d., and followed this up with further demands for payment on Oct. 14 and 17 with a threat of proceedings. On Oct. 19 the company sent them a cheque for £67. 0s. 3d., which was the price of the two tons less the 2½ per cent. discount. The cheque reached Messrs. Stoker & Bell on the morning of Oct. 20, but they at once returned it, and later on the same day they presented a petition to wind up the company grounded on the non-payment of the £68. 14s. 7d., and they alleged that the company was insolvent and unable to pay its debts. On Oct. 25 the secretary and the solicitor of the company called on Messrs. Walbrook & Hosken, the solicitors of the petitioners and tendered the £68. 14s. 7d. in cash, and asked that the petition should not be proceeded with, but the petitioners refused to accept the tender or to stay proceedings unless the costs of the petition were paid. On Oct. 26 the company obtained an injunction restraining the advertisement of the petition.

Mr. HODGE (for the company) applied that the petition should be dismissed, or, in the alternative, that the injunction should be made perpetual, and that all further proceedings under the petition might be stayed. Under sect. 130 of the Companies Act, 1908, a company had 21 days for payment after a demand was served upon it. In the present case the petition was presented within the 21 days, and it was an abuse of the process of the Court.

Mr. GIVEEN (for petitioners) submitted that their proceedings had not been improper. The full amount was due on Sept. 27, and sending a cheque on Oct. 19 for the amount, less discount, was not payment or a proper tender.

Mr. JUSTICE NEVILLE said in his opinion the petition was a gross abuse of the process of the Court, and he dismissed it with costs, including the costs of the present application and of the *ex parte* application. The amount of the costs when taxed to be set off against the £68. 14s. 7d. owing by the company.

PARLIAMENTARY INTELLIGENCE.

PAY OF CONTROLLERS OF ENEMY FIRMS.

In the House of Commons on Thursday last, Mr. PRETYMAN stated, in reply to a question, that supervisors and controllers of enemy businesses were remunerated on the basis of the time actually occupied in the work at the rate of £5. 5s. a day for principals, £1. 11s. 6d. a day for chief clerks and 16s. a day for other clerks. An increased rate had been allowed in a few exceptional cases, and in some other cases a special fee might be paid. No formal agreements had been entered into, but the controllers were informed by letter of the scale of remuneration.

TELEPHONE NUMBERS AS TELEGRAPHIC ADDRESSES.

In the House of Commons last week the Postmaster General was asked whether the Post Office would consider the advisability of permitting telephone subscribers' exchange numbers to be used as the registered telegraphic addresses.

In reply, Mr. PEASE stated that subscribers were not only permitted but invited to use their telephone addresses for their telegrams. Owing, however, to the risk of error, unavoidable from the telegraphic transmission of figures, it was essential that the name form part of the address.

Enemy Interests in British Companies.—In the House of Commons last week the President of the Board of Trade (Mr. Runciman) said he would lay on the table of the House a list of the enemy owned shares in British companies which were vested in the Public Trustee.

Mr. PRETYMAN stated that the Public Trustee was carrying on negotiations for sale of the enemy owned shares in the Enfield Electrical Cable Mfg. Co. (Ltd.), but he had not yet effected a sale.

Siemens Bros. & Co. (Ltd.)—In reply to a question, Mr. Pretyman stated in the House of Commons on Tuesday that Mr. George Chauvin was the managing director of the company, and that Mr. Carl von Siemens was no longer a director. The firm was a controlled establishment doing Government work and was under a supervisor. It was greatly to the national interest that the business should be acquired by those British firms who could make the best use of it for the future development of the electrical industry of the country. Active steps to that end were now in progress, and in the meantime it was clearly necessary that the business should be fully maintained.

The Marconi and Telefunken Wireless Interests.—In reply to a question in the House of Commons on Tuesday, Mr. Runciman stated that he was informed by the Marconi Company that certain of their directors were [illegible] on the board of the Deutsche Betriebs-gesellschaft für drahtlose Telegraphie of Berlin in which the Telefunken Company held the majority of the shares. He was informed by the Marconi Company that they had not considered it in their interests to publish [illegible] in other companies since 1914, but that the information was at all times available to their shareholders.

The Marconi Company in 1911 concluded an agreement of a commercial nature between themselves and the Telefunken Company which dealt in some matters with Australia, New Zealand and Spain, but did not embrace the United States. That agreement had not been operative since the beginning of the war.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

13,568 WALL. Means for minimising sparking at break of a circuit containing inductance and capacity in series.
13,806 LOVELACE, FORD & EDISON & SWAN UNITED ELECTRIC LIGHT Co. Electric bells and the like.
13,904 B.T.-H. CO. (G.E. Co.) High-frequency dynamo electric machines.
13,912 NEULAND. Electromagnetic power transmission apparatus.

Comprises a power transmitting apparatus of the induction type having an armature provided with a winding, and a rotatable field element in inductive relation to said armature, said field element being composed of two relatively rotatable members adapted by their relative rotation to produce a magnetic field having an angular velocity different from that of the field element, whereby said field when in synchronism with the armature causes the field element to rotate at an angular velocity different from that of the armature.

14,160 NEULAND. Dynamo-electric machines.
14,216 WALKER. Dynamo-electric machines of the commutator type.
14,232 INTERNATIONAL ELECTRIC CO. & LE NOIR. Portable telephone and telegraph instruments.
14,233 INTERNATIONAL ELECTRIC CO. & LE NOIR. Telephones.
14,650 SHAW, SHAW & SHARP. Alternating-current electric motors.
17,533 RICHARDSON & GILL. Electrical indicating devices to be used on taxicabs and the like. (Cognate application, 6,095/16.)
17,833 WILSON, ANDERSEN & CURTIS. Systems of electric welding. (31/12/14.)

1916 SPECIFICATIONS.

894 PETTERSEN, K. Current limiters or electric interrupters. 100,048.
4,413 UNWIN, T. Y., & BRITISH EVER READY CO. Electric flashlamp attachments. 101,585.
5,240 LAMKIN, A. E. Sparking plugs. 101,592.
6,735 CHURCHILL & CO., C., & GEERAERD, E. Electrolytic cells. 101,598.
7,347 RUSHTON, G., & LACY, L. R. Means for earthing electric conductor conduits. 101,604.
8,521 HARRINGTON, J. Fittings for preventing theft of electric incandescent lamps. 101,607.
8,577 O'DONNELL, J. P., & KNOX, H. S. Railway signalling apparatus. (Addition to 8,328/15.) 101,608.
8,698 AKT.-GES. BROWN, BOVERI ET CIE. Method and apparatus for varying the pressure in electromagnetically operated carbon pressure regulators. 100,788.
9,745 ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET. Electric couplings. 100,948.
10,554 VERNIER, C. Electric cable joint boxes. 100,614.
11,658 WERNER, V. G., & WARFVINGE, K. H. Means for telephonic communication to and from moving railway trains and the like. 101,343.

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 23, 1915.

13,523 LALBIN. Cold process for galvanic deposit of aluminium, &c.

September 25, 1916.

13,564 BARR. Electric water heaters.
13,585 DETRAUX. Means for carrying electric cables.
13,591 WILSON. High-tension discharge apparatus.
13,593 LANDTMETERS. Electric resistance furnaces.

September 26, 1916.

13,617 SOUTTER. Electric fire and stove.
13,631 SANGSTER. Attachment of magnetos to motor cycles.
13,659 ELLISON. Controllers for electric motors.
13,661 BRILLIE FRERES (SOC. ANON.) Electric apparatus for transmitting movement at a distance. (28/9/15, France.)
13,664 RICE. Combined electric stoves and toasters. (22/9/15, U.S.)
13,665 VAN DEVENTER. Ignition mechanism. (28/10/15, U.S.)
13,671 YOUNG & B.T.-H. CO. Dynamo-electric machines.

September 27, 1916.

13,707 CRAWFORD, PRESTON & W. SANDERS & CO. Electric switches.
13,716 RENDALL. Self-winding spring motor-starter.
13,725 SCOTT. Combined switch and plug boxes for electric circuits.
13,727 PATE & W[illegible]. Electric heating and cooking apparatus.
13,746 LAMBOURNE. Electric signalling systems.
13,754 BERRY. Electric cooking, &c., apparatus.
13,758 LAT[illegible]. Dynamo-electric machinery. (7/9/15, France.)

September 28, 1916.

13,767 HOPE. Electric switches.
13,768 THEOBALD. Trolley-pole attachment for preventing flash.
13,787 MACTAGGART & SCOTT. Telemeter apparatus.
13,798 FORBES. Therapeutic lamps.
13,803 B.T.-H. CO. (G.E. Co.) Electric motor control.
13,805 SMITH & TILLING-STEVENS (LTD.) Automobile electric apparatus for welding, &c.
13,812 BA[illegible]. Electromagnetic engine.
13,814 BETH[illegible]-GIRARDEAU. Magnetos. (20/12/15, France.)
13,816 BRITISH WESTINGHOUSE ELEC. & MFG. CO. Systems of distribution. (7/10/15, U.S.)
13,820 B[illegible] & R[illegible]. Automatic shifting device for magnetos. (2/10/15, France.)
13,8[illegible] H[illegible]MANN & WAL[illegible]. Portable electric lamps. (25/9/15, Germany.)

September 29, 1916.

13,839 TAY[illegible]. Voltage regulation on alternating-current sub-stations, &c.
13,840 T[illegible]. Sparking plugs.
13,874 SMITH & TILLING-STEVENS (LTD.) Ventilating and cooling electric generators, &c.
13,8[illegible] TI[illegible]. An[illegible] cables. (31/12/15, Germany.)
13,887 S[illegible]. Apparatus for electric transmission of rotary motion, &c.
13,8[illegible] P. C. R[illegible]. (B[illegible] Magneto Co.) Magneto dynamos.

September 30, 1916.

13,899 WILKS & CR[illegible] (T.) & SONS. Sparking plugs.
13,9[illegible] HAY. Cooling &c. storage batteries in submarines.
13,9[illegible] [illegible]. Telemeter.
13,942 L[illegible]. Electric train lighting systems, &c.
13,943 C[illegible]. Telephones.

October [illegible] 1916.

[illegible] WESTVING & FERRANTI (LTD.) Thermostat.
[illegible] H[illegible]. Magnets for magneto ignition apparatus.

October 3, 1916.

[illegible] H[illegible]. Electric heating [illegible].
[illegible] BA[illegible]. Magnetic [illegible].
[illegible] T[illegible]. Relay for [illegible] currents.
[illegible] P[illegible] & RELAY AUTOMATIC TELEPHONE CO. Connection telephones, &c., lines.
[illegible] [illegible]. W[illegible]. (11/[illegible]/16, Japan.)
[illegible] B.T.-H. [illegible] (G.E. Co.) Electric [illegible].

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

Controlled Establishments.

The Minister of Munitions announces that 74 additional establishments have been declared controlled establishments, making the total number of controlled establishments under the Munitions of War Acts, 1915 and 1916, 4,390.

* * * *

Motor Vehicles.

The Minister of Munitions has issued an order dealing with motor vehicle work.

The order prohibits until further notice any person, firm or company engaged in the manufacture or repair of any vehicle designed for mechanical transport or traction, or any part of such vehicle, from carrying out in any factory, workshop or other premises without a permit from the Admiralty, the Army Council or the Minister of Munitions any work consisting of the manufacture, assembling or erection of any new or unused motor internal combustion engine designed or adapted for mechanical traction, or of any new or unused motor chassis, motor wagon or of any tractor or other vehicles of any kind propelled by mechanical means.

Work required to complete contracts placed by the Admiralty the War Office, the Minister of Munitions, or an Allied Government on or before the date of this Order is excepted.

* * * *

Commercial Libraries.

On Friday last the Lord Provost of Glasgow (Sir Thos. Dunlop, Bart.) opened the Municipal commercial library which has been organised by the Libraries Committee of the Corporation. This is an interesting departure which might be copied by other Municipalities.

The Commercial Library is at 21, Miller-street, where it will be readily accessible to the business community. Provision has been made to meet the more urgent needs of business men. The first aim of the Libraries Committee has been to provide a representative collection of directories, guides, consular and company reports, Parliamentary and official publications, reports of Chambers of Commerce, statistical and other year-books, commercial and geographical gazetteers, maps, and atlases, standard works on commercial and industrial law, a comprehensive series of trade and technical periodicals, and a considerable collection of important dictionaries and other reference books. The Government and trade publications include recent Parliamentary papers, emergency legislation, revised statutes, reports of the Boards of Trade, Agriculture and Fisheries, also information relating to home, foreign and colonial trade, labour, finance and other matters. A classified register on cards is being compiled, and this will become a special feature of the Library. The information will include an indication of the general character of the business of each firm, with notes of their specialities or leading lines, telephone numbers and telegraphic addresses. A record will be kept of all persons competent and willing to undertake the work of translating letters and preparing specifications and other documents in foreign languages. The books relate principally to commerce and trade and deal with economics, banking, accountancy, exchange, industrial and commercial law, advertising, &c. The manufacturer and exporter are catered for by a series of hand-books, journals and reports issued by the various chambers of commerce and trade associations in the United Kingdom, France, Russia, Italy, Portugal, Spain, Norway, Sweden and Denmark, Africa, China, and South America. The leading technical and commercial journals and periodicals are included, but the specifications of patents, patent journals, and important works on the law of patents, trade marks and copyright are placed in a special department.

The Metric System.

At the recent meeting of the Bradford Chamber of Commerce there was an animated discussion on a resolution sent by Clayton Urban Council in favour of the adoption of the decimal system in British trade.

Mr. T. Whiteley expressed the view that it would be of advantage to adopt the system in the Bradford piece goods trade. He said "We were setting out to do more foreign trade, but we still cling to our system of yardage and pounds, shillings and pence, which puzzled every foreigner who got British invoices."

Mr. F. A. Aykroyd referred to the efforts to improve our trading relations with Spain and said the decimal system would be very helpful to us for that purpose. We had got to remodel our system of foreign trading on broader lines. The world as a whole was more familiar with the decimal system than with our pounds, shillings and pence, and some change was vitally necessary to assist our foreign trade.

Mr. C. Mossman said that from his experience as a traveller in Continental countries he found that a great many firms had declined to do business with English firms unless they adopted the decimal system, and he thought it was absolutely necessary to take the matter into consideration.

Mr. A. E. Lewis said the foreign purchaser wanted the quotations that were submitted to him to be in such terms as he easily understood. A Russian purchaser, for example, anxious to buy goods from England, wanted to receive the quotations in such a form that he could easily compare them with the quotations for similar goods that were sent in by other countries, and we did not meet his desire by quoting in terms of pounds, shillings and pence, which were most confusing.

The Chairman remarked that Mr. Balfour's Metric System Bill some years ago never had the slightest chance of getting through. The more he thought about the question of the metric and decimal system the more he realised what a grave revolution the adoption would mean in this country. To-day anybody could sell either in kilos or in pounds. In his view considerable propaganda work would have to be undertaken throughout the country before anything could be done.

It was eventually decided to support the Clayton resolution.

* * * *

Double Taxation of Colonial Businesses.

The liability of the profits of Anglo-Colonial electric supply and tramway undertakings and of certain business houses to double income tax is arousing considerable feeling in Colonial circles.

No doubt double income tax within the Empire is inequitable in its incidence, and, although Mr. McKenna has to some extent met Colonial demands, a further effort should be made to remove the present grievance. It was reported in "The Times" of the 7th inst. that the question was becoming an increasingly acute problem in financial and commercial circles. A private meeting of Australian merchants and financiers was held on Tuesday to discuss the matter with a view to energetic steps being taken to impress upon the Chancellor of the Exchequer the need of dealing with the subject now and not after the war. Already certain companies and firms have removed the control of their businesses from London to places abroad in order to escape the burden of double taxation, and other firms are considering the same course of action. It is even reported that several Anglo-Australian firms have dispatched buyers for the Australian market to the United States and other neutral countries in order that the double impost may be avoided. It will thus be seen that the question is one of urgent Imperial importance.

* * * *

Canadian Aluminium and Asbestos.

Early in 1915 the Canadian Government put an embargo on aluminium shipments to countries other than British, although shipments were permitted to be sent to a few American firms working on war contracts.

There were also exported to the United States from Quebec 17,000 tons more of asbestos in 1915 than in 1914, at an increased valuation of £121,626. Asbestos is an important mineral product of that province. The industry was unfavourably affected by the outbreak of war, as Germany and Austria were the principal markets for the higher grades of asbestos. It is now stated that there has been an increased demand for this article from the United States, Great Britain, France and Italy, due in a large measure to military and naval requirements. This demand has greatly revived the industry, which continues to improve, and there is reason to anticipate wider markets after the war.

* * * *

Trade of India.

It is announced that the Secretary of State for India has authorised the Indian Committee of the Imperial Institute to inquire into and report on the possibilities of further extending the industrial and commercial utilisation of Indian raw materials in this country and elsewhere in the Empire.

The Committee has already commenced its work and has appointed a number of sub-committees to deal with the more important groups of materials, to consider the results of investigations and inquiries already conducted by the Imperial Institute, and to obtain the views of leading merchants, manufacturers and other users of the raw products of India. The Indian Committee of the Imperial Institute includes Lord Islington (Under-Secretary for India), Sir Marshall Reid (member of the India Council), Prof. Wyndham Dunstan (director of the Imperial Institute), Mr. L. J. Kershaw, Sir John Hewett and Mr. Geo. B. Allen. Mr. C. C. McLeod (chairman of the London Jute Association) is chairman of the Committee, and the secretary is Mr. A. J. Hedgeland, of the Imperial Institute.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Oct. 28, 1916, *to* Nov. 3, 1916.

IMPORTS.

GOOLE.—*Sweden*: Elec. machinery, 192 pkgs.

LIVERPOOL.—*Spain*: Elec. carbons, 50 pkgs. *U.S.A.*: Carbon electrodes, 73 crts.

LONDON.—*U.S.A.*: Wire and cable, £3,792; carbon candles, £657; telephone material, £1,652; unenumerated, £6,982—654 pkgs. *Holland*: Elec. glow lamps, £155; unenumerated, £527. *Japan*: Glow lamps, £258; elec. lamps, 32 cases; elec. torches, 15 cases; unenumerated, £2,936—42 pkgs. *Switzerland*: Unenumerated, £804. *France*: Carbon candles, £308; unenumerated, £1,071. *Sweden*: Unenumerated, £42. *Canada*: Unenumerated, £139. *Norway*: Unenumerated, £1,355.

EXPORTS.

TO AUSTRALASIA.—*Auckland*: Wire and cable, £95; unenumerated, £506. *Melbourne*: Wire and cable, £3,556; elec. machinery, £752; heating lamps, £415; unenumerated, £[illegible] 249. *Sydney*: Elec. machinery, £1,542; wire and cable, £2,745; telegraph material, £140; unenumerated, £1,551. *Wellington*: Wire and cable, £78; elec. lamps, 4,900 n.o.; unenumerated, £1,18[illegible]. *Lyttelton*: Wire and cable, £87; unenumerated, £135. *Adelaide*: Wire and cable, £757; telegraph material, £12; unenumerated, £612. *Christchurch*: Wire and cable, £397; unenumerated, £75. *Perth*: Wire and cable, £151, unenumerated, £54. *Brisbane*: Unenumerated, £168. *Fremantle*: Elec. machinery, £142. *Dunedin*: Wire and cable, £725; unenumerated, £46. *Rockhampton*: Unenumerated, £15. *Oaman*: Elec. cable, £285; telegraph material, £176. *Newcastle*: Elec. machinery, £1,019; unenumerated, £34.

AFRICA.—*Durban*: Wire and cable, £4,081; elec. machinery, £663; unenumerated, £[illegible]95. *Cape Town*: Wire and cable, £266; unenumerated, £405. *Port Elizabeth*: Wire and cable, £25[illegible]; unenumerated, £13. *Delagoa Bay*: Unenumerated, £134. *Mombasa*: Unenumerated, £16. *Mauritius*: Unenumerated, £148. *Zanzibar*: Elec. machinery, £1[illegible]6.

MALTA: Unenumerated, £5[illegible].

EGYPT.—*Port Said*: Wire and cable, £44; unenumerated, £45. *Alexandria*: Telegraph material, £2[illegible]. *Port Sudan*: Unenumerated, £43.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay*: Wire and cable, £[illegible]; telegraph material, £17; unenumerated, £1,245. *Calcutta*: Elec. machinery £[illegible]; wire and cable, £1,41[illegible]. *Madras*: Wire and cable, £172; elec. machinery, £30; unenumerated, £[illegible]4. *Karachi*: Unenumerated, £216. *Ceylon*: Unenumerated, £346. *Port Swettenham*: Telegraph material, £269; unenumerated, £175. *Singapore*: Wire and cable, £183; unenumerated, £26[illegible]. *Bangkok*: Unenumerated, £139. *Sourabaya*: [illegible] unenumerated, £228. *Kilindini*: Unenumerated, £467. *Padang*: [illegible] £42.

CHINA [illegible].—[illegible]: Wire and cable, £199; elec. lamps, 145 n.o.; unenumerated £125. *H*[illegible]: Wire and cable, £4[illegible]; unenumerated, £17. *Tientsin*: Unenumerated, £53. [illegible]: Wire and cable, £266; unenumerated £78.

[illegible] AND [illegible].—*Buenos Aires*: Unenumerated, £296. *Santos*: Telegraph material, £[illegible]. [illegible]: Elec. [illegible], £142. *Valparaiso*: Unenumerated, £20. [illegible]: Wire and cable, £2[illegible]. [illegible]: Elec. cable, £250; unenumerated, [illegible]. [illegible]: Unenumerated, £16. *Tandjong* [illegible]: Unenumerated, £3[illegible]. [illegible]: Unenumerated, £26.

[illegible]: Unenumerated, £[illegible]. *Samarang*: Elec. machinery, £77; unenumerated, £[illegible].

[illegible]: Unenumerated, £[illegible].

[illegible]: Unenumerated, £[illegible]. [illegible]: Wire and cable, £586; unenumerated, £[illegible].

[illegible]: Unenumerated, £1[illegible].

[illegible]: Elec. [illegible], £[illegible]; unenumerated, £1,112. [illegible]: Elec. [illegible] £412. [illegible]: Elec. machinery, £61. [illegible]: Unenumerated, £270.

[illegible]: Elec. machinery, £250; unenumerated, £11.

[illegible]: Wire and cable, £[illegible].

[illegible]: Unenumerated, £33.

[illegible]: Unenumerated, £[illegible].

[illegible]: Unenumerated, £[illegible]; unenumerated, £54.

[illegible]: Unenumerated, £4[illegible]. *Y*[illegible]: Unenumerated, £38[illegible]. [illegible]

FOREIGN GOODS (duty paid and free).

[illegible] unenumerated, £20. *Hull*: Elec. [illegible] £1,[illegible]0. [illegible] unenumerated, £[illegible]1. *Durban*: Unenumerated, [illegible]. [illegible]: Elec. [illegible], £111. [illegible] unenumerated, £27. [illegible]: Unenumerated, [illegible]. [illegible] unenumerated, £500. [illegible] unenumerated, £32. [illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL.

Royal Technical College, Glasgow.—At the recent annual meeting of the governors the chairman (Sir Geo. T. Beilby) emphasised the importance of increasing the number of youths undergoing technical training to [illegible] of industry. In submitting the report for the session 1915-16 he directed attention to the decrease in the number of students compared with 1913-14.

Mr. [illegible], who moved approval of the minute of the Committee on Chemistry and [illegible], [illegible] to the work done for the Government in [illegible] had been carried out [illegible]. There was also work [illegible] in the analysis [illegible] the [illegible] referred to a proposal made by the [illegible] for the establishment of research scholarships for carrying out experimental work at the college in connection with their industry. The governors would be glad to note that the college was getting into touch with the industries of Scotland, and they hoped that that development would continue. A local firm of ironfounders had also suggested consultative work in metallurgy.

The minute was approved.

Mr. ROBERTSON then submitted the minutes of the Committee on Engineering, and reviewed the report of the sub-committee dealing with the work done by the college in connection with the training of workers for munitions work. He also called attention to the report by the professor of mechanics on the testing work recently undertaken in his department, for the aeronautical inspection department, for the inspector of the munitions area, and for firms engaged in munitions work.

The minute was approved.

The statistical records showed the number of individual students to be 2,524 compared with 5,011 in 1913-14. Whether they were going to go further down or not the chairman could not say, but there were encouraging features in the incoming stream of students. It was of great importance that youths should be coming forward in great numbers to take up the industrial work of the nation after the war. The ranks of experienced scientific workers had been sadly depleted. Many men had been cut off at the most promising years. It was, therefore, extremely important that we should try to stimulate the entry to the college of boys and youths so that they might undergo the necessary training. One of the great lessons of the war was that the future industry of the country must depend on men of high technical training, otherwise we could not hope to keep our place in the world's industry. An institution of that kind was the natural channel through which the need for trained men should be supplied. The prospects for the future employment of trained chemists were very bright indeed. At present it was impossible to supply all the trained chemists wanted. He submitted a return of members, students and past students on service: Of officers there were 659, non-commissioned officers 427, men 1,080, nurse 1, others on special service 13, a total of 2,180.

Bristol "Sandwich" Scheme of Engineering Training.—Since the first list of firms who have accepted this scheme was published recently, the following additional firms have accepted it:—

The Electric Construction Co. (Wolverhampton), Messrs. John Fowler & Co. (Leeds), Mawdsleys (Ltd.) (Dursley), and the Wolseley Motors (Ltd.) (Birmingham). The last-named company has also offered two Wolseley scholarships to be granted on the results of the intermediate examination for the B.Sc. degree in engineering of the University. This will excuse the winners from payment of the usual works premium (at the rate of £100 a year), and will entitle them to remuneration at the rate of 10s. a week for the first two periods of one and two months respectively while in the works, and £1 a week for the last period of 14 months.

The "sandwich" scheme, besides providing an improved method of engineering training, will also, it is hoped, bring the important firms which are taking part in it into closer touch with the University, and thus lead to more co-operation in research and other matters.

City and Guilds Examinations and Books. We have frequently called attention to the out-of-date lists of works of reference given in the "Programme" of the City and Guilds Institute, and we are glad to notice that "Electricity" is also devoting some attention to the subject. From the last issue of our contemporary we extract the following:—

"*Books and Examinations.*—Whatever some people may say to the contrary, we cannot get on without these things, and the majority of our readers have probably sat for, or thought about sitting for, one of the various excellent electrical examinations conducted by the City and Guilds of London Institute. Though the examinations are excellent, the same can hardly be said of the lists of works of reference given in the "Programme" of the Institute under the syllabus of each subject. One reason is that some of the books are unobtainable, having been out of print for years, another is that some are obviously very much out of date." Our contemporary asks its readers to inform it of one or more books which they have found useful in working-up for an examination, and to state the grade for which they worked. From the replies it is proposed to publish representative lists.

BUSINESS NOTICES.

Patent Development. The owners of British patents Nos. 8,901/1911, 21,281/1912 and 22,723/1903, relating to "Electric furnaces," desire to enter into negotiations for the development of the patents in this country. Applications to Messrs. Abell & Imray, patent agents, 29, Southampton-buildings, London, W.C.

Also the proprietors of patents Nos. 21,702/1908 and 21,708/1908, for "Improvements in and relating to electric fusible cut-outs" and for "Improvements in seal fastenings," desire to enter into arrangements for developing same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

BANKRUPTCIES, &c.

Claims against Russell Ernest Connold, formerly electrician, of 6A, The Parade, Canterbury, are to be sent by Nov. 17 to Mr. G. E. Corfield, Balfour House, Finsbury-pavement, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—Acting on the advice of the city electrical engineer (Mr. J. Alex. Bell) the Electricity Committee recommend the erection and equipment of a sub-station in York-place at a cost of £2,800.

It was intended to increase the supply in the Footdee district by an e.h.t. supply when war broke out, and the work was, therefore, held over. The continued additions to the load in this area, together with a recent application for a further 700 H.P. for a shipbuilding yard, made it imperative to proceed with the work without unnecessary delay.

Aldershot.—As the electrical engineer has been unable to obtain satisfactory tenders for laying a main to The Foleys, arrangements have been made for the surveyor to carry out the work.

Burton-on-Trent.—The 3-phase main is to be extended to works in Park-street, at a cost of £70.

Glasgow.—The Electricity Committee has adopted Mr. W. W. Lackie's scheme for meeting the increasing demand for electrical energy, and instructions have been given to obtain estimates.

Hackney (London).—It has been decided to extend the distributing main in High-street, Kingsland (at a cost of £165) so as to supply electrical energy to a factory. A guarantee of a minimum of amount £100 per year for five years has been obtained. —

Rotherham.—Plans have been passed for the Rotherham Forge & Rolling Mills Co.'s electrical sub-station, and the Electricity Department is to erect an overhead electric cable to the works.

New electrical air compressors are to be put in by the Sewerage Committee, and the Electric Light Committee will contribute £500 towards the cost.

Sheffield.—Several extensions of mains to supply electrical energy to works have been authorised.

The Electricity Committee has passed resolutions to the effect that as the Neepsend generating station is unable to supply all the power required a new generating station should be provided; that Sir Alex. Kennedy be requested to advise on the scheme and that the Town Clerk be instructed to take steps to obtain the necessary powers. The Electricity Committee has also resolved to take steps to acquire a plot of land in the East end of the city for the erection and equipment of a sub-station at an estimated cost (excluding price of site) of £8,000.

The work of converting to electrical driving the rolling mill previously driven by water power at the Old Park Silver Mills Company's works has been completed at a cost of £430.

GENERAL.

Aldershot.—Mr. Calvert, in moving at the last meeting of the Council, that the charges for electricity be increased, said, that owing to the curtailed output there was a deficit.

The only alternative to raising the price was to throw a burden on the rates. After discussion, the following rates were agreed to: (1) A flat rate of 6d. per unit in lieu of 4½d. per unit, plus 10 per cent.; (2) the existing power and heat rates of 2d. down to 1½d. sliding scale, plus 20 per cent. advance to be withdrawn, and the scale raised to 3d. per unit down to 2½d. per unit net; (3) Messrs. Gale & Polden will be charged for power consumption at 1½d. per unit (in lieu of 1d. per unit) plus 20 per cent.; (4) a rental will be charged for all meters from 1s. 6d. per quarter minimum to 2s. 6d. per quarter maximum.

Belfast.—A deputation from the electrical contractors and traders of the city recently waited upon the Council for the purpose of urging the desirability of making provision to meet the growing demands for electric current.

Mr. Stanley Johnston, speaking on behalf of the deputation, said they represented the entire electrical trade of Belfast, and they wanted to urge on the Corporation the necessity of proceeding immediately with the erection of the new electricity station at the Musgrave Channel, and to install the first set of not less than 5,000 kw. as quickly as possible. As the present station had now reached its maximum output, the members of the electrical trades felt that their business was being curtailed owing to the greatly increased demand. Other departments of the Corporation had progressed at a rapid rate. One department had been extremely busy pulling down old property, broadening the streets and making open spaces for the erection of new buildings, which would require electric current in due time. The electricity department was stagnant, and had made little effort to progress in the way that other departments had done. Every member of the Corporation, as well as every ratepayer, was anxious that Belfast should maintain its manufacturing and industrial progress, and the first essential to that was cheap power. The city accountant had told them there was a large balance to the credit of the Corporation, and surely a portion of that money could be profitably used in connection with the erection of the new station. At present Glasgow had authorised their Committee to proceed with their new station and to install 40,000 H.P. additional. There were a number of electricity stations on the other side of the water which had a greater quantity of spare plant than Belfast. Glasgow had 9 per cent., Birmingham 25, Edinburgh 80, Leeds 60 and Liverpool 90; whilst Belfast had only 11 per cent. That was a serious matter for the Corporation as well as for the general body of citizens.

Mr. W. J. M'Keown, another member of the deputation, also spoke.

The Lord Mayor said the question of extending the electricity works had received earnest consideration in the past, and it had been discussed in the Council chamber on more than one occasion. He assured the deputation that the subject would be taken up afresh, and discussed seriously; but he could not promise anything more than that. It was a very important matter, and one on which members of the Corporation were to some extent divided, but it would be considered.

Cambuslang.—The formal opening of the Clyde Mill Power station of the Clyde Valley Electrical Power Co., took place on the 1st inst., when the current was switched into the line by Mrs. D. A. Starr, wife of the company's general manager.

The new station is situated on the south bank of the River Clyde and the present plant consists of one 5,000 k.w. turbo-alternator, generating three-phase electrical energy at 25 cycles. The turbine is of the Rateau type, and was made by the British Westinghouse Electric and Manufacturing Co., who have already installed five similar machines at the company's power stations at Yoker and Motherwell. The boilers are of Babcock & Wilcox water-tube type, each evaporating 34,000 lb. of steam per hour, and working at a pressure of 200 lb. per square inch. The coal handling plant provides for the mechanical handling of the entire coal supply from the railway wagons to the bunkers. The wagons are delivered on to an elevated railway, and emptied by means of hydraulic rams, so arranged as to tip up one end of each wagon to such an angle as permits of the entire contents of the wagon being discharged by gravity into a large containing hopper, which in turn discharges its contents on to an elevator conveying the coal into overhead bunkers. The design also provides for the removal of all ash and soot by means of a suction plant. The river work on the Clyde comprises the building of a coffer dam to permit of the erection of that part of the work under river level. The whole of the operations were carried out under the personal supervision of the company's general manager, Mr. David A. Starr, M.I.E.E. The present works at Clyde's Mill form the nucleus of what, it is believed, will ultimately be one of the largest power stations in the United Kingdom.

Dublin.—The special committee appointed to inquire into and report upon the administration of the electricity supply undertaking will be considered at the next meeting of the Corporation.

The report, which is 141 pages in length, contains the reports of Col. P. W. D'Alton, consulting engineer, the City Electrical Engineer, the City Accountant, the Deputy City Electrical Engineer, and the Secretary to the Electricity Supply Committee.

We have already given an abstract of Col. D'Alton's report, which referred to the initial mistake in the choice of site of the power-house, and pays a tribute to the administrative control of the undertaking. He criticises dual control of the executive side of the undertaking by a manager and an engineer, and suggests that the engineer should be also manager and responsible for successful conduct of the undertaking from a commercial as well as an engineering point of view. In the latter point Mr. Ruddle agrees that the engineer should have absolute power of selection of the staff, but Mr. F. J. Allan contradicts this most emphatically, and points to results as justification of the existing arrangement, and says there is no complication or dual control.

Col. D'Alton also considers the prices for power and light for private supply so unduly high that they prejudice expansion of business.

Col. D'Alton was supplied with copies of the reports of the officials, and deals with these in a supplementary report, in which he states:—"Experience, I think, has demonstrated that control should be vested in the engineer, for it is impossible to put a limit in an electricity undertaking to the duties which come under technical direction. There are many cases which one could quote in support of this certainly growing, if not yet fully established, practice."

The Committee state that "having most carefully examined into the electricity undertaking and considered the report of Col. D'Alton, the reports of our own engineers, also the reports of Mr. Allan and Mr. Mangan, we believe that the best course for the Corporation to adopt would be to direct the Town Clerk to write to Col. D'Alton, asking him upon what terms and conditions he would undertake the entire management of the electricity undertaking during a period of three years; and we recommend accordingly to the Municipal Council."

Hove.—A steam blower is to be installed for creating a forced draught on one of the boilers at the Davigdor-road works at a cost of £45.

Hammersmith (London).—The Board of Trade have authorised the Borough Council to supply electricity in bulk to the Chiswick Electricity Supply Corpn.

Islington (London).—The employés of the electric supply department are to have their wages increased by a penny an hour.

Kingstown (co. Dublin).—The Urban Council have adopted a report of a special committee recommending the payment of £800 to the Dublin Southern District Electric Supply Co. in discharge of all claims against the council in connection with the eletric lighting order.

Linking Up in W. Scotland.—In pursuance of the objects of the National Electric Power Supply Joint Committee, a meeting was held at Glasgow on the 3rd inst. with a view to the formation of a Linking-up Committee for the West of Scotland.

Mr. J. K. Stothert, chairman of the Scottish Local Section of the Institution of Electrical Engineers, who had convened the meeting, presided, and representatives were present from 15 electricity supply undertakings in the West of Scotland. A letter was read from Mr. W. A. Chamen, the chairman of the National Electric Power Supply Joint Committee, and there were distributed copies of the circular explaining the position and the objects which the National Committee had set out to attain. Mr. Lackie, as a member of the National Committee, gave a brief account of the work which the Committee had already done, and on the suggestion of the chairman the meeting proceeded to elect office bearers, as follows:

Chairman, Mr. George Balfour (representing the Scottish Central Power Co.); *Vice-chairman and Secretary*, Mr. W. H. Whysall, chief engineer Greenock Corporation electricity department. As a general committee all those who had been invited to the meeting are to have one representative from each undertaking in the district. The acting sub-committee is composed of the chairman and vice-chairman, with Messrs. W. W. Lackie (Glasgow), D. A. Starr (Clyde Valley Electric Power Co.), E. G. Churchward (Scottish Central Electric Power Co.), C. F. Parkinson (Paisley Corporation), W. C. Pexon (Kilmarnock Corporation), R. A. Brown (Falkirk Corporation), and Mr. Wishart, of Dunbarton electricity department. A circular is to be sent to the various undertakings concerned with a view to the collection of the necessary data, in the hope that it will be possible in due course to evolve a scheme of linking-up for part or parts of the district.

Ripon.—On Monday the City Council decided to apply to the Board of Trade for a Provisional order.

Shipley.—At the last meeting of the Council it was reported that applications had been received from residents in Baildon for a supply of electricity from Shipley, but the Baildon Council had intimated that they did not, at present, favour the suggestion of granting general powers to distribute electricity in the Baildon area, and the matter may be considered in abeyance until the end of the war. Members expressed regret at this decision but as it is not possible to go into another authority's district without permission the proposal has been abandoned.

Stafford.—As the L.G. Board have refused sanction to a loan of £1,000 for the purchase of land adjoining the electricity works for extensions, the owners have been asked to agree to the purchase being postponed for 12 months.

Sunderland.—The Corporation have decided to enter into a 7½ years' agreement for the supply of electricity to a firm of steel manufacturers, an innovation as far as Sunderland is concerned.

Wigan.—The Electricity Committee received 106 applications for the position of borough electrical engineer, and these were reduced to the following eight:—

Messrs. H. J. L. Bull, acting electrical engineer, Wigan; John Collinge, station superintendent, Salford; J. Barcroft Hudson, deputy borough electrical engineer, Bootle; R. H. Lee, chief assistant engineer, Stockport; Edward G. Love, deputy electrical engineer, Halifax; Edgar Moxon, deputy electrical engineer and manager, Blackburn; R. Owen, deputy engineer, Leeds; and Harry Webber, borough electrical engineer and tramways manager, Keighley.

Woolwich.—The Electricity Committee has completed negotiations for the supply of electric current to one large company. Negotiations are proceeding with an important authority for a stand-by supply.

The Works Committee has entered into an arrangement in regard to the lighting of roads in certain working class areas in the borough. The cost, including the provision of columns and lanterns, will not be borne by the Council, only the maintenance and lighting charges being borne by them. An agreement has been sealed for supply of electricity to a factory at Eltham.

TRACTION NOTES.

Birmingham.—[illegible] of the tramcar service have [illegible] tramways department were considered [illegible] Committee on Friday.

At the [illegible] (Ald. [illegible]) said the main [illegible] whether it was wise to notify the [illegible] the trams would be definitely stopped [illegible] at Nechells power station, or whether it would be [illegible] that efforts should be made [illegible]. The engineer to the electricity department (Mr. [illegible]) and the manager of the tramways (Mr. Baker) had [illegible] from every point of view, and the committee [illegible] better not to make any definite [illegible] sufficient supply of current [illegible] in the morning, and again in the evening [illegible] as well as during the dinner period from half past twelve [illegible] after two o'clock.

In view of this it was thought it would be wise to let the public take the risk of the cars running at other periods of the day. If the day was fine, and the department were able to get good coal, the cars could run nearly all day, but if the fuel was poor and the weather was wet there was more danger of a stoppage, because in generating electricity wet coal was a serious factor, especially when the plant was running with heavy loads.

It was arranged that power should be given to Mr. Chattock and Mr. Baker to revise this decision if at any time they thought it necessary to do so. The Committee also considered the general question of the supply of current throughout the city. The output of the department has increased from 80 million to 150 million units during the last two years. Deliveries of plant have been delayed, and to this and the depleted staff are due the inability of the department to cope with the demands. Steps are being taken to secure the installation of plant (which should have been in working order by the end of September) before the middle of December, and when this has been accomplished it is hoped that the difficulties of the Committee will come to an end.

Blackburn.—The Council have asked Accrington Council to increase the rate per car-mile paid for the Blackburn cars running on the Accrington section, and Accrington Tramways Committee is preparing a report on the matter.

Carlisle.—The Watch Committee have refused to sanction the appointment of women as tramcar drivers.

Derby.—Owing to the shortage of labour and the increased pressure on the depleted staff, the Council is recommended to discontinue the Sunday service of cars.

Portsmouth.—In future the tramcars will be stopped 1½ hours earlier in the evening.

Rochdale.—On the 2nd inst. a tramcar which was travelling between Whitworth and Bacup got out of control and jumped some points.

The car was put back on the line, when it ran backwards at considerable speed, again jumped the metals, travelled a hundred yards on the roadway, crashed against an electric standard and overturned in such a position that it hung balanced on a low wall overlooking a valley. Of the 30 passengers in the car 12 were injured.

Sheffield.—The Tramways Committee have decided to purchase a site at the corner of Pickmere-road and Fitzgerald road for a depot.

The Tramways Committee has decided to pay an honorarium of £10 each to Inspectors Baines and Pulfrey for services rendered in connection with training women conductors and motor men respectively since the commencement of the war.

TELEGRAPH AND TELEPHONE NOTES.

Delivery of Telegrams by Telephone.—The Post Office notify that owing to the shortage of boy labour there is a difficulty in making prompt delivery of telegrams by messengers.

The difficulty will be greater during the winter months, and it is pointed out that the delivery of telegrams by telephone with delivery by post of confirmatory copies provides a good alternative. In small places fully addressed telegrams can, if the addressee agrees, be delivered by telephone but at large offices in towns such telegrams cannot be picked out. It would be of great assistance to the Post Office if the public would make greater use of the arrangement under which telegrams may be directed to the telephone address.

Wireless Telegraph Apparatus on Ships.—At the recent meeting of the North of England Steamship Owners' Association correspondence was read with respect to the recent instructions that all British ships of 3,000 tons gross and over must in future be installed with apparatus for the transmission of wireless telegraphic messages.

The Lord Mayor (Councillor Geo. Lunn) referred to the difficulty likely to be encountered in obtaining operators, and a committee was appointed to consider the possibility of providing a local school of instruction in conjunction with the Educational authorities.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says a proposal for electricity supply in Narrabri (N.S.W.), at an estimated capital expenditure of £7,500, is under consideration.

It has been decided to adopt electric lighting at Southport (Queensland).

Featherston (N.Z.) municipality has been authorised to borrow £3,000 for an electricity supply undertaking.

Mr. Justice Cussen, the arbitrator between the Melbourne Tramway & Omnibus Co. and the Tramway Board, to decide the amount to be paid to the company for its rolling stock and properties, recently commenced taking evidence. The company's claim is for £469,080.

Owing to the magnitude of the demand for electric power made upon the Tasmanian Government's hydro-electric department, surveys are being made to ascertain whether works similar to those at the Great Lake could not be profitably constructed at Lake Clair, nearly south-west of the present works. Lake Clair has an area of 30 sq. miles, and is 600 ft. deep.

Crookwell (N.S.W.) Shire Council is seeking authority to establish electricity supply works.

Egypt.—The following are extracts from a report by special Committees of the British Chamber of Commerce of Egypt, 6, Rue de l'Ancienne Bourse, Alexandria, formed in Cairo and Alexandria with the object of studying the best means of promoting British trade interests in that country:—

Egyptian imports of iron and steel are considerable. The United Kingdom supplied a considerable share, but Belgium was predominant in iron and steel plates, bar and angle iron and girders. Imports from Germany showed annual increases. Girders most in demand were of continental section of light and inferior quality and were principally supplied by Belgium.

The bulk of the machinery imported is required for agricultural purposes, the greater proportion being supplied by the United Kingdom, but in recent years Germany increased her imports. Other countries sharing in this trade are France, Sweden, Switzerland and latterly Italy. Electric motors are exported principally from the United Kingdom, but British manufacturers have neglected the market in electric appliances, the bulk of which, especially metallic filament lamps, came from Germany and Austria. Artesian well boring has recently created a large demand for pumping machinery and pipes. Unreasonably long credits have been allowed in recent years, especially by German manufacturers, who compete with inferior machinery at lower prices.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says 200 fire alarms for use in Buenos Ayres have been received from the United States. These alarms, which are to be erected in the central parts of the city, cost $32,000 gold.

The Buenos Ayres Western Railway has informed the Minister of Public Works that the electrification of the company's suburban lines is proceeding rapidly, and that the new service would soon be open to the public.

The Municipality of Adolfo Alsina (province of Buenos Ayres) recently decided to call for tenders for a public electric light installation.

A circular issued recently by the Compañia Argentina de Lamparas Electricas "Z" says the company has received 328 cases of machinery, apparatus and material for the manufacture of metallic filament electric lamps. These cases, which were brought by the Spanish s.s. "Leon XIII.," were the company's first consignment from Europe. Another consignment was expected in mid-October from the U.S.A. The manager of the company, Señor Eugenio Carrio, and the technical and mechanical staff arrived on the "Leon XIII." When circumstances become normal again, a commencement will be made on the company's works at Longchamps, F.C.S., and in the meantime the workshops and offices will be situated in the building purchased by the company at Avenida Alvear and Coronel Diaz, Nos. 2740-50-60 and Cerviño 3227-31, Buenos Ayres, which will permit lamps to be supplied to the public before the end of October.

Italy.—In a review of the construction and extension work done by the Italian Railway Department in the last two years, the "Popolo Romano" states that electrical apparatus has been set up along 140 km. (87 miles) of railway, with signalling apparatus in 146 stations.

Considerable progress has been made with the electrification of railways and the total saving of coal due to the electrification so far completed amounts to 165,000 tons.

Norway.—It is stated that electrotechnical works, to be established at Telemarken by a Franco-American syndicate, will utilise water power to the extent of 100,000 H.P. for the generation of electrical energy.

Russia.—It is stated that a large electrical undertaking is being founded in Southern Esterbothnia, three towns and 28 rural districts being concerned. It is intended to form a company to carry out the project, and to erect four generating stations at Sturo, Histaro, Kurikka and Alavu. It is proposed to absorb all the small electrical undertakings at present existing in these districts. In the region covered by the scheme there are many waterfalls and extensive peat deposits which will enable power to be generated economically.

The British Consul at Ekaterinburg reports that during the current year the production of platinum in the Urals has been seriously affected by the scarcity of labour, in the case of hand washings by tributers, and in the case of mechanical dredging plants by the difficulty in obtaining spare parts for dredges. The production of platinum in 1916 is estimated at from 100 pouds (about 3,600 lbs. av.) to 120 pouds, or one-third of the normal production.

Uruguay.—The Federacion Rural has presented a petition to the Minister of Finance asking for the repeal of the law which imposes a double land tax on the property of absentee proprietors.

The petitioners main tainthat this tax militates against the influx of foreign capital, to which the country owes railways, tramways, &c., and a money market for its national debt bonds.

MISCELLANEOUS NOTES.

Alleged Blackmail.—Last week a man named Thos. Absalom Jackson was charged at Bow-street Police Court with offering to prevent the printing of various matters concerning Marconi's Wireless Telegraph Co. (Ltd.) and Mr. Godfrey Isaacs with intent to extort money. The case was adjourned until Tuesday, when evidence was given by Mr. Godfrey Isaacs, and the accused was remanded until Saturday without bail.

A.E.G. Electric Company.—It is announced that the business of this company, one of the subsidiary companies of the A.E.G. of Berlin, has been sold by the controller appointed by the Board of Trade to Messrs. Dick, Kerr & Co., of London, Preston, &c.

The A.E.G. Electric Co. had offices and works in London, Newcastle, Cardiff and Birmingham, and it had undertaken large contracts for electrical plant, &c. These contracts varied in value from £1,000 to about £40,000, and the liquid assets held in this country amounted to over £100,000. It is understood, says "The Times," that as these assets are now transferred to the Public Trustee practically all that was saleable, apart from stock, was the goodwill, and that as the company's profits have naturally fallen off during the war, the price paid was not large. The whole of the company's capital was held by the parent company in Berlin. During the war the German staff is stated to have been replaced by a British staff, and the latter is now taken over by Messrs. Dick, Kerr & Co. together with a number of uncompleted contracts.

In regard to the Electrical Company, another of the A.E.G. subsidiaries, an order was issued at the end of July for sales to cease; and on Oct. 17 the residue of the stock was disposed of by Messrs. Wheatley, Kirk, Price & Co.

The business of the A.E.G. Electrical Company of South Africa was confined to arranging contracts for electrical apparatus with the South African mines. The controller was appointed on July 7, and the intention is to close down the business in this country very shortly. The stock in South Africa is being dealt with by the Union Government under recent legislation.

"British Opportunities in Russia."—We have received a copy of a pamphlet with the above title, and written by Mr. Louis A. Rojansky.

We have dealt with the subject in several previous issues, and the above-mentioned pamphlet gives some useful information on the mineral wealth of Russia, the goods imported, Russian manufactures, the terms allowed and the facilities given by German exporters to Russian importers, &c. The pamphlet is published by the Anglo-Russian Translations Bureau (Ltd.), 133-7, Finsbury-pavement, London, E.C., at 2d.

Customs Decisions.—Under a Customs Tariff Ordinance issued by the administrator under the British Military Administration of German New Guinea, scientific, chemical and mathematical instruments and machinery and parts thereof are admitted duty free.

Defence of the Realm Regulations.—As from Oct. 31 Reg. 30A of the Defence of the Realm (Consolidation) Regulations (1914) applies to steel hexagons, steel rounds and squares, &c., heavy steel melting scrap and steel turnings and borings. Applications for permits should be addressed to the Director of Steel Production, Ministry of Munitions, Whitehall, London, S.W.

Enemy Firms Wound-up. The Board of Trade has ordered the winding up of 356 businesses controlled by alien enemies.

The latest list includes J. L. & P. Weidner, 58A, City-road, London, E.C., selling branch of German manufacturers of bronze powders, leaf metal and aluminium. (Controller: G. Bostock, 21, Ironmonger-lane, E.C.) Josef Mainzer, 70, Finsbury-pavement, London, E.C., dealer in bronze paints, powders, &c. (Controller: Peter Leask, St. Mildred-court, E.C.) Bosch Magneto Co., 204, Tottenham Court-road, London, W., manufacturers of magnetos. (Controller: A. E. Woodington, 5, Philpot-lane, E.C.)

Claims against the Electrical Co. (Ltd.), the A.E.G. Electric Co. (Ltd.), and for the A.E.G. Electrical Co. of South Africa (Ltd.), are to be sent to the Controller, Mr. Maurice Jenks, 6, Old Jewry, London, E.C., by Nov. 30.

Claims against Burstinghams & Co. (Ltd.), 11, Eastcheap, London, E.C., engineers' agents, are to be sent by Nov. 27 to the controller, Mr. A. J. Foster, 37, Walbrook, E.C.

Claims against Kampe & Co., 2, Sandlands-street, Red Lion-street, London, W.C., machinery merchants, are to be sent by Nov. 30 to the controller, Mr. Thos. A. Fox, 79 Mark-lane, E.C.

TENDERS INVITED.

Telegraph Stores.

The Directors of the NORTH EASTERN RAILWAY Co. invite tenders for six and twelve months' supply of (1) Telegraph Apparatus and (2) Telegraph Wire and Line Stores. Forms of tender from Mr. C. H. Ellison, Telegraph Supt., York. Tenders to the Secretary at York by 9 a.m. Nov. 23. *See also an advertisement.*

Boilers, Stokers and Cooling Towers.

The Generating Station Committee of the STALYBRIDGE, HYDE, MOSSLEY and DUKINFIELD Tramways and Electricity Board invite tenders for the supply and erection of Water-tube Boilers, Mechanical Stokers and Cooling Towers. Specifications, &c., from the engineer-in-chief, Mr. Robert Blackmore.

Telephone and Telegraph Material, &c.

Tenders are invited up to Dec. 22 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492.

The GT. NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m. Nov. 23 for six or 12 months' supply of Telegraph Material, Castings, Ironmongery, Rubber Goods, Oils, &c. Forms of tender from Stores Supt., 80, Guild-street, Aberdeen.

SLIGO, LEITRIM & NORTHERN COUNTIES' RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Electric Telegraph Material, Wire, Rubber Goods, &c. Forms of tender from the Secretary, Enniskillen.

The CHESHIRE LINES COMMITTEE require tenders by 10 a.m. Nov. 22 for twelve months' supply of telegraph materials, carbons, &c. Specifications, &c., from Stores Superintendent, Warrington.

Tramway Construction, Materials, Stores, &c.

JOHANNESBURG (Transvaal) Council require tenders by noon Nov. 29 for supply of 500 or 1,000 Trolley Wheels for their tramways department (Contract 181). Specification, &c., from the Municipal Offices.

JOHANNESBURG Corporation require tenders by noon Nov. 27 for 250 Field Coils for Tramcar Motors (contract 192); and by noon Jan. 3 for Iron Axles and Bushes (contract 163). Specifications, &c., from the Municipal Offices (Room 53).

ROTHERHAM Tramways Committee require tenders by Nov. 16 for supply of Six Electric Double-deck Top-covered Tramcars. Particulars from the General Manager.

Electrical Stores, Lamps, &c.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Jan. 8 for (*a*) 33,000 volt Switchgear; (*b*) Conduit and Fittings; (*c*) Fuses; (*d*) Insulators; (*e*) Insulator Straps and Bolts; (*f*) Lamp Holders; (*g*) Mica; (*h*) Switches; and (*i*) Wire Flexible, &c. Specification of (*a*) and particulars with regard to other items may be obtained at the Town Hall, Sydney.

The Postmaster General, ALEXANDRIA (Egypt), will receive tenders until noon Nov. 15 for one year's supply of Lamps, Electric Fans, &c. Specifications, &c., from Sir A. L. Webb, Queen Anne's Chambers, Broadway, Westminster, S.W.

CHATHAM Borough Surveyor's Dept. require tenders by 10 a.m. Nov. 15 for 12 months' supply of Electric Lamps, Ironmongery, &c. Specifications, &c., from the Borough Surveyor.

Turbo-Alternator, &c.

[illegible] Corporation want tenders by 11 a.m. Jan. 3 for a [illegible] Steam Turbo-alternator and Condensing Plant. Specification (No. [illegible]) from Borough Electrical Engineer.

Electric Crane.

The N.S.W. RAILWAY AND TRAMWAY DEPARTMENT require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Coal Transporter Plant.

Tenders are invited for the supply, delivery and erection in MELBOURNE, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Pty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders by noon Dec. 11.

Pressure Regulators.

JOHANNESBURG Corporation require tenders by noon Dec. 20 for Automatic Pressure Regulators for a.c. Turbo-generators. Specification, &c., from the Municipal Offices (Room 53), Johannesburg.

Carbon Brushes and Cut-outs.

Johannesburg Municipal Council require tenders by noon Nov. 27 for the supply of 12 gross of Carbon Brushes for Electric Motors. (Contract No. 178.)

JOHANNESBURG (Transvaal) Council also require tenders by noon Nov. 27 for the supply of 1,000 sets of Single Pole Iron-clad House Service Cut-outs (Contract 187).

Specifications from the Municipal Offices.

Converter Plant, Batteries, Booster Plant and Switchboards.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Jan. 22 for (A) Converter Plant (three-phase to c.c.), (B) Two Storage Batteries, with switches and accessories, (C) Booster Plant, (D) l.t. c.c. Switchboards. Specification, &c., from the General Manager of the Electric Lighting Department.

Electricity Supply Concession.

Extension of Time.—The time for sending in tenders for Generating and Supplying Electrical Energy for Lighting and Power in ST. GEORGE (Grenada) and its suburbs is extended to Dec. 31. Particulars from Colonial Secretary, Grenada (British W. Indies).

TENDERS RECEIVED AND ACCEPTED.

WOOLWICH.—The Borough Council has accepted the tender of G. & J. Weir (at £325) for a roto-feed pump having a capacity of 10,000-12,000 gallons.

LONDON COUNTY COUNCIL. The tender of the Jackson Electric Stove Co. (at £58. 10s.) has been accepted for the supply of 26 radiators.

BACUP. For the supply of sub-station switchgear the tender of the General Electric Co. has been accepted.

SHANGHAI.—The Municipal Council of the International Settlement has ordered Osram lamps for use throughout the Settlement, and the General Electric Co. of China, of Shanghai and Hong Kong, have just secured this year's contract from the Municipal Council of the French Settlement also, so that both Settlements of Shanghai are now exclusively using Osram lamps for street lighting.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

◆

Western Telegraph Co. (Ltd.)

The [illegible] under the presidency of Sir John Wolfe Barry, K.C.B.

The SECRETARY [illegible] read the notice convening the meeting.

The CHAIRMAN [illegible] the financial year of the company, which closed [illegible] uneventful, although the receipts from messages were less by somewhat over £15,000, the interest from investments, &c., almost balanced this amount, resulting in a net decrease of slightly over £1,000 in revenue. I must remind the shareholders that in the year 1914-1915 our message revenue was the highest in the history of the company. Not only were a smaller number of messages transmitted, but a larger proportion of the total were "deferred" at half rates. On the other side of the account the expenses show an increase of over £23,000, due to the maintenance of cables account, the amount of which was abnormally low in the previous year. Income tax and excess profits duty were more by £105,000. After providing £32,747 for debenture stock interest and £138,396. 15s. 8d. for income tax and excess profits duty, there remains a balance of £448,808. 12s. 9d.; to this is added the sum of £85,880. 0s. 5d. brought forward from June 30, 1915, making a total of £534,688. 13s. 2d. Three interim dividends, amounting to £93,568. 10s., have been paid. £100,000 has been applied towards the further reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £100,000 transferred to the general reserve fund, £30,000 to the land and buildings depreciation fund, and £100,000 to the provision on account of investment fluctuations. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, also the payment of a bonus of 2 per cent., or 4s. per share, both free of income tax, which together will amount to £72,775.10s., leaving a balance of £38,344. 13s.2d. to be carried forward. The dividend and bonus will be payable on Nov. 9 to shareholders registered on Oct. 31, 1916.

As already stated, the net profit to the company is less than that for the previous year, but you will observe that an unusually large balance of nearly £86,000 is brought forward from June 30, 1915, and in view of the satisfactory condition of the company's financial position, the directors feel justified in recommending the payment of a bonus of 2 per cent. instead of the 1 per cent. which has been paid in past years, making a total distribution of 8 per cent. for the year free of income tax. The variable and at present high rate of income tax is pressing heavily on all, and with a view to assisting the shareholders who are entitled to exemption or abatement we are furnishing, with the dividend warrants which will be posted this afternoon, a statement of the tax payable by the company in respect of the dividends paid during the past financial year; similar information will also accompany future dividend warrants.

With regard to the revenue since June 30 last, the traffic receipts for the three months to the end of September show scarcely any variation as compared with the corresponding period last year. The shareholders are asked to sanction a proposal that the remuneration of the directors be paid free of income tax, as is the practice in the case of many companies of great position and importance. This is considered equitable, as not only are the dividends paid free of the tax, but the salaries and wages of the staff are also paid without any deduction on that account. I now move that the report of the directors and the accounts for the year ended June 30, 1916, now submitted be approved and adopted, and that a dividend be now declared of 3s. per share, making, with the interim dividends already paid, a total dividend of 6 per cent. for the year, and also a bonus of 4s. per share, making in the aggregate a distribution of 8 per cent. in respect of the profits for the year, the said dividend and bonus to be respectively tax free.

The DEPUTY CHAIRMAN (Sir JOHN DENISON-PENDER, K.C.M.G.) seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed that the remuneration of the Directors be paid free of income tax as and from the commencement of the period covered by the accounts submitted to the meeting.

The DEPUTY CHAIRMAN seconded the resolution.

A discussion ensued. Mr. Ennis moved an amendment which found no seconder, and a second amendment having been withdrawn by its proposer (Mr. J. Barber Glenn), the original resolution was put to the meeting, and carried unanimously.

On the motion of the CHAIRMAN, the retiring Directors, Sir John Denison-Pender, K.C.M.G., Mr. John Gordon and Mr. Francis Alexander Johnston, were re-elected. Messrs. Deloitte, Plender, Griffiths & Co., and Messrs. Gane, Jackson, Jefferys & Freeman were also re-elected auditors.

Mr. ENNIS then proposed a cordial vote of thanks to the Directors and to the staff for their conduct of the business in the past year. This was seconded by Mr. FULLER, and carried unanimously.

PARAGUAY CENTRAL RAILWAY CO. (LTD.)—At the recent meeting the receiver and manager (Mr. Binder) said that with regard to the past outlay of over £200,000 in connection with the Asuncion Tramway, Light & Power Co., the result of that company's operations had up till quite recently been very disappointing. Although a small operating profit had been shown, that had been practically counterbalanced by the amount overdue from the municipality for public lighting; consequently it had never been able to accumulate working capital, and, moreover, it now required further capital for improvements and extensions. The establishment of a better exchange rate had helped its receipts recently, and the earnings for the last few months had been more encouraging. Nevertheless, the receiver of the tramway company had had to have recourse to borrowing to carry on the business, and the municipality still owed a comparatively large sum.

UNITED ELECTRIC TRAMWAYS OF CARACAS (LTD.) The report states that the local company has again declared a dividend absorbing their net profits for the year, which enables the directors to continue their policy during the period of the war of fully distributing amongst the shareholders the whole of the available net revenue. After adding balance from last year (£1,299), the balance is £14,328, out of which the directors recommend payment of a dividend for the year of 7 per cent. (less tax), which will absorb £11,900, leaving £2,428 to be carried forward. The profits of the local company were again adversely affected by the war, but during the last months of the year they exhibited a tendency to improve. The receipts for the current year are more likely to increase than decrease. The percentage of operating expenses to gross receipts is 53·10, or 1·72 per cent. more than the previous year, due to the larger mileage run and higher cost of material and working.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The report of the directors for the half year ended June 30 last states that the amount of credit to revenue is £45,230. 0s. 7d., compared with £36,454. 3s. 9d. in the corresponding half-year of 1915, and the expenses have been £33,651. 15s., against £27,225. 0s. 8d. The result is a balance of £11,578. 5s. 7d., to which is added £1,799. 8s. interest on investments, and £2,880. 6s. 5d. brought forward, making a total available of £16,258. The directors propose payment of the following dividends for the half-year: On first preference shares at 6s. per share (£10,368. 18s.), on second preference shares at 6s. per share (£1,400. 14s.), and on ordinary shares at 6d. per share, tax free (£2,208. 0s. 6d.), leaving £2,280. 7s. 6d. to carry forward. The traffic receipts for the half-year show an increase compared with those of the corresponding period, business in the West Indies having been active at prices remunerative to the planters. Similar conditions have so far ruled during the current half-year The cost of maintenance of cables was unusually heavy, being £7,633 in excess of the outlay in the same period of last year. The repairs effected were more numerous and expensive, as regards both the mileage of cable used and the time occupied by the ship on the work. There was, moreover, no set-off from the hire of the ship to other companies, such as occurred in the period under comparison. Following what is now the general practice of telegraph companies, it is suggested that after May of next year the report and accounts should be presented annually. The financial year would, in that case, be from Jan. 1 to Dec. 31, and the annual meeting would be held in May. This arrangement would not preclude payment of interim dividends in November of each year.

NEW COMPANIES, MORTGAGES & CHARGES.

◆

NEW COMPANIES.

BRITISH MINIATURE ELECTRIC VEHICLES (LTD.)—(145,135)—Reg. Oct. 23, capital £5,000 in £1 shares, to carry on the business indicated by the title and that of engineers, contractors, &c., and to adopt an agreement with W. Bleakley and S. W. Copley. Private company. S. W. Copley is permanent governing director, and may act with or without ordinary directors.

LEABANK MFG. CO. (LTD.)—(145,180)—Reg. Oct. 28, capital £9,500 in 7,500 preferred shares of £1 each and 3,000 ordinary shares of 5s. each, to take over (with the authority of the Board of Trade) the business carried on at Hoddesdon, Herts, and elsewhere in England by P. and F. Doerwaldt as the Flender Co. (being a business the books and documents of which are liable to inspection under the Trading with the Enemy Act), and to carry on the business of manufacturers of and dealers in wooden and metal pulleys and other machinery and appliances for use in connection with power transmission, engineers, &c. Private company. First directors are C. J. Mortimer, F. W. Kent and C. H. Tipple.

LIGHT RAILWAYS (LTD.) (145,152)—Reg. Oct. 25, capital £50,000 in £1 shares, to manufacture and contract for the supply, delivery and carriage of, and to erect, maintain and work any material, machinery, plant, rolling or other stock or tools required for or used in connection with any system of locomotion, transport, &c. Private company. First directors are M. Sharpe, J.P., A. T. Clay, M. Horner, J. S. Horner, A. Hoare and A. G. Birch. Reg. office: 2, London Wall-buildings, E.C.

LONDON LORRIES (LTD.) (145,137)—Reg. Oct. 23, capital £5,000 in £1 shares, to carry on the business of builders and repairers of steam or electric motors, lorries and cars, &c. Private company. First directors are C. J. H. McRea, F. C. Bradshaw and R. Tozer (all permanent). Reg. office: Bush-lane House, Cannon-street, E.C.

MILTON MFG. CO. (LTD.) (145,183)—Reg. Oct. 28, capital £60,000 in £1 shares (10,000 preference), to carry on the business of mechanical and electrical engineers, manufacturers of and dealers in all things for use in connection with electrical installations, electrolytic processes, electrolytic or chemical bleaching and other appliances and apparatus, manufacturers of chemicals, &c. Private company.

NAVARRO AIRCRAFT CO. (LTD.) (145,030). Reg. Oct. 9, capital £2,000 in £1 shares, to carry on the business of aircraft builders, electricians, engineers, &c. Private company. Reg. office: 10, Essex-street, W.C.

NEW LONDON ELECTRON WORKS (LTD.) (145,161)—Reg. Oct. 26, capital £15,000 in £1 shares, to take over the business of the London Electron Works Co. (Ltd.), to carry on the business of iron, steel, lead, brass and metal masters, makers and converters, smelters, metallurgists, electrical and electro-chemical engineers, &c., and to adopt a contract between A. Taylor, F.C.A., receiver for the debenture holders of the old company and Geo. Cohen, Sons & Co. Private company. First directors are B. Cohen (chairman), M. G. Cohen, L. Levy, J. B. Batchelor, H. W. Robinson and C. T. Batchelor.

RAILWAY ACCESSORIES (LTD.) (145,088.) Reg. Oct. 16, capital £1,000 in 980 ordinary shares of £1 each, and 400 deferred shares of 1s. each, to carry on the business of railway contractors, merchants, engineers, &c. Private company. First directors are E. F. Peterson and R. W. Fergusson, J.P. Reg. office, 28, Victoria-street, S.W.

MORTGAGES AND CHARGES.

BOURTON-ON-THE-WATER ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on Oct. 24, 1916, of £20 debentures, part of series of which particulars have already been filed.

DERBY LAMP WORKS (LTD.)—Second mortgage debenture, dated Oct. 20, 1916, charged on company's undertaking and property, present and future, to secure £5,000. Holders; W. L. T. Arkwright and H. S. Golding.

RECEIVERSHIP.

SHIPSTONE ELECTRICAL CO. (LTD.)—Notice of appointment of A. E. Mason, Wolverhampton-street, Dudley, as receiver, on Oct. 23, 1916, under powers contained in debentures, dated Oct 16, 1913, has been filed.

CITY NOTES.

MEMORANDA (Nov. 8).—**Bank rate** 6 **per cent. (since** July 13, 1916). **Consols** 56½. Consols Pay Day, Dec. 1. **Stocks and Shares Ticket Days**, Nov. 14 and 29. Pay Days, Nov. 15 and 30. Price of Silver, 34⅛d.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. (less tax) for the year 1916.

BRUNNER, MOND & CO. (LTD.)—An interim dividend for the half-year ended Sept. 30 at rate of 25 per cent. per annum, less tax.

COMPANIES STRUCK OFF THE REGISTER. The following were struck off the Register of Joint Stock Companies on Oct. 24: Aladdin Lamp Synd., Atlas Anti-Friction Metal Co., Electric Ozone Synd., Improved Vacuum Cleaner Co., International Asbestos Co., United Lighting & Maintenance Co., Vortex Engineering Co., Wireless Electric Light Co.

The following companies were struck off the Register on Oct. 31:—

Anglo-German Wireless Synd., Autobloc Synd., Blanchard Lamp Foreign Patents Co., Bridlington Electrical Engineering Co., British Metallurgical Co., British Molybdenite Co., Fan Publicity Co., Helis Cell & Accumulator Co., Houchen Electroplating Co., Improved Railway Signals, International Filaments, International Inventions & Finance Co., New Century Arc Light Co., New Ignition Synd., Paris Accumulator Co., Power Transmission Synd., Smokeless Consumption (Cowper Coles Patents), United Elec. Light & Power Supply Co., Warner Engineering Co.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.) An interim dividend has been declared on the shares of 2½ per cent., being at rate of 5 per cent. per annum.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 7, the following as the present basis prices of—

New Metals.	Per lb.
Solid Drawn Brass Tubes	16¼d.
Solid Drawn Copper Tubes	19¼d.
Brazed Copper Tubes	19¼d.
Brazed Brass Tubes	18¼d.
Brass Wire	15½d.
Copper Wire	19d.
Rolled Brass	15¾d.
Brass Sheets	16¾d.
	Per ton.
Copper Sheets	£168 0 0
Spelter	53 15 0

	Per ton
English Lead	Nominal.
Antimony	Nominal.
Old Metals.	Per ton
Clean Copper Scrap	£115 0 0
Clean Brass Scrap	66 0 0
Brazing Copper Scrap	90 0 0
Old Lead	26 0 0
Old Zinc	38 0 0
Hollow Pewter	130 0 0
Black Pewter	90 0 0
Gun Metal	86 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Nov. 7, the following approximate prices of Scrap Metals:—

	Per ton.
Aluminium Cuttings	£110 0 0
Clean Mixed Brass	67 0 0
Clean Copper	117 0 0
Brazery Copper	92 0 0
Gun Metal	95 0 0

	Per ton.
Old Lead	£4 under English lead price
Old Zinc	38 0 0
Hollow Pewter	132 0 0
Stripped Black Pewter	90 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80, Commercial Tinman's Solder, £97, Blowpipe Solder, £107.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 7.

Shrs.	Last Dividend	NAME.	Price, Tues., Nov. 7	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
1	6%	B[illegible] & P[illegible] E.L. Ord.	8¼	7 1 2	Mar., Sept.
1	4½%	Do. 4½% Cum. Pref.	7¾	5 16 2	Feb., Aug.
1	6%	Do. 6% Cum. 2nd Pref.	9[illegible]	6 1 6	Feb., Aug.
1	[illegible]	[illegible] & K[illegible] Ord.	6¾	7 [illegible] 9	Mar., Sept.
[illegible]	7%	Do. 7% Pref.	[illegible]	5 9 [illegible]	Mar., Aug.
[illegible]	4%	[illegible] E[illegible] G. Deb.	80	4 1[illegible] [illegible]	[illegible]
St.	4	[illegible] West E[illegible] & [illegible] Deb.	[illegible]	5 0 [illegible]	Jan., July
[illegible]	[illegible]	Do. 4½ Pref.	[illegible]	6 1[illegible] 1[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	7 1[illegible] 1	Aug., Feb
[illegible]	4½	[illegible]	[illegible]	[illegible] 18 [illegible]	Jun., Dec
[illegible]	4	[illegible] Elec. Supply Co. Ord.	[illegible]	6 8 7	Mar., Sept
[illegible]	4½	[illegible]	[illegible]	5 3 [illegible]	Jan., July
[illegible]	[illegible]	[illegible]	1[illegible]	6 16 2	Feb., Aug
1	[illegible]	Do. [illegible] Pref.	1[illegible]	[illegible] 17 1	Mar., July
[illegible]	[illegible]	Do. [illegible] Deb. St.	97[illegible]	4 17 [illegible]	Jun., Dec
[illegible]	4½	Do. 4½ Deb.	7[illegible]	5 13 2	Jun., Dec
1	7	[illegible]	[illegible]	6 [illegible] [illegible]	Mar., Sept
1	[illegible]	[illegible]	1[illegible]	[illegible] 17 [illegible]	Feb., Aug
[illegible]	4½	[illegible]	[illegible]	[illegible] [illegible] 11	Jan., July
[illegible]	4½	[illegible]	[illegible]	[illegible] 6 [illegible]	May, Nov
[illegible]	4	[illegible]	[illegible]	6 3 [illegible]	June
[illegible]	7	[illegible]	[illegible]	6 11 9	Feb., Aug
[illegible]	4	[illegible]	[illegible]	[illegible] [illegible] 4	Jan., July
[illegible]	[illegible]	L[illegible]	[illegible]	7 1 [illegible]	[illegible]
[illegible]	4	Do. 4 Mort. Deb.	[illegible]	4 19 [illegible]	Jan., July
[illegible]	3	[illegible]	[illegible]	[illegible] 3 1	Mar., Aug
[illegible]	4	Do. [illegible] Mort. Deb.	[illegible]	[illegible] 11 6	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 1 0	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	6 0 [illegible]	Mar., Sept
St.	[illegible]	[illegible]	[illegible]	[illegible] 8 8	Mar., Sept
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 3 10	Apl., Oct
4	[illegible]	[illegible]	[illegible]	[illegible] 13 4	Mar., Sept

† [illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Nov 7	Rate per cent Yielded	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6⅜	6 5 6	Feb, Aug
5	7%	Do. do. Pref.	5 27/32	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72½	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1 5/32	6 18 5	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6	5 16 8	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	83½	5 19 9	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	76	7 17 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	65	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82½	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	75	5 6 8	Jan, July
St.	4%	City & S. London Deb.	74¾	5 7 0	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2⅝	5 16 0	Jan, July
St.	4%	Do. 4% Pref.	61¾	6 9 7	Mar, Sept
St.	4%	Do. 4% Debs.	70⅜	5 13 8	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	22¾	4 5 6	Feb, Aug
St.	3½%	Do. 3½% Pref.	60	5 16 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	58	6 0 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	60	5 16 8	Jan, July
St.	3½%	Do. 3½% Debs.	63	5 11 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15¾	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	69	6 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105	5 14 3	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	69	5 15 10	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2⅞	5 2 7	Apl, Oct
1	6%	Do. 6% Pref.	1 11/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1⅜	5 1 10	Mar
100	5%	Do. Prior Lien Debs.	91	5 9 11	Jan, July
1	6%	Do. 6% Pref.	29/32	6 12 5	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	11 13/16	7 8 2	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 5/32	5 16 4	Jan. July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	85¼	5 4 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2 15/32	6 1 6	April
100	6%	Do. 6% Prior Lien Debs.	99¼	6 0 9	Apl, Oct
St.	4%	Do. 4% Mort. Deb St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12 9/16	7 19 2	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A. £3 pd.	⅜	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1 1/32	7 5 5	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
10	6%	Do. 6% Pref.	9 29/32	6 1 2	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16⅛	6 4 4	Feb, Aug
5	5%	Do. 4½% Cum. Pref.	4 3/16	5 7 6	..
St	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, C. P. &c., Ord.	12½	8 0 0	Feb, Aug
10	5%	Do. Pref.	7¾	6 9 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38¼	6 5 6	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	1⅞	6 13 4	May, Aug
1	5%	Do. 5% Pref.	29/32	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	78¼	5 2 3	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¾	4 10 2	June, Dec
St	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	94⅜	6 6 10	Fb, My, Aug, N
St	1½%*	Do. Def. Ord.	23¼	7 2 8	Fb, My, Aug, N
St	4%	Commercial Cable 4% Debs.	70¼	5 13 16	Ja. Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6 5/16	6 6 9	Ja, Ap, Jly, O
St.	8%	Eastern Tel. Co. Ord.	144	5 11 0	Ja, My, Jly, O
St.	3½%	Do. 3½% Pref.	64¾	5 8 1	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	75½	5 6 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	13⅛	6 13 4	Ja, Ap, Jly, O
10	2[illegible]	Gt. Northern Tel. Co. With Coup. 11	38	5 15 9	Ja, My, Jly
25	13	Indo-European	51¼	6 6 10	May, Nov
1	1[illegible]%	Marconi's Wireless Tel. Co.	2[illegible]	3 10 4	April
1	7%	Do. 7% Pref.	2[illegible]	2 19 9	July
10	1%	West India & Panama Ord.	[illegible]	10 13 0	May, Nov
10	6%	Do. 1st Pref.	7 11/16	7 16 1	May, Nov
10	[illegible]%	Western Telegh. Co.	14[illegible]	5 9 2	Mr, Jly, O, Dec
St	4%	Do. 4% Deb. St.	76¼	5 4 7	June, Dec
[illegible]	4½%	Western Union 50-yr. Bds.	99⅛	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	13/16	7 7 8	Nov
1	1[illegible]%	Oriental Telephone Ord.	2 3/32	4 7 8	Apl, Oct
St.	4%	Do. Db. St.	78¾	5 1 7	Jan, July
St.	4½%	Teleph. Co. of Egypt Db. St.	83	5 8 5	Jan, July
[illegible]	8%	United River Plate Ord.	6¾	5 18 6	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4 25/32	5 4 7	Jan, July
St.	4½%	Do. Deb. Stk.	85½	5 5 3	Jan, July
		Financial and Investment.			
1	6%	Globe Teleg. & Trust	12⅜	4 17 0	Sp, Dc, Mr, Jn
[illegible]	6%	Do. 6% Pf.	10⅜	5 15 8	Sp, Dc, Mr, Jn
1[illegible]	[illegible]%	Mackay Companies Common	85¼	5 17 6	Ja. Apl, Jly, O
[illegible]	4%	Do. $100 Pref	70	5 14 3	Ja Apl, Jly, O
1[illegible]	6%	Submarine Cable Trust Cert.	1[illegible]	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply Co. [illegible]	4 11/16	6 1 6	Mar, Sept
St.	5%	Do. 5% Db. [illegible]	94½	5 5 10	Jun, Dec
[illegible]	6%	Bombay E. S. & T. 6% [illegible]	1[illegible]	5 15 8	..
St.	4½%	Do. 4½% [illegible]	83	5 8 5	Jan, July
[illegible]	9%	Calcutta E. S. Corp. Ord.	[illegible]	6 15 10	May, Nov.
[illegible]	5%	Do. 5% Pref.	4[illegible]	5 16 9	Mar. Sep

* Plus 3/6 [illegible] † Ex dividend or interest.

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NOTES.

The Kelvin Lecture.

LAST week the eighth Kelvin lecture was delivered before the Institution of Electrical Engineers, the lecturer on this occasion being Dr. ALEXANDER RUSSELL. From the abstract which we give on another page it will be seen that Dr. RUSSELL covered a wide range of topics. Not the least interesting were the notes on KELVIN's early training. It must have been a strange experience to know a boy whose brain developed so rapidly that he matriculated at the age of 10 and was to all intents and purposes a graduate at 11. Yet KELVIN did not show abnormal mental activity at the expense of physical development, as may be seen by the fact that he won the Colquhoun Sculls at Cambridge and by his practical love of yachting. Dr. RUSSELL is one of the few who, as an old pupil, can speak of KELVIN's teaching. It is evident that this teaching, although doubtless above the heads of many in his classes, was marked by that enthusiasm which is so essential to the teacher who is to make a lasting impression on his pupils. The youthful mind is particularly susceptible to the attitude of his teacher in dealing with research, and we fear that this attitude in some teachers is enough to stifle the scientific imagination in those around them, and to bring about a feeling that progress in scientific thought is best left alone.

The Raw Materials Situation in America.

IN a recent address before the Association of Edison Illuminating Engineers, Mr. GUY E. TRIPP, the chairman of the Board of the Westinghouse Electric & Mfg. Co., gave an analysis of the electrical manufacturing situation. From this it would appear that in America the question of raw materials is very acute. In the case of steel, Mr. TRIPP relates how in July, 1915, promises of delivery were for 20 to 60 days after placing of orders, and states that it has only been by constant pressure that they have been able to get material ordered as long ago as October and November, 1915; some of it was received in July this year and some has not yet been shipped. The copper situation is very similar to the steel. At the beginning of January one of the largest copper manufacturers in America issued a statement as follows:—

"Any orders received by us are accepted only on the basis that they are not subject to cancellation, and, in addition, they will be filled as soon as conditions will permit; and, furthermore, that these orders will have to be on our book 30 days before we will even give you any information as to when you can expect the material."

We agree with Mr. TRIPP that such a condition of affairs makes the stockkeeper's job one of some magnitude. Aluminium is little better than copper, six months being required for the delivery of sheets, meter discs and covers.

The Munition Worker and "Sacrifice."

LAST week the Minister of Munitions is reported to have said, "We shall have to make more and more demands upon those who are not at present engaged in work of war importance. We shall have to ask those ineligible for military service to come to the munition factories, making sacrifices comparable to (the sacrifices made by) those who are already there with the one purpose of arming and equipping those who are going in streams to the battlefields." The meaning is a little obscure, but we take it that Mr. MONTAGU intends to convey the impression that the majority of the 1,850,000 men and the growing regiment of 400,000 women have made sacrifices. If this be so we challenge the accuracy of the statement. We go further, and state that the vast majority of men and women engaged in the manufacture of munitions are drawing considerably higher wages than they did before the war. Perhaps by "sacrifice" Mr. MONTAGU means the doing of something by those who in the past have done nothing. In our opinion this is sacrifice of a negative kind. If the pay sheets are taken as evidence of the sacrifice that is being made by the munition worker, we say deliberately that ere we are in a position to dictate peace, sacrifices of a very different kind will be demanded of our people. For a Minister to speak of the sacrifice of a class which has made none is to insult the dependents of those who have made a real sacrifice. The sacrifices of the munition worker under existing conditions are on a par with those that have been made by the munition maker, and amount to nothing more than the loss of sleep and leisure for considerable financial gain. Our idea of sacrifice is that every able-bodied member of the community should at this time work for the State on the same terms as those offered to the soldier—namely, a shilling a day. To talk less of patriotism and to be more patriotic is a lesson which 90 per cent. of the community have yet to learn. When concerns which were semi-bankrupt in pre-war days are allowed by the State to declare enormous dividends as the result of the war, we marvel at the temerity of any one wasting time by talking of mere sacrifice.

Selling Organisation.

In our present issue we publish the last of three valuable Papers on "Works Organisation." The first of this series dealt with manufacturing organisation, the second with financial organisation and the present article discusses the selling organisation. We think there is a tendency for the purely technical engineer to look down upon the selling engineer as a man who is concerned with selling and very little else. This, however, is a mistake; or perhaps it would be more correct to say that the selling engineer should not (as too often hitherto) be merely a man who is concerned simply with the selling side of the business. It is probably due to this mistake that we are behind our Continental and American competitors in this branch of work. There is nothing more disappointing to the technical purchaser than to come across a salesman who knows nothing worth speaking of in regard to the technical qualities of the plant he is selling. The selling engineer should be able to discuss the technical advantages of his plant to the fullest possible extent. It is no doubt an appreciation of this fact that has led to salesmanship being regarded as a science in the United States, and we do not doubt that Mr. G. H. Tweddell is right in his view that if we are to depose the Germans commercially after the war we must radically improve our methods of selling. If we accept the principle that a selling engineer should be an engineer first and salesman after, then it follows as a matter of course that the training of the selling engineer should be thoroughly technical at the start: and not only so, but that he should maintain his technical knowledge at such a level as to be fully acquainted with the various advances that are continually being made. It is for this reason that the cheap but foolish method of appointing numerous agents, and regarding these as a substitute for a selling organisation, can only lead to unsatisfactory results when in competition with selling engineers who know all the technical details of the plant they have to sell.

Mobilise the Engineers.

It is probably the worry and stress of the last two years that account for the growing irritation of men and women against those in authority over them. Not without reason the man in the street feels that those in authority have been guilty of lack of foresight in most things connected with the war. When things go wrong and the incompetents introduce the word "gamble" in connection with casualty lists, no wonder the plain man begins to be worried. The glowing accounts of the State conducted tours to the front which fill the columns of the daily press are for the most part the work of journalists who have not the ability to understand any of the details connected with the war. Even if they had the ability we very much question whether they would be allowed to criticise any of the arrangements. It would be more satisfactory in every way to invite representatives of the several engineering institutions to take part in these State-aided tours. Not only would we give civilian engineers the privilege of inspecting the work of the Royal Engineers, but we would invite criticism, not necessarily for publication, upon the work. The roads in the Somme area may be taken as an example. The roads used for military purposes will have a total length of several hundred miles, and during the 24 hours several thousand vehicles will pass along an insignificant road of, perhaps, 15 ft. to 18 ft. in width. The maintenance of the roads is a matter of vital importance, and it would be regrettable if rapid movement of the armies in the field was impossible on account of the bad state of the roads. One naturally imagines that such a question will be uppermost in the minds of the engineers, but events have shown that this does not necessarily follow. Otherwise how can one explain why our men were allowed to be short of ammunition of the right kind during the first 12 months of war? Road-making and a score of other engineering matters are as important as shells, and for this reason we say it would be useful to have the opinions of the civilian engineers. Failing this we imagine that eminent civilian engineers will be hurriedly drafted into the Army in the near future to make good deficiencies which ought never to have occurred.

Sand Test for Detonators.—The "Colliery Guardian" describes a new form of test for detonators, ordinary and electric. The charge is embodied in a bomb of suitable construction and is fitted into a mass of 100 grammes of standard sand. After the explosion the sand is passed through a series of small meshes and the degree of pulverisation is taken as an index of the detonating power.

Arctic Copper Deposits.—Dr. R. M. Anderson, who has recently returned from an inspection of Arctic copper deposits for the Canadian Government, reports that vast areas rich in copper occur near Coronation Gulf and Bathurst Inlet, some of the seams in the lava being filled with pure copper. It is possible that these deposits could be rendered accessible by building a railroad from the Mackenzie River, which is navigable for five months in the year, to Great Bear Lake, and a further railroad from thence onwards.

Electric Light Signals on American Railways.—An interesting feature in connection with the electrification of 440 miles of the Chicago, Milwaukee and St. Paul Railroad, U.S.A., is the use of light signals both by day and by night. The installation, when complete, will be the longest single line of light signals made. The signals are of the three-light (red, green and white) type, and will render the ordinary semaphore methods unnecessary. The range of the lights in the daytime is given as 2,000 ft. to 3,000 ft.

Standardisation of Carbon Electrodes for Furnaces.—It appears that as a result of war conditions in Germany carbon electrodes for furnaces are now being standardised. According to the new rules round carbons for steel furnaces are to be made in sizes varying in thickness from 100 mm. upwards by steps of 25 mm., the tolerance varying from 3 mm. to 6 mm. according to size. For rectangular electrodes used with other kinds of furnaces a standard size of 500 mm. square is proposed. For the time being the standard length is fixed at 2 metres, but all lengths may be valued in multiples of 20 mm. Tables for dimensions of threads are under consideration.

Electrical Indication of Saline Impurities in Feed Water.—In the "Colliery Guardian," a recent patent covering an invention for detecting the presence of small saline impurities in feed water is described. A cell, in which the water to be tested forms the electrolyte, is placed in series with an incandescent lamp and connected to the electrical supply. If the liquid is pure no appreciable current will flow and the lamp will not light. But the presence of small quantities of saline impurities renders the liquid conducting and a current passes, causing the lamp filament to glow red. A further indication is afforded by a voltmeter placed across the terminals of the cell. With a practically pure electrolyte this will read only slightly below the supply voltage. But as the impurity increases the diminishing resistance of the cell causes the reading of the instrument to fall steadily, thus furnishing another indication of the amount of impurity present.

The Late Sir William Ramsay.—In addition to the movement set on foot in London to commemorate in a suitable way the late Sir William Ramsay's connection with University College, a committee has also been formed with a similar object in the city of Glasgow, where Sir William Ramsay was born and educated. It is not yet decided what form the memorial will take.

Telegrams by Telephone.—The Post Office are asking those who desire to telegraph to friends who are on the telephone to give instructions for the message to be telephoned to the recipient instead of delivered by hand. Delivery by messenger is becoming increasingly difficult on account of the shortage of boy labour. After the despatch of a "phonegram" confirmatory copies of the message can be sent by post.

Export of Swiss Electric Energy.—"Engineering" reports that, according to recent statistics, the Swiss Diet has, during 1914 and 1915, granted five concessions for the export of electricity, of which three refer to Germany, with an aggregate of 15,015 kw.; one refers to France, with an aggregate of 10,000 kw.; one refers to Liechtenstein, with an aggregate of 200 kw. The latter was for a period of three years. Of the others, one was for 15 years and the other for 20 years.

Women in Engineering. The Ministry of Munitions is making a special appeal to university women and other women with a good education to join classes for training in skilled branches of engineering work. Classes are being opened in London, and the complete course lasts from eight to nine weeks. To those who pass a preliminary test at the end of a fortnight or three weeks a maintenance allowance will be paid for the remainder of the course, and when proficiency is attained a minimum wage of £2 a week may be expected.

Electrification of Wool.—A discovery of some scientific interest is announced by Dr. S. A. Shorter, of Leeds University, who has been working on the electrification of fibres. Hitherto it has been generally assumed that such electrification, which is a source of trouble in textile processes, is due to friction. Dr. Shorter has established the fact that electricity can be evolved as a result of drying, accompanied by a subsequent lowering of the temperature. Among the suggested methods of getting rid of such electrification are the use of metallic discharging points or of ultra violet light. The humidification of the atmosphere has also a beneficial effect.

Wolfram Ores for High-Speed Steel.—It is stated that 8 square miles of Wolfram-bearing ore have been located at Hatch's Creek, Northern Territory (Australia). Developments in this direction in Australia will be watched with close interest in view of the fact that previous to the war the extraction of tungsten from wolfram ore formed an important German monopoly. The High-Speed Steel Alloys Co., established at Widnes by 31 firms interested in the making of high-speed steel, is already producing an article claimed to be superior to the best German material, and is keeping in close touch with Australia and other parts of the world where tungsten-bearing ore is being discovered.

Use of Electricity on Zeppelins. According to "L'Industrie Electrique," there is reason for thinking that the Zeppelins now make use of a "fish-shaped" aluminium basket, suspended at a distance of 1,000 metres from the vessel and carrying an observer. The basket is furnished with electric light, fed from a small battery of accumulators, and the observer is in telephonic communication with the Zeppelin. In this way it is often possible to arrange between the observation car and the vessel a screen of clouds which hides the latter from view. The dropping of bombs is directed by the observer who cannot be seen from below. The Zeppelin itself is electrically lighted throughout and equipped with a wireless receiving station.

Paris Lighted by Candles. A drastic Lighting Order has just been announced in Paris. As a measure of war economy, and with a view to achieving a saving in coal and fuel, it is decreed that in future shops must not be lighted after six o'clock by gas, electricity, petroleum or spirit. An exception is to be made in the case of shops dealing in foodstuffs, druggists, hairdressers and tobacco dealers. Shops are not compelled to close at six o'clock, but after this hour they must find other means of lighting, such as candles or acetylene. The hours of lighting of theatres and other places of amusement are unaltered but all such establishments will have to close one day a week. It is also contemplated that cafés and restaurants will close in future at 9.30 in the evening.

Power from Tidal Currents in the Bay of Fundy.—The chief difficulty involved in schemes for utilising tidal power to generate electricity is connected with the periodic variations in the head of water available, making it necessary to employ huge storage reservoirs. In exceptional cases, however, strong tidal currents make the scheme more feasible, and a case in point appears to be presented by the Bay of Fundy, separating the provinces of New Brunswick and Nova Scotia. Here the tides are said to be higher than anywhere else in the world, at certain points reaching a height of 50 ft., and the peculiar formation of a neck of land known as Cape Split gives rise to exceedingly swift currents. It is hoped, according to the "Journal of the Royal Society of Arts," to promote a big power scheme in this locality, where, within a radius of 100 miles, there is an urban population exceeding that of any Canadian city except Montreal. The scheme will utilise the strong tidal currents rather than a fall of water, the only storage required being during the short periods every 24 hours when the tidal flow ceases.

German Plant in South Africa.—Some notes on German electric power plant in South Africa, taken from a recent address on "The Power Supply of the Rand," by the president of the South African Institution of Engineers, appeared in the Board of Trade "Journal" for November 6th:—

British engineers, the President said, are no less skilful than their German competitors, and, in his experience, the merits of German design have often been considerably over-rated. German plant in South Africa has often been hopeless when viewed from a practical standpoint. The winding of a large alternator, for example, is complicated enormously merely to gain some slight benefit in rating, but at the sacrifice of features which are infinitely more valuable to those who will operate and maintain the finished machine. Six 4,000 k.v.a. alternators made by a German firm had to be entirely re-wound, and seven 12,000 k.v.a. alternators (including a spare stator) had to be entirely re-jointed. The smaller machines were originally wound for 10,000 volts, so as to avoid the use of step-up transformers, and the design of these high-tension windings was totally inadequate. Lightning made short shrift of them, but in any event their life could not have exceeded a few years. On the largest sets the joints between slot bars and end connections overheated very soon after the machines went into commission, and caused a long succession of serious and expensive breakdowns. The design of these joints had to be radically modified, involving a most tedious and costly programme of work. Numbers of sub-station transformers of 1,000 and 500 k.v.a. capacity, made by the same firm, proved incapable of standing the stresses imposed at times of fault on consumers' circuits. The method of clamping the coils had to be entirely re-designed. The high-tension switchgear for 40,000, 20,000 and 10,000 volts proved lamentably deficient. It is quite clear that in those days this firm knew very little indeed about the design of high-tension switchgear for large systems. They were quite satisfied to proportion up the dimensions of a low-tension switch. When asked to advise on the problem of lightning protection, experts (so-called) were sent out by the German firm to report, but despite all their theoretical argument nothing of practical value was produced. Although the turbines were a good job in many respects, heavy maintenance charges were incurred on account of defective blading. The steam pipes, valves and lagging were a most shoddy job. The flanges on the steam pipes were expanded on without riveting, and a serious accident was but narrowly averted at one power station due to the expansion and consequent withdrawal of one of these flanges. It has been necessary to re-expand and rivet-on every flange of every steam pipe at two power stations, and the whole of the lagging, which had begun to break away before the pipes were dismantled, had to be scrapped and replaced by material of better quality. Seven 12,000 k.v.a. three-phase transformers made by another German firm had to be entirely re-wound. The original windings were deficient in insulation, and the surface of the copper conductors had been burned during the process. The President of the Institution added that, while he was quite ready to admit the merit of much of the German workmanship and design, and while he could not but admire the organising power displayed by German concerns, he did not think they have reason to be proud of the record of the plant they have installed in South Africa. It is quite certain that leading consulting engineers and manufacturers in the United Kingdom would have avoided many of the mistakes which South African power companies have had to correct.

OBITUARY.

Prof. H. M. Waynforth.—By the death of Prof. H. M. Waynforth, until recently Professor of Engineering in King's College (London), Engineering teaching has suffered a great loss. As stated in our last issue, Prof. Waynforth died on the 5th inst. after a long illness.

Prof. Waynforth, who was born in 1867, was educated at the Haberdashers' School, and at the Finsbury Technical College, his apprenticeships being served at Messrs. Bennett & Sons. He was assistant to Prof. Perry at Finsbury for some time, after which he went to Mason's College, Birmingham, as demonstrator in engineering. In 1896 he left Mason's College to join the engineering staff of King's College. He was appointed assistant professor of engineering in 1902 and University Professor in 1912. His work for engineering teaching in the University of London was most valuable and important. The present syllabus for the B.Sc. degree in Engineering, especially in Theory of Structures, Strength of Materials and Theory of Machines, owes much to his energy and professional ability. An eminently practical man, he laboured assiduously to keep the syllabus as practical as possible, and at the same time to maintain a high standard of academic attainment. He was for many years chairman of examiners for the degree of B.Sc. (Eng. of the University of London). He did a good deal of original work on the testing of materials, but it will be as a great teacher that he will be best remembered. His lectures at King's College were marked by great freshness and vigour, and his breadth of mind and cordial sympathy endeared him to all his students. His loss will be felt by his old colleagues at King's College and in the University of London, but he will be especially mourned by the large number of King's men who now, on many battle fronts and in the Grand Fleet, are applying the principles he taught so well to the engineering problems of the war.

PERSONAL.

We understand that Mr. W. H. Allen, for a number of years borough electrical engineer at Loughborough, has joined the firm of Chance & Hunt (Ltd.), Oldbury, to act as advisory electrical engineer for the works at Oldbury, and in other parts of the country. Messrs. Chance & Hunt are particularly interested in the application of electric power on a considerable scale to chemical production, and it is in connection with this department that Mr. Allen's services have been engaged.

At the meeting of the Marylebone (London) Council yesterday (Thursday) the Electric Supply Committee recommended that the resignation of Mr. T. K. Richardson, station superintendent, be accepted as from Dec. 31 next. Mr. Richardson has been on sick leave for some months, and we regret to learn that the heart disease from which he is suffering is considered by the Council's medical adviser to be of a permanent character.

Mr. H. H. Holmes, sales manager of the Marylebone (London) electric supply department, has been offered an Army appointment, with a commission, and he has to report for duty on Monday next.

Mr. F. W. Mozley, son of Mr. H. Mozley, Burnley tramways manager, has been gazetted second-lieutenant.

Royal Engineers (T.F.). The following appointments have been made:—

London Electrical Engineers: Sec.-Lieut. (temp. lieut.) R. H. Smith (Lon. O.T.C. unattached list, T.F.) to be sec.-lieut. (from Aug. 23 instead of as notified in the "London Gazette" of Oct. 24).

Tyne Electrical Engineers: Lieut. (temp. capt.) C. M. Campbell to be temp. maj.; Sec.-Lieuts. (temp. lieuts.) H. O. Rogerson, H. Sherlock, C. I. Scott, D. Myles, F. B. C. Sutthery, T. T. Tucker, W. H. James, J. Lawther, R. H. Rookeby to be temp. captains; Sec.-Lieuts. H. G. Campbell, E. A. Baldwin, E. Harrison, O. W. E. Hedley, W. W. Wilson, C. B. S. M[illegible], W. Fox, J. B. Murray, C. Graham, J. L. Batey, D. F. R[illegible], A. S. Burdis, J. R. T. Emerson and F. T. Hamilton to be temp. lieutenants.

War Honours.—Sergt. Burt, a former employee of the Accrington Electricity Works, and Sergt. J. W. Wood (R.A.M.C.), of Marylebone electricity department, have been awarded the D.C.M.

APPOINTMENTS VACANT AND FILLED.

A principal and secretary is required for the Technical School, Lurgan. Salary £200. Applications to the Acting Secretary by noon Nov. 21.

The Edison Swan Electric Co. (Ltd.) are inviting applications for the position of manager of their lamp works at Ponders End. Applicants must have thorough knowledge of the various processes of manufacture of drawn wire lamps and be efficient managers and organisers. Applications to the Chairman of the company, 123, Queen Victoria-street, London, E.C. *See an advertisement.*

A London electric supply company advertises for an assistant engineer to take charge of a watch at one of its stations.

Mr. Charles Fenner, principal of Ballarat School of Mines, has been appointed superintendent of technical education in South Australia at a salary of £600 a year. The position has recently been created under the South Australian Education Act.

INSTITUTIONS AND SOCIETIES.

Institute of Radio Engineers (New York).—A meeting of the institute was held on the 1st inst., when a Paper by Messrs. Bowden Washington and T. H. Boyster on "A Determination of the Energy Losses in a Radio Telegraph Transmitter" was read.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 17th (to-day).

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster. Report of the Hardness Tests Research Committee.

SATURDAY, Nov. 18th.

Association of Mining Electrical Engineers.
(Notts and Derbyshire Branch.)

3.30 p.m. At University College, Nottingham. Paper on "Some Electrical Troubles and their Remedies," by Mr. Thomas Anderson.

Birmingham and District Club.

7 p.m. At the Swan Hotel, New-street, Birmingham. Paper entitled "Notes on the Export to the Far East," by Mr. W. G. L. Riddle.

MONDAY, Nov. 20th.

Electro-Harmonic Society.

6.15 p.m. At the Holborn Restaurant (King's Hall). Ladies' Night.

WEDNESDAY, Nov. 22nd.

Royal Society of Arts.

4.30 p.m. Paper on "The Economic Development of Russia and Britain's Share Therein," by Mr. Leslie Urquhart.

THURSDAY, Nov 23rd.

Institution of Electrical Engineers.

8 p.m. At the Institution, Victoria Embankment. Paper by Mr. J. S. Peck, on "The Parallel Operation of Electric Power Stations."

FRIDAY, Nov. 24th.

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington.

The North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At Bolbec Hall, Newcastle-on-Tyne. General Meeting.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week:—

Officer for the Week.—Platoon Commander A. Gerard.

Next for Duty.—Platoon Commander W. J. A. Watkins.

Monday, Nov. 20.—Technical for Platoon No. 9, at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.25 to 8; Lecture on Telephones, 7.30.

Tuesday, Nov. 21.—School of Arms, 6 to 7; Lecture, 7.15, "Squad and Platoon Drill," Company Commander Fleming.

Wednesday, Nov. 22.—Instructional Class, 6.15; Platoon Drill, Platoon No. 2.

Thursday, Nov. 23.—Platoon Drill, Platoon No. 7; Ambulance Class by M.O., 6.

Friday, Nov. 24.—Technical for Platoon No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.25 to 8.25; Lecture on Telephones, 7.30.

Saturday, Nov. 25.—Parade 2.20, uniform, for Inspection by the County Commandant, at 3.0. As a full muster it is important every member should attend.

Sunday, Nov. 26.—Entrenching at Otford. Parade Victoria (S.E. & C. Rly. Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday rations to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice and Tables A and B at Headquarters.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

AN ARTIFICIAL TRANSMISSION LINE WITH ADJUSTABLE LINE CONSTANTS.*

BY C. E. MAGNUSSON AND S. R. BURBANK.

Summary.—A description is given of an artificial transmission line which can be readily adjusted to represent 200 miles (321·86 km.) of commercial transmission lines of any spacing up to a maximum of 120 in. (3 metres) and any size wire up to 4/0 copper. It can also be made to correspond to aerial or cable telephone lines and to power cables. The use of this type of line in laboratory courses on transmission line phenomena is illustrated by a number of typical experiments. It is shown that quantitative data, sufficiently accurate for instructional purposes, may be obtained by using portable voltmeters and ammeters and by the oscillograph.

It has been proved by extended research that actual transmission line phenomena can be accurately reproduced in the laboratory, and that the theoretical equations correctly express the quantitative relations between the line constants, voltages, currents, time and space phase angles and other factors that enter in the general transmission line problem.

The purpose of this Paper is to describe the design and construction of an artificial transmission line, and to report a few typical experiments. The line consists of 20 units connected in series. Each unit is complete in itself and represents approximately 10 miles of a power transmission line. The line can readily be adjusted within wide limits, to any spacing or size of wire, or converted into a standard telephone line. The apparatus represents one line to neutral and can therefore be used in experiments on either single-phase or polyphase systems. The spark-gap on each unit can be adjusted so as to provide protection to the condensers against excessive voltages that may develop under resonance conditions. The 10-mile unit was selected as a sufficiently close approximation to the uniformly distributed line constants of industrial transmission lines for frequencies up to 800 cycles per second.

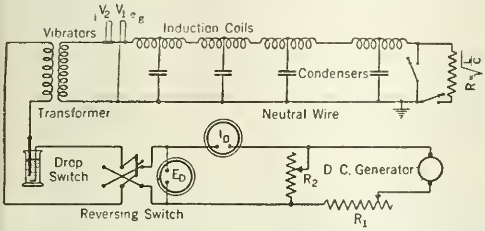

FIG. 1.—WIRING DIAGRAM FOR IMPULSE OSCILLOGRAMS IN FIGS. 6, 7, 8, 9, 10, AND 11.

The line is so designed that it can readily be adjusted so as to correspond to a line of any spacing up to 120 in. and for any size of wire up to No. 4/0 hard-drawn copper. By the insertion of a 50-ohm non-inductive resistance between each unit it is converted into a telephone line of practically standard specifications.

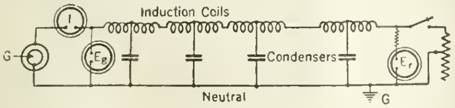

FIG. 8.—WIRING DIAGRAM FOR LINE CHARACTERISTICS, FIGS. 9 TO 14, AND RESONANCE CURVES, FIGS. 24 AND 29.

To comply with the above requirements the line constants must be adjustable within the following limits:—

Resistance, minimum value = 2·59 ohms.
Inductance, maximum value = 0·021 henry.
Condensance—from 0·1 mfd. to 1·0 mfd.

The author next gives full details of the experimental line.†

Instruments.—For accurate measurements an alternating-current potentiometer is necessary, and an instrument like the Drysdale-Tinsley alternating and continuous-current potentiometer gives excellent results. Quantitative values, sufficiently accurate for instructional purposes, may be obtained by means of ordinary portable voltmeters and ammeters, for numerous experiments, as may be seen by comparing the calculated and the observed values in several of the experiments described in this Paper. The instruments used were standard voltmeters, ammeters, speed indicators and a three-element oscillograph.

Great care must be exercised in keeping the frequency constant throughout each test. Slight changes in frequency will cause considerable changes in the voltmeter and ammeter readings.

Typical Experiments.—The experimental data have been selected from students' laboratory reports, and the circuit connections are shown in Figs. 1, 8 and 15. The oscillograms and the drawn curves are in a large measure self-explanatory. In all cases the size of wire was equivalent to No. 4/0 hard-drawn copper. The spacing was either 96 in. or 120 in., as noted below each figure. Experiments with other spacings and for other sizes of wire gave similar results.

The experiments selected may be grouped into three divisions:—

1. Sudden impulses impressed on the line.
2. Voltage and current readings along the line Constant voltage at the generator end and constant frequency.
3. Resonance.

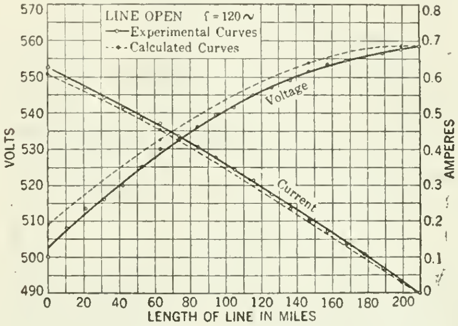

FIG. 9.—VOLTAGE AND CURRENT CHARACTERISTICS.

GROUP 1.

A direct-current generator was connected to the primary of a transformer and the line to the secondary. Between the generator and the transformer was a drop switch, Fig. 1. Upon closing the switch a sudden impulse was impressed on the line from the secondary winding of the transformer.

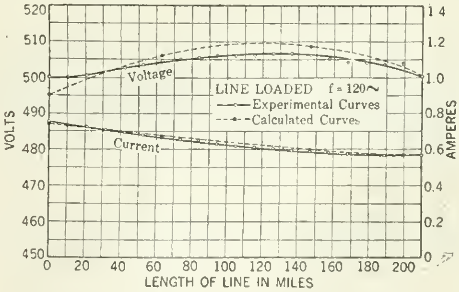

FIG. 10.—VOLTAGE AND CURRENT CHARACTERISTICS.

For Figs. 2, 3 and 4 overleaf the line constants were $R=51{\cdot}7\ \Omega$, $L=0{\cdot}427$ henry, $C=2{\cdot}92$ mfds. The original voltage and current impulses with the reflections are shown for receiver end open in Fig. 2 and short-circuited in Fig. 3. No reflections appear in Fig. 4 when the receiver has a resistance equal to $\sqrt{(L/C)}$ ohms.

Calculating the length of the line from the line constants it should be equivalent to 208 miles. Measuring the time taken for the impulse to be reflected from the receiver end as in Fig. 3, and assuming a velocity of $3 \cdot 10^{10}$ cm. per second, the equivalent length of line was 214 miles. A number of trials gave a similar discrepancy of approximately 3 per cent. Subsequently the condensers, a cheap grade, were replaced by condensers of a better quality. Measurements on oscillograms taken after the new type of condensers were on the line, as in Figs. 5 and 6, checked more closely with the length calculated from the line constants. Thus for Figs. 5, 6 and 7 the line was

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

† *See* THE ELECTRICIAN, Vol. LXXV., p. 613.

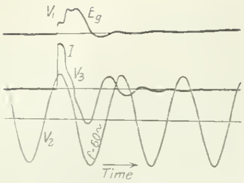

Fig. 2.—Receiver End Open.

Spacing = 120 in. $E_D = 98$ v. I_D = 6·[illegible] amp.

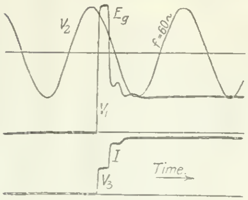

Fig. 3.—Receiver End Short-circuited.

Spacing = 120 in. E_D — 100 v. I_D — 2·5 amp.

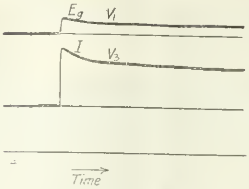

Fig. 4.—Receiver End Closed through $\sqrt{L/C}$ ohms.

Spacing = 120 in. E_D = 104 v. I_D = 2[illegible] amp.

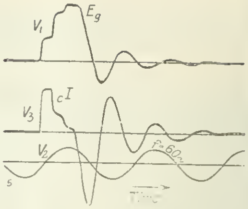

Fig. 5.—Receiver End Open.

Spacing = 96 in. E_D — 110 v. I_D = 19·8 amp.

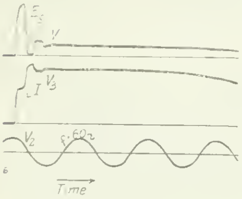

Fig. 6.—Receiver End Short-circuited.

Spacing = 96 in. E_D = [illegible]01 v. I_D = 20·0 amp.

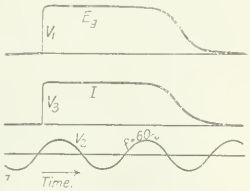

Fig. 7.—Receiver End Closed through $\sqrt{L/C}$ ohms.

Spacing — 96 in. $E_D = 110$ v.
I_D — 19·7 amp.

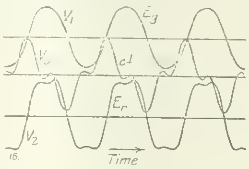

Fig. 16.—Receiver End Open.

Spacing = 120 in. $f = 60$ ~. $L = 0·427$ h.
$C = 2·96$ mf. $E_g = 500$ v. $E_r = 558$ v.
$I = 0·63$ amp.

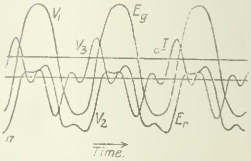

Fig. 17.—Receiver End Open.

Spacing = 120 in. $f = 66$ ~. $L = 0·427$ h.
$C = 2·96$ mf. $E_g = 500$ v.

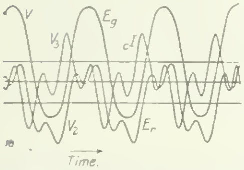

Fig. 18.—Receiver End Open.

Spacing = 120 in. $f = 72$ ~. $L = 0·427$ h.
$C = 2·96$ mf. $E_g = 500$ v.

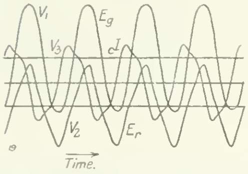

Fig. 19.—Receiver End Open.

Spacing = 120 in. f = 100 ~. $L = 0·427$ h.
C = 2·96 mf. E_g = 5.0 v. E_r — 655 v.
$I = 1·06$ amp.

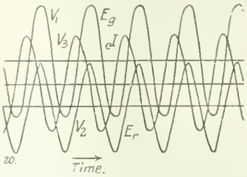

Fig. 20.—Receiver End Open.

Spacing = 120 in. $f = 120$ ~. $C = 2·96$ mf.
$L = 0·427$ h. $E_g = 500$ v. $E_r = 716$ v.
$I = 1·34$ amp.

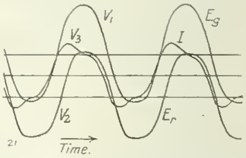

Fig. 21.—Receiver End Loaded.

$I_r = 0·56$ amp. Spacing = 120 in. $f = 60$ ~.
$C = 2·96$ mf. $L = 0·427$ h. $E_g = 500$ v.
$E_r = 500$ v. $I = 0·75$ amp.

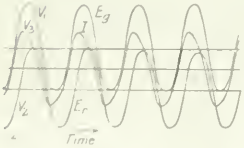

Fig. 22.—Receiver End Loaded.

[illegible]

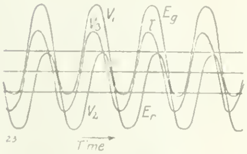

Fig. 23.—Receiver End Loaded.

[illegible] I_r [illegible] amp.
L = 0·427 h. [illegible] E_g [illegible]
E_r [illegible] I [illegible] amp.

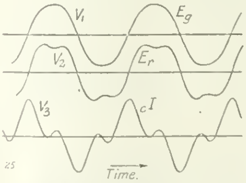

Fig. 25.—Receiver End Open.

[illegible] 96 in. f = 60 ~. C = 3·03 mf.
[illegible] 412 h. E_g 500 v. E_r 570 v.
I 0·70 amp.

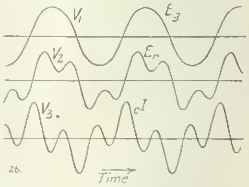

Fig. 26.—Receiver End Open.

Spacing 96 in. f = 74 ~. C = 3·03 mf
L = 0·412 h. E_g 500 v. E_r 690 v.
I = 1.35 amp.

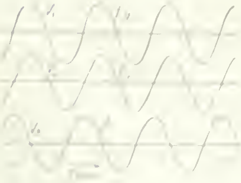

Fig. 2[illegible]. Receiver End Open.

[illegible]

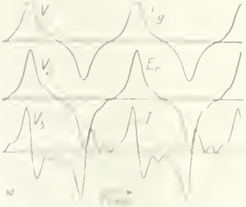

Fig. 30.—Receiver End Open.

[illegible]

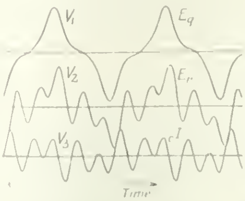

Fig. 31.—Receiver End Open.

[illegible] 96 in. [illegible] C [illegible] 3·03 mf.
[illegible] 0·412 h. E_g [illegible] v. E_r = 420 v.
I 1·00 amp.

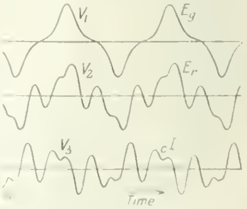

Fig. 32.—Receiver End Open.

Spacing = 96 in. f = 50 ~. C = 3·03 mf.
L = 0·412 h. E_g = 250 v. E_r = 325 v.
I = 0·55 amp.

adjusted for a spacing of 96 in. The line constants were $R=52\cdot9$ ohms, $L=0\cdot412$ henry, $C=3\cdot03$ mfds. From the line constants the equivalent length of line was 208·5 miles. From measurements on the oscillogram in Fig. 5 the equivalent length was 206·5 miles, and from the oscillogram in Fig. 6, 208 miles. A slight leakage in the first set of condensers probably caused the retardation of the electromagnetic wave. After three reflections in the open line (Figs. 2 and 5), the transformer and the line oscillate together, causing an oscillatory transient of lower frequency.

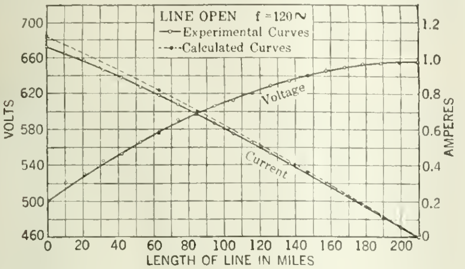

Fig. 11.—Voltage and Current Characteristics.

Group 2.

The change in the magnitude of the voltage and current along the line is shown in Figs. 9 to 14 inclusive, for the line open and for frequencies of 60, 100 and 120 cycles respectively in Figs. 9, 11, and 13, and similarly for the line loaded so as to have generator and receiver voltages each equal to 500 volts, in Figs. 10, 12 and 14.

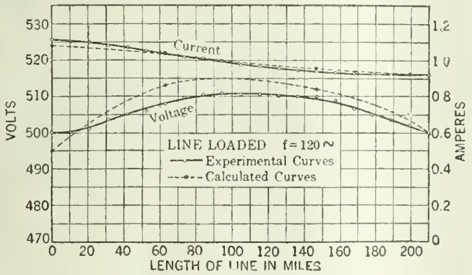

Fig. 12.—Voltage and Current Characteristics.

Necessarily the shunting of the voltmeter across the line changed the conditions in each case and caused discrepancies in the curves as indicated by the difference between the drawn and broken lines. Extreme care had to be exercised in keeping the frequency constant for each set of readings. A slight change in frequency will cause a considerable change in the receiver voltage with the line open. This is readily seen by comparing the receiver voltages for 60, 100 and 120 cycles in Figs. 9, 11 and 13.

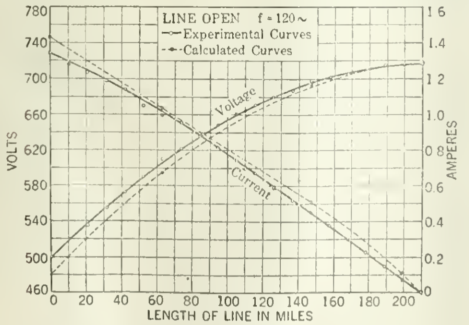

Fig. 13.—Voltage and Current Characteristics.

Group 3.

In obtaining the data on resonance, two single-phase alternators were used. Alternator A gave a voltage wave which appeared to be simple harmonic, but on analysis was found to have a small third harmonic, about 1 per cent., of the fundamental. The shape of the voltage wave of alternator B is shown in Fig. 28, consisting of a fundamental combined with a 28·2 per cent. third harmonic and a 5·4 per cent. fifth harmonic. The frequency of alternator A was normally 137 cycles and for B, 60 cycles.

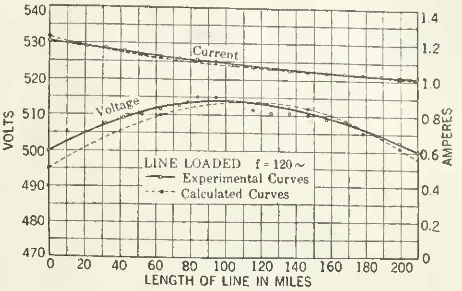

Fig. 14.—Voltage and Current Characteristics.

At first it was assumed that alternator A gave a simple sine wave. The first indications that the assumption was not true were difficulties in securing consistent readings at all frequencies, particularly between 70 and 75 cycles. With the generator voltage of 1,000 volts and the frequency about 72 cycles, the condensers in unit No. 20, at the receiver end, were punctured. Upon investigation it was found that the third harmonic caused resonance in the line and that the receiver voltage was greatly in excess of what would be produced by the fundamental. To prevent a similar accident spark-gaps were placed in each unit.

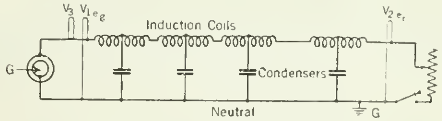

Fig. 15.—Wiring Diagram for Oscillograms in Figs. 17 to 23, 25 to 27, and 30 to 33.

To secure accurate readings on resonance values, an alternating-current potentiometer is necessary, but the effect may be observed on ordinary oscillograms and to some extent measured by portable voltmeters.

In Figs. 16 to 20, inclusive, are shown the oscillograms of the generator and receiver voltages and the charging current for 60, 66, 72, 100 and 120 cycles using alternator A. The generator voltage is nearly a sine wave in all cases. The receiver voltage and the charging current show a third harmonic in Fig. 16; an increased distortion in Fig. 17 and a maximum third harmonic in Fig. 18 or at 72 cycles. The distortion is smaller at 100 cycles, Fig. 19, and practically disappears at 120 cycles, Fig. 20. The line constants give a resonance frequency of 222·2 cycles and hence for the third harmonic in resonance the fundamental frequency would be 222·2/3=74 cycles.

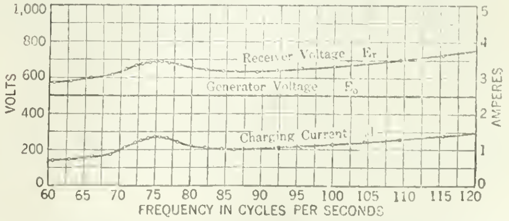

Fig. 24.—Resonance Curves with Machine Giving nearly Sine Wave as Source (about 1 per Cent. Third Harmonic).

Similar oscillograms for a spacing of 96 in. and for frequencies of 60, 74 and 120 cycles are shown in Figs. 25 to 27. The third harmonic is at a maximum for 74 cycles.

The dampening influence of the load on the receiver end is shown by comparing the voltage and current waves in Figs. 21 to 23 with the wave shapes for the corresponding frequencies in Figs. 16, 19 and 20.

A much greater distortion is produced when using alternator B. The influence of the frequency for resonance conditions of both the third and fifth harmonics are shown in Figs. 30 to 32.

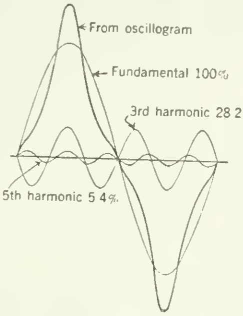

Fig. 28.—Analysed Wave of Peaked Wave Alternator.

For 25 cycles, Fig. 30, the receiver voltage is practically of the same shape as the impressed voltage wave at the generator end. For 43·5 cycles the fifth harmonic produces resonance and causes a marked distortion of the receiver voltage. At 72·5 cycles the third harmonic is near resonance and the receiver voltage consists chiefly of the third harmonic. At 50 cycles, Fig. 32, the distortion of the receiver voltage is less than for either 43·5 or 72·5 cycles.

Not only the wave shape but also the magnitude of the receiver voltage is affected by the resonance of the harmonics in the impressed voltage wave. In Fig. 24 is shown the receiver voltage and charging current plotted as ordinates with the frequency of the impressed voltage from alternator A as abscissæ. The voltage at the generator end of the line was held constant at 500 volts. The hump in the curve between 70 and 80 cycles is due to resonance produced by the third harmonic.

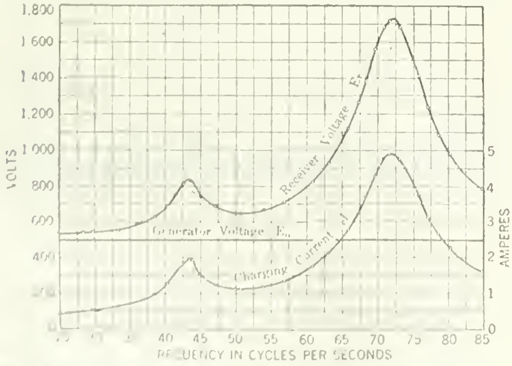

Fig. 29.—Frequency Curves with Machine Giving Peak Wave, as [illegible] 5·4 per cent. Fifth and 28·2 per cent. Third Harmonic).

In Fig. 29 the receiver voltage and charging current curves are drawn for alternator B. The humps in the curves are produced by resonance in the line by the fifth and third harmonic.

The resonance point for the fifth harmonic comes at 43·5 cycles and for the third harmonic at 72·5 cycles. The great increase of the receiver voltage for resonance of the third harmonic should be noted, while at 85 cycles the measured receiver voltage drops to a comparatively low value, although considerably in excess of what would be produced by a sine wave.

WORKS ORGANISATION.*

BY A. D. C. PARSONS, B.A., EDWIN L. ORDE, AND G. H. TWEDDELL.

(*Concluded from page* 174.)

In this Paper the question of works organisation is divided into three main parts, covering: (1) Manufacturing, (2) Costing, and (3) Selling, of the works product. In our last issue was given the part covering costing.

PART III.—SELLING ORGANISATION.

BY G. H. TWEDDELL.

The Value of Salesmanship.—The selling engineer may be considered the life-sap of any manufacturing concern, as upon the results of his activities the success of the industry largely depends. The value of good salesmanship is not yet fully appreciated in this country. The fact that "salesmanship" is regarded as a science in the United States will come as a revelation to most of us. If we are to depose the Germans after the war we must radically improve our methods of sale.

Selling Representatives.—Many manufacturers seem to think a good sales organisation consists in appointing a large number of agents or travellers on commission, and further, that in consequence advertisement is unnecessary. This is a fallacy. These agents—usually most estimable men—accept these agencies and "go on the road" without any special training or knowledge of the product they are handling, or any executive power to make a "deal" if the opportunity arises. In engineering work consulting engineers and buyers generally grow tired of interviewing representatives of this kind. What they require to see is the equivalent of a principal.

Statistics prove that of those entering the ranks of salesmanship, only 5 per cent. succeed. Success does not come easy even with the best of equipment, and it is strange that greater stress is not laid by both employers and salesmen upon the necessity of thorough preparation for sales work.

A Typical Selling Organisation.—One of the first points to be considered in a manufacturing business is the market for the product, and the best methods of reaching and holding that market. This requires a selling organisation, the nature of which depends upon the type of product to be disposed of, the area or territory to be covered, and the volume of business with which it is proposed to deal. As these factors vary in every business, it is impossible to outline an organisation suitable for all classes of trade.

As an alternative to outlining a hypothetical selling organisation, it may be preferable very briefly to describe an organisation with which the author is associated. This organisation is perhaps the largest and is reputed to be one of the most efficient of its kind existing. Fig. 7 indicates the general scheme.

The Works Commercial Department (of which the outside selling staff is a part) is under the direction of a general sales manager to whom the district office managers and special representative report, through the manager of home sales. The works correspondence department is an integral part of the commercial department, and forms a connecting link between the various district offices and the engineering departments.

The varied and technical nature of the products to be marketed calls for high-class men as representatives, and a large number of such men. These same conditions require that the Company's representatives should live in the same district as its customers, with the result that a system of local or what are termed district offices has been created, one in each natural market of territory, controlling sufficient business to warrant its existence and so constituted as to meet the demands of what territory and the customers it has to serve.

Stated briefly, there are eight district offices situated in the largest towns in the chief manufacturing centres of the United Kingdom. Similarly abroad, four district offices are situated in Johannesburg, Calcutta, Bombay and Melbourne, and are supplemented by a number of agents located in territory not covered by the Company's own offices. The export business is done through the office of the manager of export sales. European business is conducted through the French, Italian and Norwegian allied companies. In the case of Russia and Spain, the business is done through export agencies controlled by branch offices.

From the above it will be seen that, aided by agents and allied companies, this selling organisation covers the whole of the British Empire, including a considerable portion of Europe. The total orders secured by this force are remitted to Trafford Park and manufactured at one works employing 9,000 hands.

Each district office and works selling representative is provided with two loose-leafed pocket-books; one of these is a series of price sheets giving the latest prices of all the standard apparatus manufactured by the Company. The leaves of this book are revised and re-issued from time to time by the price department as prices or standards change, or new apparatus is introduced. The other book contains a set of technical data referring to the standard apparatus, which is also kept up to date in a similar manner. Each district office is also provided with specifications of standard apparatus, outline drawings and diagrams of connections, &c., and a proper stock of literature descriptive of the Company's apparatus, so that with these aids the district office representative is able to handle all ordinary inquiries for standard apparatus without reference to the works. When the purchasers' requirements cannot be met by means of standard apparatus, or when there is some doubt in the selling engineer's mind upon this point, the inquiry is referred to the works.

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* Abstract of Paper read before the North East Coast Institution of Engineers and Shipbuilders.

Up to this point the customer has dealt with one man who has a general knowledge of his requirements, but now his case is put into the hands of experts who have specialised in the particular commodity which is the subject of his inquiry. In the case of an inquiry covering various apparatus, it is felt that it would be disconcerting and annoying to the customer to have to deal with a number of correspondents in different departments. An arbitrary rule is therefore made which determines that inquiries covering certain materials shall be dealt with by one commercial department. Any correspondence with the customer or the district office respecting this inquiry will come through that department's hands, and any information required on other items in the inquiry that do not come under that department's supervision must be obtained by it from the other departments at the works, and embodied with the other information sent to the purchaser.

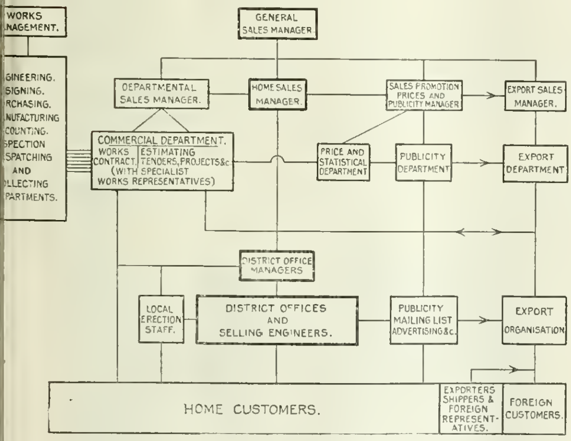

Fig 7.—Sales Organisation.

Each commercial department at the works is controlled by a sales manager who has under him a staff of correspondents and one or more selling engineers. The works selling representatives are specialists and are called in by the district offices to assist in particular cases where special knowledge is required.

For each commercial department at the works there is a corresponding technical department which gives the necessary technical information respecting the matters under consideration to the commercial department to transmit to the customer. Should the tender be successful and result in an order, the correspondence respecting that order is undertaken by one of the commercial departments at the works. A similar rule to that mentioned above determines which department shall handle the whole correspondence for any particular order. It is then the function of the commercial department to clear up any doubtful points and to instruct the technical department to put the work in hand in accordance with the customer's requirements. The technical departments then issue their instructions to the factory and to the drawing office for the carrying out of the work. Thus by easy stages from the preliminary inquiry which was handled by the district office salesman and which might comprise a great variety of articles all manufactured in different parts of the works, the required information is, as it were, sorted and distributed in a fan-like direction so that the specialised workmen, who may be spending the whole of their lives in assembling one small piece of apparatus are finally brought in to satisfy the ascertained requirements of the purchaser.

Besides the commercial departments mentioned above, there are the publicity and statistical departments, engaged in sales promotion, whose function it is to compile and analyse statistics, to produce catalogues, leaflets and other literature describing the various manufactures of the Company, and by Press and other forms of advertising widen the market for the sale of the Company's goods, and generally co-ordinate the results obtained. A confidential bulletin is published once a month for the information of salesmen and heads of departments, in order to let them know what is going on in other branches. Also a monthly house organ is published and distributed to important purchasers, giving descriptions of the work executed by the Company and articles of general interest by one or other of the experts which they employ.

A comprehensive mailing list (containing approximately 30,000 addresses) is on file. This list is sectionalised into various trades to which suitable literature and special publications are forwarded from time to time, as issued. The reason for this classification is to ensure the right literature reaching the right customer, it being obviously a waste of money to send a shipyard an expensive publication, say, on electric winding-engines for collieries.

District Office Organisation.—This should be as simple as possible, with one head, usually known as district manager. Working under his direction are the selling engineers, erection and clerical staff.

It is hardly necessary to define the qualifications of a district manager. Business concerns usually make use of the best material available in their employ. Apart from the essential requirements of honesty, reliability and intelligence, he should be a good judge of human nature, and have had sufficient experience to use such judgment to advantage. An engineering education and experience is usually considered as essential, and unless a man has had such education and experience he must have all the other qualifications remarkably well developed to be able to occupy his position successfully. He should have a thorough knowledge of the apparatus he has to sell, together with a knowledge of the established customs and policy of the Company.

A district office staff should be selected with care. It is the natural inclination to secure additions to the staff from the works organisation, as the knowledge of the details of apparatus brought into the office by a man from the works is of great value. Such a man also is, as a rule, only selected on account of his superior intelligence, and is promoted to the district office after a more or less extended experience in the works departments.

Finally, it may be of interest to add the organisation described deals with a turn-over aggregating between £2,000,000 and £3,000,000 per annum, one or more of the district offices in question dealing with an annual turnover of £500,000. Some of the sales are obtained as the result of individual effort, whereas others are only secured by bringing all the salesmanship, all the engineering talent, and all the influence of every sort available in the Company into play.

This section perhaps might be usefully concluded by offering one or two suggestions for the use of those who control a selling staff. Daily report forms are provided by most firms nowadays for their salesmen to fill in. These should be carefully scrutinised, with a view to counteracting any tendency upon the part of a salesman to become too set with one particular clique, to the avoidance of the more difficult and less congenial interviews. Whenever possible, an encouraging word from the director or manager should be given.

Where a number of selling engineers are employed, opportunities should be given for intercousre between them. The idea adopted by some firms of calling a meeting quarterly with the directors and works departmental managers is a good one. Points possibly in dispute between the manufacturing and sales side are discussed, the future policy of the Company explained, new apparatus or modifications to existing products described, and the general exchange of ideas has, in the writer's experience, been found to be extremely useful.

A point which is often imperfectly appreciated is that nowadays customers buy not merely apparatus but service, which, besides including the apparatus, covers technical advice, guidance during erection, instructions *re* operation, &c. The various items of service mentioned are not necessarily carried out by the selling staff, but by other members of the organisation. Nevertheless, carelessness or incompetence in connection with any one of the services would give reasonable ground for dissatisfaction, and prejudice the prospects of securing future business.

Training for the Industrial Side of Engineering. The need for training and preparation for sales work for the selling engineer of the future has already been emphasised in these notes. It is here proposed very briefly to outline what is being done in this and other countries with a view to training youths for commercial and technical positions.

In Germany this training has been dealt with on a national basis. In America a similar movement, but on different lines, has been strongly supported by engineering and other manufacturers. In Great Britain, whilst a good deal has been done for the training of the technically educated man, comparatively little has been done to provide the best possible training for youths who are to become skilled workmen.

Some works make no effort at all to train men for technical positions, and rely on recruiting their staff from other firms, a policy which in the long run is very short-sighted.

The need for well-trained engineers for the commercial and selling side is becoming more and more appreciated by manufacturers. From the point of view of the technical student, however, there is sometimes a tendency to regard this branch of employment as suitable for one who has not pursued his college career very energetically, and for which strenuous training is not so essential as in the case of the other manufacturing positions. This is an erroneous idea, since sound technical knowledge and a considerable amount of practical training are nowadays almost indispensable for a successful selling engineer, especially in the many-sided electrical industry. The technical positions in engineering manufacture referred to above are as follows:

(1) The works side—comprising such positions as works and departmental managers, together with assistants in the inspection, testing, estimating and draughting departments.

(2) Designers.

(3) Commercial or selling engineers.

Engineering training in this country consisted until a few years ago principally of a practical apprenticeship or pupilage course in works, and only comparatively recently has it been fully recognised that training is not complete unless it also comprises a course of technical study.

It should be pointed out that up to a certain point the training of youths for the manufacturing and commercial sides is identical, and it is often not until their technical and practical training has been completed that an apprentice decides which side he will take up.

In Germany the importance of the technical side of engineering training has become universally recognised, and comparatively little importance is attached to the practical side of an engineer's training. In recent years, however, it has become a recognised practice for a young engineer to spend one year on a practical course in works. The technical course in engineering extends over at least four years.

Comparing generally the English and German systems, there is no doubt that the facilities for technical training in the latter country are much superior to those in the former; while on the other hand, as regards practical training, the English system is on quite different lines, and much more thorough. In Germany the general education is carried further, and the complete course is finished at a much later age than in England.

In America numerous engineering colleges and training institutions have been built and expensively equipped, most of them being heavily endowed by wealthy patrons. Attempts have been made to embody practical training on a fairly large scale with the college course; further, there are ample facilities for obtaining practical experience in works, the demand from firms usually exceeding the supply. The complete college course varies from four to six years, and this may be followed by from six months to two years' practical training in works. Comparatively few facilities for evening technical study are provided in the engineering colleges.

In England opinion in the past has been very divided as to the best lines upon which an engineering training should be carried out. The older school clung firmly to a purely practical training, the newer school pinned its faith to theoretical training, more or less at the expense of practical training. Of late years all engineering authorities have agreed that a period of technical as well as practical training is essential. A satisfactory training would be—after a sound, general education extending to the age of 16 or 17 years—a three year period of education in engineering science spent at a technical college, and another period in practical engineering work. There are various methods of obtaining the above training, viz.:

(a) By a short period of, say, a year in works, then a technical course, followed by works apprenticeship.

(b) By taking a complete technical, and then a works course.

(c) By sandwiching technical and works training in varying periods.

There are advantages in favour of each of the above methods, and whilst many prefer the sandwich system, the writer favours the technical course first as being preferable. Whichever method is adopted it is desirable that the training should terminate in the works, since a better opportunity is afforded the student for obtaining permanent employment with the firm in which he has obtained his training.

As the author's company has during the past 12 years trained engineering apprentices on certain well-defined lines, a brief description of their plan of training may be of interest. The apprenticeship courses are divided into classes, as follows:—

Two-year Course.—Young men of the age of 20 and upwards who have had a thorough scientific training at a university and possess an honours degree in engineering are admitted to a two-year course of apprenticeship on the recommendation of their college authorities.

Three-year Course.—Young men of from 18 to 20 who have had a good technical education are apprenticed for three years.

Four-year Course.—This applies to youths of over 16 years of age who possess a good general education and some elementary technical knowledge.

Trade Apprenticeship Course.—This covers five to seven years of work, and is open to lads of over 14 years of age. There is a school in the works at which daily instruction in trade subjects is given.

The object of these courses is to train suitable young men for the Company's service in either the works, design departments, or the commercial sections, or selling organisation at home or abroad. In the two, three, and four years courses, the general procedure is the same. The apprentices are moved from department to department as a rule every few months, and there given every opportunity of becoming familiar with the construction and general design of the Company's products, and as they show ability and as opportunity offers, they are given a trial in one or other of the commercial or designing parts of the organisation. The embryo selling engineer is eventually moved to one of the commercial or corresponding departments, and ultimately to a district office, there to take his place in the firing line as a junior with a fair prospect—with reasonable ability—of success both for himself and for his Company.

It will be appreciated that an engineer trained on the lines indicated above should go further on his own and his Company's behalf and give greater satisfaction to the purchaser, than a man with only a superficial acquaintance with the product he is handling, and no technical or practical engineering knowledge to support him.

Essentials of Success in Salesmanship.—The young engineer may rest well assured that there is no loss of dignity in taking up the commercial side of engineering, but a salesman failing to combine business ability with technical skill is doomed to limited advancement, if not to failure. In the more highly paid positions, men with sound commercial ability are conspicuous rather than men with high engineering knowledge.

The prime object of the salesman should be (1) to sell at a profit, (2) to accomplish the work required, (3) to satisfy the purchaser. If he accomplishes this, success is assured.

It is imperative that a profit should accrue from the transaction of business. This is a fundamental law of all barter and trade, though this point occasionally appears to be overlooked by some of us in our eagerness to transact a large volume of business, and it appears to our enlightened minds as though other manufacturers forget this first principle even more often than ourselves.

One of the readiest and most certain means of assuring a profit is to sell standard apparatus. This ensures the order going through without a hitch and incidentally with every chance of the delivery date being kept.

It is essential that the salesman should know the apparatus he is selling. If he knows the purchaser's conditions and the capacity and performance of his own plant, he will feel satisfied as to whether or not his apparatus will accomplish the work required. It has been said that a salesman can make better progress in the sale of a piece of apparatus which he does not know too much about, since his faith is not shaken by an intimate knowledge of his shortcomings. This may have been well enough in the old days of salesmanship, but the selling engineer of the future should know all there is to know of the design and be trusted to take care of himself.

The true art of salesmanship consists in marketing goods (it is understood at a profit) and in such a way as to ensure future preferential dealings with the customer. We are all salesmen to a degree, whether we sell machinery, our manual or mental services, or even the use of our money. Like everything else worth having, the becoming of a successful salesman requires effort and study.

The art of expression is a rare accomplishment, and one that almost any man of education can develop to a high degree. Perhaps no accomplishment counts for more in successful salesmanship than does the power of terse and lucid expression.

General business honesty is again a particular qualification for an efficient and successful salesman. No business has ever progressed, or ever will progress that is not to the mutual advantage of both parties.

A comprehensive knowledge of the products offered for sale has already been mentioned as an essential to success. A successful salesman must know when to talk and when to keep still. One writer has said "A real salesman is one-part talk and nine-parts judgment." This is fairly near the truth. A characteristic which is at once the cheapest commodity, and one which pays the best profits of anything in a salesman's armoury, is the habit of respectfulness and courtesy; to this might be added fairness to your competitors when it is necessary or advisable to mention them or their products.

A further faculty to be developed is resourcefulness and adaptability. In the process of a negotiation of any size the setting is liable to change between its inception and its closing. In fact it is changing every moment it is in progress, otherwise an end would never be reached. It is necessary that the salesman should be able to size it up and quickly change his tactics. Resourcefulness will enable the salesman to know when to pursue the policy he has been following, and when to change it. He must be quick to adapt himself to any circumstances which may arise throughout the negotiations.

To sum up, if the candidate for success in the sales field lives a clean life, has a knowledge of human nature, and ability to recognise it when he meets it, a knowledge of the material he is handling and its application, has honesty, energy, courtesy and enthusiasm, he may rest assured that he will quickly develop into a successful and efficient salesman.

AN APPARATUS FOR THE COMMERCIAL TESTING OF PERMANENT MAGNETS.

BY G. B. BETTERIDGE.

One of the many new British industries created by the war is the manufacture of permanent magnets. At the outbreak of war only one or two makers were in a position to supply magnets magnetically equal to those of German origin, but other steel makers were not slow to realise that we must produce our own. To-day magnets supplied by British firms are in every respect as good as those we once used to import.

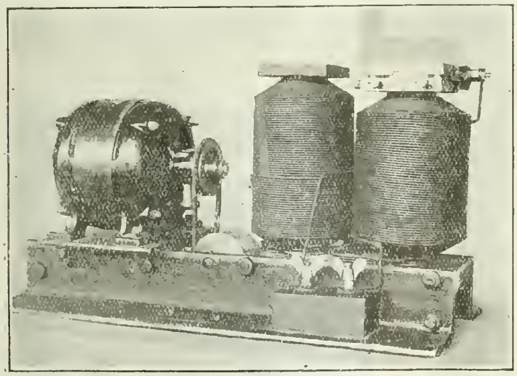

Fig. 1.—Apparatus for Testing Permanent Magnets.

The principal call for permanent magnets comes from magneto and electrical meter manufacturers. The need for a first-class magnet in meter work is well known, for upon its permanency depends the accuracy of the instrument. The case of the magneto is, perhaps, not so well known, but for an efficient magneto it is highly desirable that the magnets should possess certain properties.

The two most important features that should be known of a magnet are :—

(*a*) The coercive force.
(*b*) The remanent flux.

The meter manufacturer is most concerned with the second property, while it can be shown that for an efficient magneto it is desirable that the coercive force should be as high as possible, as the magneto often has to work under strenuous conditions, and if the magnet is of poor quality the energy given out in the form of heat in the spark rapidly falls off.

With the growing use of magnets in the magneto trade, came the need for some ready means of testing their properties, and a consequent need for the introduction of some form of suitable testing apparatus. The number of magnets to be tested is very large, and the testing apparatus will have to be used under actual shop conditions. It should, therefore, satisfy the following conditions :—

1. Allow of individual testing of magnets.
2. The test should take the minimum time to carry out.
3. The apparatus employed should be as simple and robust as possible.
4. The indications obtained should, wherever possible, be direct reading and readily interpreted, so that the apparatus could be used by comparatively unskilled persons.
5. The results obtained should be as accurate as possible, and should give as far as possible the true value of the magnetic properties of the magnet.

The most accurate method of testing magnet steel would be to employ samples in the form of a closed magnetic circuit wound with wire and a search coil and tested by the ordinary ballistic method, but this, although very accurate, is far too cumbersome to comply with the first four requirements.

Another method would be to use a Grassot fluxmeter or equivalent arrangement. This, although more convenient than the ballistic test, has its disadvantages, and is not on the whole so satisfactory as the method about to be described.

The apparatus to be described gives simultaneous values of flux and magnetising force at any moment, while the magnetising force is varied in any manner which is desirable, and the indications are read directly without the use of any search coil.

The apparatus illustrated in Fig. 1 consists briefly of an electromagnet of soft iron and a flux measuring device which consists of a copper disc driven at a constant speed by a small motor and arranged in an air-gap forming part of the magnetic circuit. Carbon brushes run on the spindle and edge of the copper disc, and are connected to a millivoltmeter, which reads the voltage induced in the disc by virtue of its rotation in the magnetic field, this voltage being, therefore, a measure of the magnetic flux passing in the apparatus. The magnetic circuit is completed by the magnet under test. It is then only necessary to excite the electromagnet with continuous current measured on an ordinary ammeter and observe the voltage induced in the copper disc by the millivoltmeter. These two readings when multiplied by suitable constants give directly the flux in the magnet and the magnetising force applied to it, and by varying the exciting current the properties of the magnet can be investigated and its hysteresis loop obtained.

This type of apparatus was found to be liable to errors due to leakage flux cutting the disc, but not actually threading the

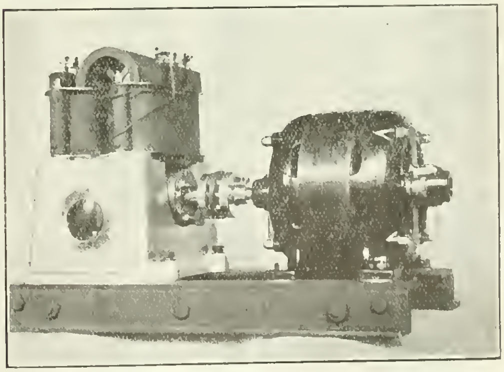

Fig. 2.—Apparatus for Testing Permanent Magnets.

magnet. It was found possible to correct for this by providing iron guards or side plates attached to the electro-magnet in such a manner that the leakage flux was provided through the guards by the electro-magnet itself without passing through the disc. Consequently the leakage flux was not measured, and hence when the millivoltmeter reading fell to zero the magnet under test was really completely demagnetised.

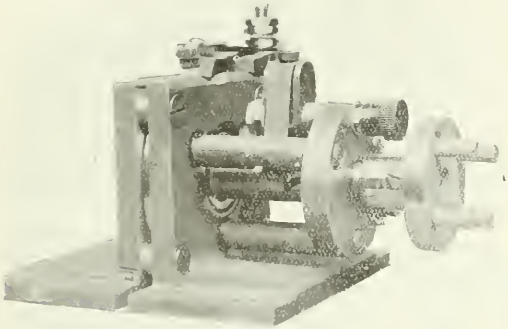

Fig. 3.—Revolving Disc and Brushes of Apparatus shown in Fig. 2.

The chief drawback to this arrangement lay in the fact that a fresh arrangement of guards had to be provided for each size of magnet to be tested, and moreover the proportions of the guards could only be properly found by experiment, the usual method being to overwind a magnet with a magnetising coil, and adjust the size of the guards until the figures obtained with the apparatus agreed with those obtained, using the winding on the magnet.

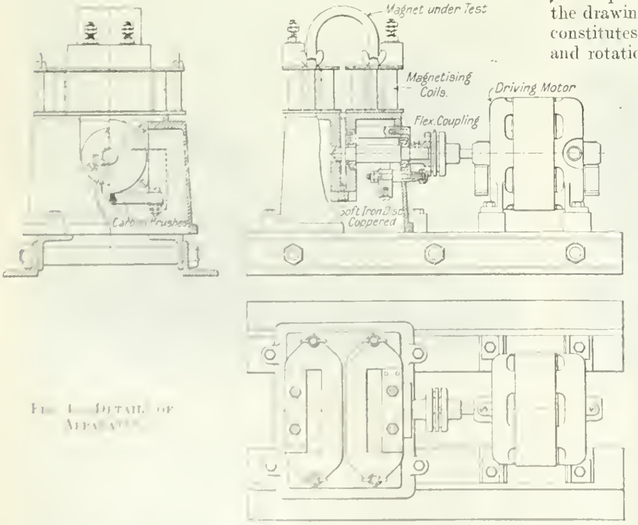

Fig. 4.—Detail of Apparatus.

A further disadvantage lay in the fact that it is practically impossible properly to magnetise a really high class magnet by means of a magneto-motive force applied *en masse* to its two ends. The quality of magnets has steadily improved during the last two years, so that while before the war the average magnet with a coercive force of about 60 could be readily saturated in such a manner, the present-day magnet giving 70 to 75 coercive force cannot be properly magnetised except by the application of a continuous magneto-motive force, such as can be applied by interlinking the magnet with a coil of wire.

A fresh design of instrument has, therefore, been evolved, in which these points have been considered, and a testing apparatus produced capable of handling magnets of varying dimensions and up to the highest value of coercive force which can be produced. This instrument is shown in Fig. 2, from which it will be seen to consist of a pair of magnetising coils into which the magnet is introduced mounted on a base which contains the flux measuring device proper. This is shown in detail in Fig. 3, which illustrates the revolving disc running between iron pole-pieces and the carbon brushes which run on the edge of the disc and the spindle to which it is attached.

Fig. 4 shows the method of construction adopted. The magnet to be tested rests on a pair of angles carried in an aluminium base casting. These angles are separated by non-magnetic distance pieces and in the space between them runs a soft iron disc having a copper ring attached to its outer edge.

The disc is carried on a spindle made of a copper alloy, and carbon brushes run both on this spindle and on the periphery of the disc. The spindle is carried in ball-bearings, one in one of the angles, and the other in a separate casting bolted thereto. By using ball-bearings it is possible to work with small clearances so that the reluctance of the air-gap is negligible in comparison with the magneto-motive force provided by the magnet.

The magnetising force is provided by two coils of wire wound on adjustable brass bobbins, which are attached to the upper face of the angles. These bobbins can be moved to a sufficient extent to permit of the testing of magnets of various sizes.

For extremely accurate work the bobbins should be made to fit the magnets closely in order to avoid the introduction of leakage flux, but for ordinary commercial testing it is found that bobbins made for magnets with a section of 85 mm. by 12 mm. can be used for all ordinary magneto magnets down to the smallest sizes.

The path of the flux will be clear from an examination of the drawing. It will be seen that the revolving disc virtually constitutes a small homopolar dynamo, the directions of flux and rotation being such as to induce an E.M.F. radially outwards in the disc. This E.M.F. is communicated by means of the carbon brushes, which run on the spindle and disc to the millivoltmeter which serves as flux measurer.

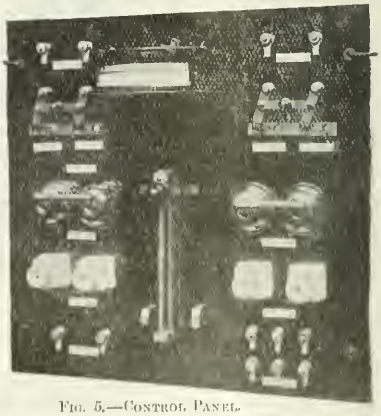

Fig. 5.—Control Panel.

The disc is driven by means of a flexible coupling from a small reduction motor on alternating-current circuits or shunt-wound motor for continuous current, and as the power required to drive it is quite neglibible, the speed of rotation is sensibly constant.

The testing apparatus proper is generally combined with a control panel which permits the magnetising current in the coils to be varied as desired between the extreme plus and minus limits. This panel—an example of which is shown in Fig. 5—usually carries the milli-voltmeter which serves both as a measurer of flux and also, by the use of a suitable shunt coil and change-over switch, as a measurer of current. It also carries a sliding regulator permitting of smooth variation of the current, and a reversing switch, in addition to the switches and fuses controlling both the magnetising and motor circuits.

Such an apparatus has been found to give good service when testing magnets in large quantities, being employed both by magnet manufacturers and users. It can be used by comparatively unskilled labour, and is quick in operation, a smart operator being able to test a batch of magnets for both coercive force and remanence at a rate of about 30 to 45 seconds per magnet, and the results can be repeated in successive operations within an extreme error of 2 per cent.

A modified form is now being introduced in which B.H. curves may be obtained directly without the necessity of any plotting of recorded observations. In this case a special form of rheostat is employed which is slowly traversed by means of a small motor. This rheostat is coupled to the card on which the record is made, the method of coupling employed being such that the movement of the card is proportional to the current in the magnet coils. The flux may either be recorded on the card by the use of a recording milli-voltmeter, or else by an adaptation of the well-known Brearley curve tracer. In the former case a record is obtained without the need of any operator, and in the latter, while an operator is required, the work needs very little skill, and the tedious process of plotting a long series of observations is entirely avoided.

DIRECT AND INDIRECT METHODS OF MAKING NITRIC ACID.*

BY E. KILBURN SCOTT.

The manufacture of nitric acid from the atmosphere can be effected with the aid of electricity in two different ways. The first is called by the author the "direct electric method," because it is a single process and mainly electrical, and the second, the "indirect method," because it consists of several processes and is partly chemical and partly electrical.

In the direct electric method air is blown through a high tension arc flame and forms nitric oxide gas, which, on cooling, takes up more oxygen and becomes nitrogen peroxide. When the peroxide is brought into contact with water in absorption towers it gives nitric acid. Electric power is used once only, on the air that is passed through the furnace. The whole operation is carried out in a single factory containing simple plant, and as the raw materials are merely air and water, such a works can be established anywhere where cheap electricity is available.

The indirect method is a combination of nine separate operations, conveniently carried out in three separate plants or factories. In the first of these calcium carbide is made by treating coke and lime in an electric furnace. When cool the carbide is ground to a very fine powder, and in order to prevent an explosion by acetylene, the grinding has to be carried out in an inert atmosphere in closed vessels. In the second plant the carbide is made into calcium cyanamide, being fed into retorts with layers of crinkled paper, the purpose of which is to provide passages for the nitrogen. In the centre of each retort there is a carbon rod, and the ends of each rod are connected to a source of electricity. Each retort is also connected to a source of pure nitrogen, which is usually made by a liquid air plant. The temperature of the carbide is raised in the retort to a certain point by passing current through the carbon rod, and this incidentally burns up the crinkled paper, and nitrogen gas is then admitted for about 18 hours. This combines with the carbide to form calcium cyanamide, which, after cooling down, is ground to a powder. The third factory makes nitric acid from the cyanamide, which is therein treated with superheated steam, ammonia gas being given off. The ammonia is then passed with air over a catalyst consisting of platinum which is heated to a certain temperature. As a result of this the nitrogen and hydrogen of the ammonia combine with the oxygen of the air to form nitric acid, which is of about the same strength as the acid obtained from the direct electric method.

It will thus be seen that with the indirect method the raw materials required are coke, limestone and air; also pure nitrogen to make the calcium cyanamide and superheated steam to make the ammonia.

In comparing the processes it should be noted that the raw materials of the direct electric method are available everywhere, being air which costs nothing, and water which is a very small charge. Some caustic soda is required to make the sodium nitrite which is a by-product of the process, but it is a very small amount and can be obtained very cheaply.

The manufacture of nitric acid from Chili nitrate, on the other hand, is expensive. The raw material has to be transported 5,000 miles in expensive tonnage, and at great national expense, because of the policing of the long sea route. There is considerable national risk in being dependent on an overseas supply of raw material, because it will be remembered that before the battle of the Falkland Isles the presence of a few enemy cruisers off South America was sufficient to hold up supplies absolutely for seven weeks, and partly so for a much longer period. It is conceivable, if not probable, that this might happen again.

The whole of the plant and material, &c., for the direct electric method can be obtained in this country, and therefore not a penny need be sent out.

By manufacturing from Chili nitrate, on the other hand, very large sums are having to be paid for the nitrate and for transport, insurance &c. Large sums are also required for the pyrites and sulphur for the manufacture of sulphuric acid which is required to treat the nitrate.

Before the war the Central Powers were the largest purchasers of Chili nitrate. Germany alone took twice as much as the next consumer, the United States, and over six times as much as this country. Now they do not require any, because they have established immense plants to make nitrates from the air. It will easily be seen that by keeping money in the country they are at a great economic advantage. This development of the manufacture of nitrates from the air in Germany and Austria is one of the most remarkable features of the war.

The author believes that three scientific developments were amongst leading factors in deciding Germany that the opportune time had arrived for starting the war. They were (*a*) the manufacture of nitrates from air by which the Central Powers were rendered independent of Chili nitrate; (*b*) the success of aircraft, especially the Zeppelin, which nullified the insular position of this country; (*c*) the success of the gyro compass, which solved the problem of exact steering of battleships and submarines by making the compass independent of magnetism and the electric current.

Before the war the price of Chili nitrate was about £11 a ton, now it is over £17 a ton, and it is important to note that this figure represents only a portion of its total cost, because the nitrate requires considerably more than its own weight of concentrated sulphuric acid for its decomposition, and this acid is lost in the process. The cost of transport of the raw materials—pyrites, sulphur—with which to make the sulphuric acid, the transport of the finished acid and of the by-products lead to heavy expenses and loss of time through congestion on the railways.

In the manufacture of nitric acid from Chili nitrate sodium sulphate is left in the reaction pot or vessel, and in order to get this to run out freely so that the process can be carried on regularly, about 30 per cent. of sulphuric acid is run out with it. The result is a material called nitro cake.

Since the war this cake has been produced in enormous quantities, and very large amounts have been and are even now being "dumped in the sea or sent to the tip." As this nitro cake contains about 30 per cent. of free sulphuric acid, some idea can be obtained of the enormous losses of sulphuric acid. It is true that uses have now been found for some of it for scouring wool and for pickling metals, but there is still enormous wastage.

If the methods of making nitrates from the air had been developed in this country then we should not only have been independent of Chili nitrate but the sulphuric problem would not have arisen. Nitric acid up to 60 per cent. strength which is high enough for picric acid, &c., is produced by the direct electric method without any sulphuric acid whatever. For higher concentrations sulphuric acid is used to remove the excess water, but is not lost, but is used over and over again.

When making nitric acid by the direct electric process there are no impurities because the electric arc flame is neutral and the raw materials are pure.

Chili nitrate, on the other hand, contains chlorides and other impurities, and the sulphuric acid with which it is treated is also liable to contain arsenic. The importance of this question of purity is shown by the fact that sodium nitrate made by electric power sells freely in competition with the sodium nitrate from Chili, even in peace time.

The author is of opinion, in view of the great superiority of ammonium nitrate as a fertiliser compared with other nitrous compounds, and seeing the great advantages in favour of this country derivable from possessing the raw materials necessary, that steps should at once be taken to develop the manufacture of ammonium nitrate, using gas power for the production of electricity to be employed in the production of the nitric acid necessary, the ammonia being obtained altogether or in part from the power gas.

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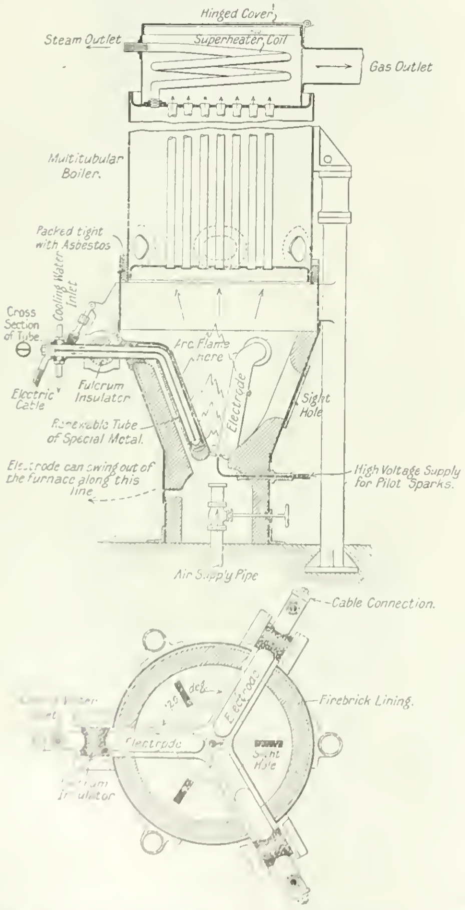
* Abstract of a lecture delivered at University College, London.

In reference to the electrical production of nitric acid by a coal-burning plant, the works at Bitterfeld in Germany are instanced, the power of the plant being greater than that of the whole of the power stations in the London area, and the whole of the energy being obtained by the combustion of a highly inferior fuel, a brown lignite of low calorific value.

The author also pleads for the erection of nitrogen plants of as little as 1,000 kw. size as adjuncts to electricity generating stations for the purpose of equalising the load, and for large plants using blast furnace or Mond gas either independently or in conjunction with other gas plants producing ammonia needing economical utilisation.



Sectional Plan and Elevation of the Kilburn Scott 3-phase Furnace for the Direct Fixation of Atmospheric Nitrogen.

The popular opinion that electric furnace products can only be made with water power is entirely erroneous. The idea is partly due to ignorance of modern power conditions, and it is traded upon by those who are interested in the factoring of foreign products. Chief among these are the financiers whose interests are centred in the mining, refining, transporting and factoring of Chili nitrate, also those members of the acid conventions who are mainly interested in the working up of Chili nitrate.

Where interests involving millions of money are at stake it is to be expected that the interests brought to bear to maintain the *status quo* will be both powerful and subtle. These interests are very highly organised, and constantly make themselves felt in the Press and in political circles. The innocent-looking paragraphs which from time to time appeared in the daily papers throwing doubt on the new methods of producing nitrates from the air, or whether it will pay to make them, and so on, are all engineered by these interests, and it is high time that the people of this country had their eyes opened to the fact. It is of national importance that reactionary influence should be stopped and immediate steps taken to bring this country into line with other countries in the adoption of modern scientific methods.

The Kilburn Scott Furnace.—This furnace is shown in the accompanying diagram. One of the distinguishing features is that it works with three-phase alternating current, whereas other furnaces used for a similar purpose abroad work only with single-phase current. The largest furnaces used in Norway also require continuous current as well as alternating current for their operation, which means additional electrical apparatus and expense, besides the cost of the extra continuous current used.

By combining three arc flames together, a balanced load is given and continuity of working is assured, because current is always flowing in one or other of the phases, thus enabling the arcs to maintain each other. This is important from the point of view of the supply and regulation of power. The combined three-phase arc flames take the form of an inverted cone, and thus a larger proportion of the air passing through the furnace is enabled to come into intimate contact with the arcs than is possible with separate flat flames, in separate furnaces, each having several leakage paths by which the air can get past without contact. A combined three arc flame is hotter than if the same energy were expended in three separate single-phase furnaces, because the latter have much greater radiation losses due to increased wall area and to requiring twice as many electrodes. In a given period there are three times as many arcs struck in a three-phase furnace as there are in a single phase, and naturally this increases the temperature. The cost of the furnace is also less.

The general structure of the furnace is very simple, consisting of cast iron, with triangular shaped electrodes enclosing the arc chamber. The firebricks are remote from the flames, and thus do not require renewal, except at long intervals.

The part of the electrode which is subject to wear is so arranged that it can be quickly renewed, and such renewal can be effected in a few minutes by swinging the electrode out of the furnace.

The arcs between the electrodes are started by a stream of high-frequency sparks projected into the space between the electrodes where they are closest together. The air dielectric is thus broken down by pilot sparks, which enable a lower main voltage to be used and tends to high electrical efficiency. It is also possible to control a furnace by means of quite a small switch. The electrodes do not require constant adjustment, as is the case with the furnaces used abroad, and they can be placed at the best distance apart for the free passage of the air.

The roof of the furnace is not the usual ordinary structural one built of firebricks and difficult to maintain, but it is provided by a steam boiler which forms an integral part of the whole. One special function of this boiler is to provide the cooling zone whereby the nitric oxide formed on the arc flames immediately below is rapidly cooled and so fixed permanently. This is very effective by reason of the latent heat of steam. The steam so raised can be utilised for generating electricity for the furnace, and by thus working the combination regeneratively the gain may be about 15 per cent. None of the furnaces in use abroad have a boiler applied directly.

SOME ASPECTS OF LORD KELVIN'S LIFE AND WORK.*

BY DR. ALEXANDER RUSSELL.

1. *Early Training at Glasgow.* The period of Kelvin's life which is of the greatest human interest and well deserves special study by educationists is from his eighth to his sixteenth year. His father, James Thomson, was appointed to the Chair of Mathematics in Glasgow University in William's (Lord Kelvin's) eighth year. We know that when William was eight years old he and his elder brother James attended unofficially their father's junior mathematical class. It is recorded that William once electrified the class by asking his father's permission to answer a question. His own family had the highest possible opinion of his ability. When he was ten years old he matriculated at Glasgow University and went through the Arts Course, going up to Cambridge at the beginning of his seventeenth year.

His father carefully superintended William's course at Glasgow, fostering his love for physical science and giving him judicious help in his mathematical and classical studies. Although he was a strict disciplinarian yet he never alienated the affection of his children. In his later life Kelvin often recalled that all that he had learnt as a boy in English geography, history, mathematics and classics was taught him at home along with his brothers and sisters by his father. He used also to add that he never met a better teacher in anything than his father was in everything.

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* An abstract of the Eighth Kelvin Lecture, delivered before the Institution of Electrical Engineers, Nov. 9th.

During his course at Glasgow he studied under several famous professors and won distinction by carrying off most of the prizes. The preparing for examinations at this period encouraged that hot, intemperate method of study which caused in after years so much anxiety to the second Lady Thomson. Luckily, however, the Glasgow session lasted only during the six winter months, and so Prof. Thomson and his family could spend a considerable part of the summer vacation in holiday-making. The letters of the family show how much they all liked these happy months at villages on the Firth of Clyde. William then acquired that lifelong love for navigational problems and for the

"Billows and breeze, islands and seas,
Mountains of rain and sun,"

which are typical of the West Coast of Scotland. The swimming, boating and mountaineering in which he then delighted both accentuated his mental activity and perfected his bodily health. He read and studied mathematical works assiduously, being eager to qualify himself to attack those physical problems about which he had heard so much at college. One of his favourite books was De Morgan's "Differential and Integral Calculus." Some of the difficulties in this book were doubtless explained to him by his father, but the reading of it he regarded as relaxation, as it gave him great pleasure.

His last year at Glasgow University was one of unexampled mental activity. Some years later, on looking back on this period, he said that "his mental vision was clearer then than it was now." He had little desire to read novels and read very few; in fact, from 1840 to 1843 he read none.

Before Thomson came up to Cambridge he wrote a Paper criticising a theorem given in Kelland's "Theory of Heat." The Paper is purely mathematical, and is a remarkable production for a boy of 16. It was the forerunner of many hundreds of Papers, some of which opened up unexplored regions of science and all of which were characterised by clear thinking and deep physical insight.

2. *Electrostatics.*—The first important Paper of Thomson's was written four months later, just before he entered Peterhouse Cambridge as a freshman. It was entitled, "On the Uniform Motion of Heat in Homogeneous Solid Bodies, and its Connection With the Mathematical Theory of Electricity." He points out how the problem of the flow of heat in a conducting solid is exactly analogous to the problem of the electrostatic field in an insulating medium. The lines of flow in the heat problem are coincident with the lines of force in the corresponding electrostatic problem.

It readily follows from Thomson's Paper that the thermal conductance between two isothermal surfaces at temperatures θ_1 and θ_2, *i.e.*, $Q/(\theta_1-\theta_2)$ equals $(4\pi/\lambda)kC$, where C is the "capacity between the two surfaces" in the corresponding electrostatic problem. This is the "capacity" which electrical engineers use. Looked at from this point of view it will be seen that the conceptions of the "capacity" of a body and the "capacity between two bodies" are really the same. The capacity of a conductor is the capacity between its boundary, which is an equi-potential surface and the equi-potential surface of zero potential.

In this Paper Thomson gives a clear statement of Green's theorem, which he, like Gauss, Sturm and Chasles had independently discovered.

3. *Cambridge.*—In 1843, William Thomson rowed in the May races at Cambridge, first as No. 7 and then as bow, and was largely instrumental in preventing the Caius boat, which had a great reputation, from bumping Peterhouse. Six months later he won the Colquhoun sculls. In these days the racing boats had hole pins and were old-fashioned. Hence the experience he gained in the summer holidays boating on the Firth of Clyde stood him in good stead. It is related that at the end of the race for the silver sculs he was very exhausted, having done very little training for it.

In 1884 he was second wrangler and first Smith's prizeman. He therefore felt that he was free to devote himself whole-heartedly to investigating physical problems with the help of mathematics. He specially studied the problem of the distribution of electricity on two spherical conductors when near one another. Poisson, as early as 1812, had obtained the complete mathematical solution of this problem, but his solution was not adapted to numerical computation. Sir William Snow Harris, in a Paper published in the "Philosophical Transactions" for 1834, describes very careful experiments he had made to measure the attractions between spherical conductors. His results seemed to throw doubt on the accuracy of Coulomb's law. He found, for instance, that when two equal spherical conductors had unequal charges of the same sign, then if they were initially far apart they repelled one another, but if they were close together initially they attracted one another. When very close together a spark passed from one to the other and repulsion again ensued. At a certain distance apart they were in neutral equilibrium, provided that the charges were of the same sign and unequal in magnitude.

4. *Electric Images.*—Thomson, therefore, attacked the problem of calculating the mutual attractions and repulsions of the two electrified conductors, and obtained a complete solution from which numerical values could be found without very much difficulty. In obtaining this solution he used the method of "electric images," with which his name will always be associated. He shows that if we have two conducting spheres with given electric charges the field round the conductors can be exactly reproduced by an infinite series of point charges placed at certain definite points inside the two spheres and on the line joining their centres. This method is useful in the theories of heat, hydro-dynamics, sound, &c. and also in pure mathematics. Robert Murphy had previously suggested in his book on "Electricity," published in 1833, how an approximate solution could be obtained by a method which he called the "method of successive influences." Thomson refers to this method and shows that the effects of the successive induced charges can be produced by means of image charges.

Thomson proved that the behaviour of electrified conductors as described by Snow Harris was in exact accordance with theoretical deductions from Coulomb's law. He also criticised, mistakenly in the author's opinion, certain of Snow Harris's experimental results. Although Snow Harris was certain that his experimental results were accurate, he was most impressed by the ability of the young Scottish mathematician.

It was not, however, until 1853 that Thomson published the solution of the problem and gave a table and formulæ by means of which the attractions, capacities, and neutral distances of the two spheres can be easily and accurately found, provided that they are not too close together.

If the potentials of the two equal spheres are v and $-v$ respectively, and if F be the attraction between them, it can be proved by Coulomb's law that

$$F=\alpha(a/c)^2v^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where a is the radius of either sphere, c the distance between their centres and α a number that depends only on the value of a/c. Values of α are given in the "Journal," I.E.E., 1912, Vol. XLVIII., p. 265. In (1) F is in dynes, and v is measured in absolute electrostatic units.,

For instance, if c is 3 and a is 1, we have, on the assumption that the dielectric coefficient of air is unity,

$$F=0{\cdot}3178v^2 \text{ dyne nearly,}$$

where v is in electrostatic units. Assuming Maxwell's theory, and knowing that the velocity of light is 3×10^{10} cm. per second, we find that the unit of electrostatic pressure is 300 volts. Hence, if the potentials in volts of the two spheres be V and $-V$ respectively, we have

$$F=0{\cdot}000003531\ V^2 \text{ dyne.}$$

For example, if $V=15{,}000$ volts, we have

$$F=794{\cdot}5 \text{ dynes}=0{\cdot}8097 \text{ gramme weight.}$$

Conversely, by weighing the attraction F between the spheres, we can readily find the voltage $2V$ between them. This method can easily be applied to measure the voltage of high-pressure transformers. It is to be noticed that the voltage is completely determined when the dimensions of the spheres and the force of attraction between them are given. In standardising a voltmeter of this kind no electrical measurements are necessary. The spheres, however, must not be too near to one another, otherwise a spark will pass between them.

5. *Absolute Units.*—In the fourth Kelvin lecture, Dr. Glazebrook has given us the history of the absolute units, beginning with the appointment of the Electrical Standards Committee of the British Association in 1861. But 10 years before this Thomson had found that all the effects of electromagnetic and electro-dynamic induction could be explained by the principle of the Conservation of Energy—a principle first clearly enunciated by George Green. In the "Philosophical Magazine" for December, 1851, appeared Thomson's remarkable Paper on the "Applications of the Principle of Mechanical Effect to the Measurement of Electromotive Forces and of Galvanic Resistance in Absolute Units." Since the E.M.F. of the electrochemical action in a cell equals the dynamical equivalent of the whole chemical change effected by a current of unit strength in a second, the E.M.F. of a Daniell cell can be calculated (1) on the

assumption that the whole chemical action is electrically efficient, or (2) on the assumption that only the oxidation or deoxidation of the metals is electrically efficient.

In this Paper Thomson points out that if H be the heat developed [illegible] wire and J be Joules' equivalent we have $JH=EI$, and therefore, [illegible] Ohm's law, $JH=RI^2$. Hence since J and H are known and I can be measured at once, in absolute units (by a tangent galvanometer, for instance), R is found, and therefore also E. The values of the C.G.S. units of current, resistance and E.M.F. can thus be found.

Thomson defines the volume resistivity ρ and the mass resistivity ρ' of the copper forming a wire by the equations

$$R=\rho(l/A) \text{ and } R=\rho'(l^2/m),$$

Where R is the absolute resistance of the wire, l its length, and m its mass. He then compares the resistivity of the wires used by Jacobi, Kirchoff, Weber, and Joule, the values being given in foot-grain-second units. At this date it will be seen that Thomson had very clear views about electrical units.

6. *Electric Oscillations.*—In 1853 Thomson read an epoch-making Paper on the "Oscillatory Discharge of a Leyden Jar" to the Glasgow Philosophical Society. Six years previously Helmholtz had discussed a puzzling phenomenon he had noticed when a steel knitting needle was magnetised by the discharge current from a Leyden jar. In some cases the needle was left magnetised with the north pole at one end, and sometimes with the north pole at the other. If the discharge were oscillatory this would explain these results. Thomson proved mathematically that this was true in certain cases, and obtained a formula by means of which the rapidity of the oscillations can be computed. He suggested also that an experimental verification of this might be obtained by means of Wheatstone's revolving mirror. Feddersen did this in 1859. The invention of the oscillograph has enabled us to study these discharge currents in detail and prove that Thomson's theory is very approximately correct. The great practical importance of this Paper lies in the fact that it led many physicists to study the problems of oscillatory discharge most carefully, and wireless telegraphy was the direct although unexpected outcome of their labours. It has to be remembered, however, that Thomson's theory is not complete. Of the energy originally stored in the jar we know that some is radiated into space. In many cases this amount is negligibly small and Thomson's theory is directly applicable. But he did not show how the radiated energy could be taken into account or state the limitations of his formulæ.

7. *Peristaltic Induction.*—In the "Proceedings" of the Royal Society for May, 1856, Thomson published a Paper on the "Peristaltic Induction of Electric Currents." The phenomena observed when testing submarine cables proved to him that the capacity effects between a wire and the sheath, or between neighbouring wires, were most important. In this Paper he neglects the effect of electromagnetic induction, as this is permissible for slow signals. Thomson had very clear views about the electrostatic coefficients of neighbouring conductors. His work on the forces between electrified spheres proves this. He saw that when we have several wires in a cable and they have static charges the potentials of each wire can be found by means of these coefficients. This is still true when the charges are in motion. "They present a very perfect analogy with the mutual influences of a number of elastic tubes bound together laterally . . . and surrounded and filled by a liquid which is forced through one or more of them." Borrowing a medical term he called this "peristaltic induction." As the electricity was in motion it seemed to him illogical to talk about "electrostatic induction."

8. *Atlantic Cable.*—The first attempt to lay a cable across the Atlantic was made in 1857. It broke in 2,000 fathoms of water 330 miles west of Valentia. In 1858 it was decided that the U.S. frigate "Niagara" and H.M.S. "Agamemnon" should steam in opposite directions each with half the cable on board and splice it in mid-ocean. Prof. Thomson was engineer in charge of the electrical testing on board the "Agamemnon." After many mishaps the cable was safely laid on Aug. 6, 1858, and some messages were sent. On Sept. 6th of this year messages ceased to pass and Thomson and the other engineers were appointed to report on the cause of the breakdown. In experimenting with the cable from the Valentia end, Thomson found that it acted in the same way as if it were an insulated copper conductor 279 miles long with its end connected with a copper plate sunk at this distance in the Atlantic. He took the opportunity of investigating the earth currents in it. He proved that electromagnetic induction due to the diurnal variations of terrestrial magnetism was a prominent cause, but he failed to trace the other disturbing cause or causes. A day seldom passed without the direction of the earth current changing several times. So far as he was able to see, however, there was no connection between the times of reversal of current and the tidal hour.

In 1865 and 1866 Thomson acted as electrical engineer during the laying of the second and third Atlantic cables. He also acted as consulting engineer for various cable companies.

The troubles experienced with the 1858 cable led Thomson to invent the mirror galvanometer. The "ironclad" mirror galvanometer used with this cable is kept with other historical apparatus in the laboratory at Glasgow University. This was replaced by the spark recorder and finally by the siphon recorder. The arrangement of the suspended coil and magnets in this latter device is the same as in ordinary moving-coil galvanometers. Thomson was at this time a member of the firm of Thomson, Varley and Jenkin, consulting engineers, which is well remembered by our older readers.

9. *Sparking Distances.*—In 1860 Thomson read a Paper to the Royal Society on the "Measurement of the Electromotive Force required to Produce a Spark in Air Between Parallel Metal Plates at Different Distances." He used his absolute electrometer to measure the voltage, and was very surprised to find that the potential gradient required to break down a very thin stratum of air was greater than that required to break down a thicker stratum. He saw, however, that when the disruptive voltage exceeded several thousand volts the potential gradients at which the discharge occurred were practically constant.

It is interesting to remember that these experiments were carried out in the cellars and laboratories of the Old Glasgow College, practically next door to the workshop in which James Watt invented the condensing steam engine. Few appreciate the difficulties that had to be overcome in equipping a research laboratory in these early days. His assistants, also, were willing but untrained students. John Kerr, the great physicist, used often to tell how he did research work from 1846 to 1849 in the "coal hole" in which Thomson had set up the first physical laboratory in Great Britian. Kerr was then a divinity student. In later years he used sometimes to come to Thomson's senior class. In 1882 the author remembers Thomson gracefully introducing him to the rest of the class as one of his most distinguished old pupils.

Thomson's Paper on sparking distances was the first of the long series of Papers on this subject which have been published by physicists in almost every country. The electrodes generally employed are spherical. The results prove that the voltage at which the disruptive discharge occurs, or at which a corona first appears, depends on the maximum value of the potential gradient, provided that the electrodes are farther apart than about one-tenth of an inch.

10. *Vortices.*—The motion of a whirlpool or a whirlwind is an example of a simple vortical column with two ends. A smoke ring is an example of a circular vortex closed on itself. The analogy between the motion of vortex rings in a liquid or gas and the magnetic forces due to an electric current flowing in a ring or to the magnetic forces due to a small magnet was perceived by Thomson as early as 1850. But it was not until Helmholtz published in 1858 his classical Paper on the dynamical laws of vortex motion that Thomson fully appreciated this analogy.

The ultimate nature of matter was a problem which strongly attracted Thomson, and he made many speculations concerning it. In his class he taught the atomic theory of gases, but he regarded the infinitely rigid atom of Lucretius as a monstrous and totally untenable assumption. Stoke's theory explaining the phenomenon of spectrum analysis requires that the ultimate molecules which form a body must have one or more periods of vibration. To assume such a property in the Lucretian atom is to give it that very flexibility and elasticity which it is supposed to explain. Now vortices once started in a perfect fluid will exist for ever. They have perfectly definite periods of vibration, and their period is the same now as when they were created. May not the constitution of matter be explained by a vortex atom theory? One of his suggestions was that the sodium atom might consist of two vortex atoms looped together like links in a chain. Ultimately, however, the theory became so complex that he was reluctantly compelled to abandon it.

11. *The Diffusion of Heat.*—In the session 1881-82 Sir William Thomson lectured to his senior mathematical class on the theory of the conduction of heat. He discussed Fourier's theorem, the equations to the flow of heat, the method of images, the propagation of summer heat downwards into the earth, and the diffusion of heat. As there were many demands made on the professor's time at this period, one or two of the lectures he gave us were unfinished. In particular, the lecture on the "rate of diffusion" seems to have ended somewhat abruptly. This is developed at some length by the author.

12. *The Cooling Effect Produced by a Covering.*—In March, 1884, Thomson read a Paper to the Royal Society of Edinburgh, entitled "On the Efficiency of Clothing for Maintaining Temperature." Only the title was published, but a letter from J. T. Bottomley, printed in THE ELECTRICIAN for April 19, 1884, tells us the main

points of the Paper. Thomson showed that if a body be below a certain size the effect of clothing may be to cool it. In particular he stated that for a globular body if the radius be less than $2k/e$, where k is the conductivity of the covering medium and e the emissivity, the temperature will be diminished by increasing the thickness of the covering until it equals $2k/e$. It will then be increased for greater thicknesses of the covering. Thomson knew the experimental result. He also knew that Fourier's assumption that e is constant is not legitimate. He therefore doubtless intended to rewrite the Paper. A more accurate solution giving the same general result has been published by the author in the "Journal" I.E.E., 1911, Vol. XLVII., p. 744.

The corresponding problem for an insulated cylindrical wire placed in a cooling medium flowing transversely against it with velocity is of importance in power transmission. The author discusses this problem and shows that under certain conditions the covering of overhead transmission wires with a suitable material would not only prevent the losses due to the formation of a corona but would allow more power to be transmitted without overheating the wires.

13. *Age of the Earth and Sun.*—The age of the earth and the age of the sun were two problems to which Thomson devoted his best energies. It was undoubtedly a labour of love on his part. The "age of the earth problem" he had studied when a boy. He saw that the solutions given by Fourier would enable him to make an estimate provided that the average thermal diffusivity of the earth's crust were known. He and P. G. Tait carried out researches at Craigleith quarries near Edinburgh. From these data he made a rough estimate that it was about a hundred-million years since the surface of the earth was molten. The discovery, however, that a small mass of radium can emit spontaneously an enormous quantity of heat has made it probable that his conclusion will have to be modified. It is possible also that a more accurate knowledge of the value of the diffusivity of the materials forming the earth and especially of how the value of this diffusivity varies with the temperature, may appreciably alter the figure found by his method. The author remembers how in the session of 1881-82 Thomson discussed this point at length and quoted results obtained by several experimenters. The problem was also investigated from other points of view.

In his later years Kelvin was strongly attracted by the mystery of radium. Curie's astounding discovery that it emitted heat at the rate of about 90 calories per gramme per hour seemed to him explainable only on the theory that the energy of the radium was supplied by ethereal waves from outside. He gave as an illustration the case of a piece of cloth hermetically sealed in a glass vessel surrounded by water and exposed to the sun's rays. We know that the water will be perceptibly hotter when the cloth is black than when it is white. The energy travels into the black cloth by rays of sunlight and outwards through the same space by thermal conduction. The idea that the energy could arise by a change in the atom seemed to him incredible.

14. *High-frequency Resistance.*—In his presidential address to the Institution in 1889, Thomson explained the variation in the density of a high-frequency current in a cylindrical conductor over its cross-section. He supposed that the conductor was either at a great distance away from the conductor for the return current, or that it was the inner conductor of a concentric main. He points out that at very high frequencies the current is practically confined to the surface of the conductor. This result might have been deduced from Willoughby Smith's experiments on the screening effect of metals. He gives a formula for the effective resistance of the conductor and also a table calculated by Magnus Maclean of the numerical values of the functions in terms of which the solution is expressed.

15. *Electrical Engineer.*—About 1870, telegraphists discussed the desirability of founding a society of telegraph engineers, and many of them naturally desired to have Sir William Thomson as the first President. As a matter of fact the initiative seems to have been taken by Col. Sir Francis Bolton, General Webber, Sir William Siemens, and Col. Malcolm of Poltalloch. In 1872 Sir William Siemens was our first President, and it was not until 1874 that Sir William Thomson became President, Lord Lindsay, who was afterwards the Earl of Crawford and Balcarres, being one of the Vice-Presidents.

In 1877, when a juror at the Exhibition of Philadelphia, Thomson wrote a report on the exhibit of Gramme dynamos. He fully appreciated the enormous advance made by the abolition of permanent magnets. In 1878 he advocated the generation of electricity "in bulk." In 1879 he pointed out the suitability of the electric arc for street lighting and estimated its efficiency as 1·8 candles per watt. In 1881 he was most enthusiastic over the Faure accumulator, and his encouragement was a great help to the industry. This year he enunciated Thomson's law and pointed out the load at which the electrical efficiency of a shunt dynamo was a maximum. He also patented a special winding for a shunt dynamo. Ferranti independently invented an improvement of this design. They therefore entered into a working agreement, and this association was influential in turning Thomson's attention to several of the problems which were then occupying the minds of engineers. In 1889, when the Society of Telegraph Engineers and Electricians changed its title to the Institution of Electrical Engineers, Thomson was again President. He was our President for the third time in 1907, the year of his death.

The wonderful series of electric measuring instruments which Thomson invented will always bear witness to his genius, his energy and his inventive skill. Three of his ampere balances have been in use practically continuously at Faraday House for the last 27 years under ordinary commercial conditions. They are as accurate and useful now as when they were bought.

16. *Thomson as a Teacher.*—The author attended Sir William Thomson's Natural Philosophy class at Glasgow University in 1878-79 and his higher mathematical class during the sessions 1878-79 and 1881-82. In the Natural Philosophy class Thomson was a most inspiring teacher and showed many most interesting experiments. Those students, however, whose ambitions were limited to passing degree examinations got more help from Mr. Bottomley and Donald Macfarlane, his assistants.

In the higher mathematical class of 1878 Thomson started lecturing on simple cycloidal systems. As the new edition, Vol. I., part I, of Thomson and Tait's "Natural Philosophy" was then in the press, he was very busy correcting proof sheets and making additions. In fact, most of the paragraphs numbered 345^{1} to 345^{25} were given as part of the lectures. The author was sadly puzzled in trying to understand what a cycloidal system was. Thomson defined it as a system so constituted that the positional forces are proportional to displacements, the motional forces to velocities, and in which the kinetic energy is a quadratic function of the velocities with constant coefficients. Lagrange's equations of motion were then written down.

Although the author failed at the time to grasp the mathematical principles of the motions of gyrostats, yet he thoroughly enjoyed the lectures and seeing gyrostats swing so as to be "azimuthally stable, one inclinational mode unstable the other stable without rotation; with rotation two unstable, one stable." Prof. Andrew Gray, in the Sixth Kelvin lecture, showed some of these experiments. He also gave the theory in a form which can be readily grasped and gave several novel and valuable results.

Thomson was always so enthusiastic in these lectures, getting his class to work out mathematical theorems which some of them could do and giving them all kinds of interesting information. He told them, for instance, that once when showing a gyroscope to Helmholtz the wheel flew off and utterly demolished Helmholtz's new hat. He had, therefore, "to cage it in like a wild beast." It was necessary also to change its name, and so he called it a gyrostat. The author left his class in 1879 badly fitted to pass examinations and with very hazy notions about the theory of gyrostats, gimbals, azimuthal motions, and Lagrange's equations, but with the highest admiration in every way for Sir William Thomson and an appreciation of the pleasures of original research. In particular he admired Thomson's way of never passing over difficulties.

During the session 1881-82 Sir William Thomson lectured on the theory of heat and gave the Fourier mathematics. The author finds by looking back at his notes that he quite understood all that was given. Thomson was very busy at this time with all manner of electrical experiments but he did not refer to them in this class.

In solving problems the mathematical processes Thomson used nearly always had a physical significance. He solved problems in one branch of physics by methods suggested by other branches. For instance, he found the electric attractions of spheres by the optical method of images and obtained the solutions for the propagation of signals in a submarine cable by analogy with the problem of the diffusion of heat along a bar. He also solved many magnetic problems by analogy with the corresponding hydrodynamical problems. Much of his success was due to his ability to grasp quickly the analogy between problems in various branches of physics.

With pure mathematics he had little sympathy. He regarded it merely as a tool. He could not understand how to the pure mathematician the work of the physicist sometimes appears trivial. From the mathematical point of view the really important matter is to obtain the solution. The mathematician is little interested if a physicist at a later date applies his solution to explain some physical phenomenon. To Thomson this attitude of mind seemed a symptom of mental disease.

The address, besides dealing with many of the points mathematically, is followed by eight appendices, partly mathematical and partly historical.

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LINKING-UP THE ENGINEERING SOCIETIES.

From time to time individual members of our technical societies return from a visit to New York and tell us what a sensible course has been followed by the engineering societies of that city in combining to have a single house for their activities. The scheme was brought to fruition some few years ago, and there was only one society which refused to play a part therein, namely, the American Society of Civil Engineers. This Society has now decided that more is to be gained than lost in a scheme of this kind, and has made terms with the United Engineering Society whereby the building is to be increased in height by three stories to provide the necessary accommodation.

At present feverish haste is being displayed in the United States in securing "preparedness," and we do not doubt that when the war comes to an end the United States will be one of our most serious competitors, and will have the great advantage of enormous wealth accumulated during the war. In other words, the suffering of others will have placed them in a unique position to compete with those who have suffered and who have therefore been weakened for the commercial struggle which is to come. We do not doubt that the co-operation of the engineering societies and the closer contact which will necessarily follow their being in a single building will materially aid in this competition.

In Great Britain our characteristic individuality leads to separate societies in separate buildings and ideals to which we cling somewhat tenaciously. There are no doubt difficulties in suggesting any scheme which will be taken up by our main societies, the chief difficulty being that our older societies have obtained a certain position and a certain wealth owing to many years of existence, and they do not see why other younger societies should participate in these advantages. Nevertheless, a co-operative scheme is worthy of careful consideration if it can be shown that the advantages obtained will materially increase the efficiency. The war has done much to alter our ideas, and it may, perhaps, be said that nothing short of a European war would root out some of the ideas, of doubtful value, with which we are imbued.

A single building has obvious advantages of a physical kind to which we need scarcely allude, but what appears to us far more important are the immense advantages of a co-operative library. The library of the United Engineering Society in New York gives a foretaste of what is possible. It consists of 60,000 volumes on engineering, and receives over 1,000 engineering periodicals and publications of societies. It is not merely a library into which one enters and wastes time in searching for information by the usual process of trial and error. The library is there for real work and it is prepared to do it. Thus, for certain fees, the following services are rendered : The member can be kept posted on the current literature on any engineering subject, reference slips with full citations being sent every two weeks. Translations can be made, there being a corps of efficient translators and abstractors. Photographic copies can be made from any book or periodical. Reference lists on engineering subjects can be obtained, there being over 1,000 lists of this kind on file. Searches showing the "state of the art" are undertaken for patent cases. And, lastly, statistical data are compiled on engineering subjects. Further, we understand that the library is open to the public.

To be able to obtain information in this easy fashion (not merely within the building, but in any part of the United States) is a most valuable feature of such a scheme. Moreover, the importance of a really comprehensive up-to-date library cannot be over-estimated. This is becoming increasingly the case owing to the interlinking of the various sciences. At the present day in London, if one desires to look up a subject on the border line between two or more branches of science one may well go to the library of the Institution of Electrical Engineers and pick up certain information, and then pass on to the Institution of Civil Engineers and obtain something more. The process may be continued, perhaps to the Institution of Mechanical Engineers, and finally to some one of the societies dealing with chemical technology. But such a process is most inefficient and is necessarily unsatisfactory. If these libraries could be combined under one roof, brought thoroughly up-to-date, and put into such a form as to give really useful commercial service, a valuable asset would be obtained for the industries of this country, and even for the Empire.

We notice that Sir Robert Hadfield, F.R.S., is at present advocating combined action on the part of the Iron and Steel Institute, the Institute of Mining and Metallurgy, the Institute of Metals and the Institution of Mining Engineers, none of which have sufficient accommodation. If there is some move towards co-operation it would seem a pity not to extend it so as to be thoroughly comprehensive. The only difficulty is to suggest a course of a practical kind. It occurs to us that the least disturbance of the existing institutions would result if the Government would give facilities and funds for obtaining a large proportion of the land adjoining the Institution of Civil Engineers. On this ground each of the older institutions might very well have a building of its own. For example, that of the Institution of Civil Engineers would remain as it is. Equally the Institution of Mechanical Engineers might possibly remain, a subway being provided for communication between the existing building and the newer buildings. In the case of the Institution of Electrical Engineers a new building would be necessary, and we suggest that this would be worth it. A fourth building might be erected which would house the smaller societies, and a fifth would be used simply for housing the combined libraries, which would be suitably divided into sections, brought up to date, and run as a single unit. We would prefer not to stop short of the engineering societies or of those dealing with iron and steel and mining, but we would, if possible, bring in also the Chemical Society and the Society of Chemical Industry. But such a scheme involves expenditure. In the United States the difficulty of finance was surmounted through the munificence of Mr. A. Carnegie who gave a sum of $1,560,000 towards the building and advanced a further sum of $540,000 at 4 per cent. interest for purchasing the site. Would not Mr. Carnegie help this object in London as he did in New York? The scheme is surely worthy of his consideration, for by this means a federation of societies worthy of the country would be obtained, without loss of individuality, and we venture to suggest that the gain to the industries concerned would be almost inestimable.

EFFECT OF DAYLIGHT SAVING.

When the Summer Time Act was passed at the beginning of the present summer there was some speculation as to its effect on the output of electricity stations. Some people held the opinion that the loss to electricity undertakings would be serious, and others that there would be no saving in daylight showing contradictory points of view. Now that the normal time has been resumed it is worth while to inquire what has been the effect.

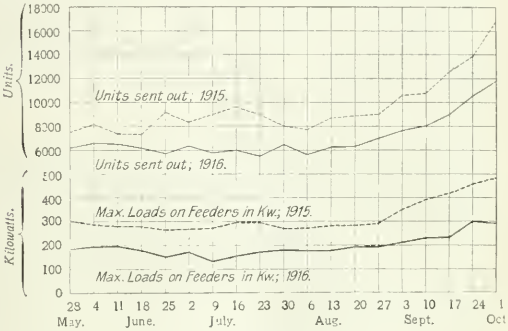

Fig. 1.—Curves showing Effect of the Summer Time Act at Winchester.

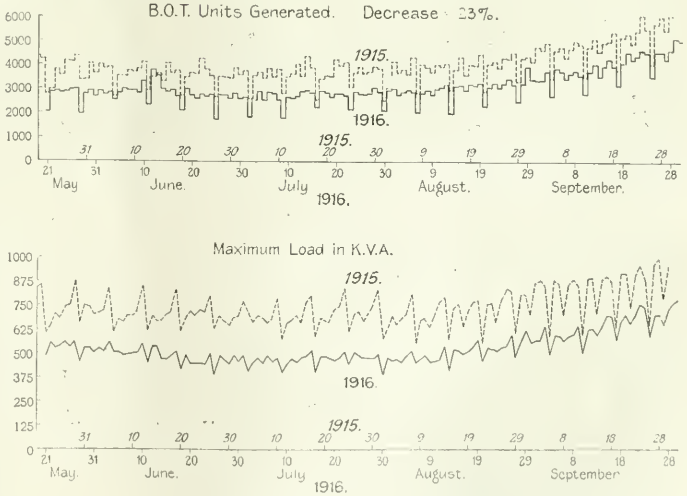

Fig. 2.—Diagrams showing Effect of the Summer Time Act at Ealing.

In the case of large stations, having a heavy power load, the loss, as would be expected, has been negligible as a percentage of the whole, or it has been masked by the general progress that has taken place. Thus, at Birmingham, Mr. R. A. Chattock informs us that accounts of consumers in residential areas show a reduction of a little over 16 per cent. compared with the corresponding period last year. But this part of the output is only a small part of the whole, probably less than 10 per cent.

On the other hand, where an undertaking is largely dependent on the lighting load, the result of the Summer Time Act has been marked. This is illustrated in Figs. 1 and 2. The first diagram, which is published through the courtesy of the city electrical engineer, Mr. R. Ayton, shows the loss at Winchester. This seems to be about 25 per cent.

Fig. 2, for which we are indebted to Mr. J. Douglas Knight, the borough electrical engineer, shows that the loss at Ealing is about 23 per cent.

PHYSICAL SOCIETY.

At a meeting held on the 27th ult. at the Imperial College of Science, Mr. F. E. SMITH, A.R.C.Sc., Vice-President, in the Chair, a Paper, entitled

"The Application of the Kerr Effect to the Determination of the Saturation Values for Magnetism of Ferro-Magnetic Metals, Compounds and Alloys,"

by S. G. BARKER, D.I.C., Ph.D., was read, in the absence of the author, by Dr. S. W. J. SMITH, F.R.S.

The Paper describes work carried out in the laboratory of Prof. Du Bois on the relation between the intensity of magnetisation of various ferro-magnetic materials and the rotation of the plane of polarisation of plane polarised light reflected from a polished surface of the material. The specimens, in the form of circular discs 5 mm. in diameter and 0.5 mm. thick, were soldered to one of the pole pieces of a large electromagnet. Through an aperture in the other pole, monochromatic light, polarised in two nearly coincident planes by means of a Lippich polariser, was incident almost normally on the polished surface of the specimen. The reflected beam passed through an analyser, the rotation of which could be measured, by means of an auxiliary optical system, to a high degree of accuracy. In the first part of the Paper results are given for a number of materials of known magnetic properties in order to establish the validity of the method, due to Du Bois, of obtaining the value of the saturation intensity from the curve connecting field strength with rotation. The method is then applied to materials of unknown properties. The variation of the Kerr constant with the wave-length of the light was also determined for a number of substances.

Mr. D. OWEN asked if the Paper, in addition to establishing the view that the rotation was proportional to the intensity of magnetisation, brought forward any new results that were useful to theory. For instance, he recollected a Paper by B. Hopkinson, in which it was found possible to obtain an intensity of magnetisation greater than that obtainable with pure iron, and he noticed that in the present Paper there was an alloy of iron and cobalt which exceeded pure iron in saturation intensity. Was it now taken for granted that it was possible in an alloy to obtain magnetisation greater than that of either component, or were the results in the Paper somewhat novel in this respect?

Dr. SMITH said that saturation intensities of magnetisation were of importance for various reasons. For instance, as Weiss had shown, it was of theoretical interest to know their temperature variations. Again, in the case of a "mechanical" mixture of two substances, the saturation intensity would be related in a simple manner to those of the constituents. There was much evidence that annealed steels are mixtures of iron and iron carbide. Hadfield and Hopkinson, in the Paper which had been referred to, had shown that the saturation intensities of magnetisation of [illegible] were compatible with this view, and had deduced a value for the saturation intensity of the carbide. It would have been of interest if Dr. Barker had determined the latter directly, as had been his [illegible] when his work was interrupted. Alloys were not, however, [illegible]. The steels examined by Hopkinson and Hadfield to which Mr. Owen had referred, was a nickel steel, and its total magnetisation was [illegible] than the sum of those which its constituents would [illegible], although it was not as great as that of pure iron. [illegible] was that nickel iron alloys form solid solutions [illegible] instead of mechanical mixtures. The same is probably true of [illegible] alloys, although in this case a material can [illegible] (namely a compound) whose saturation magnetisation is [illegible] greater than that of pure iron. It had been proposed to use this alloy [illegible]. Other solid solutions were known in some of which [illegible] and in others less, than that which [illegible] would have exhibited.

A Paper entitled

"The Influence of the Time Element on the Resistance of a Solid Rectifying Contact,"

was read by Mr. D. OWEN, B.A., B[illegible]

The resistance of a solid rectifying contact, and consequently the exact shape of the resistance characteristic, depends upon the time for which the testing current is allowed to flow. A series of characteristics are given corresponding to durations of contact extending over the range one forty-thousandth of a second to 30 seconds. The following conclusions are drawn :—

1. That the variation of resistance with voltage may be attributed entirely to thermal effects.

2. That the characteristic obtained by applying the testing voltage for one hundredth of a second is, at moderate voltages, materially the same as that which would be found at the expiry of a period of the order of a millionth of a second.

3. That the sensibility of a wireless receiving circuit (in which the rectifying contact is used) does not differ very appreciably from that deduced from a slow period characteristic.

4. That an important fraction of the contact-resistance resides in a stratum of molecular thickness at the interface of the two elements of the contact; and that it is in this region alone that rectifying action at very high frequencies is effected.

Prof. G. W. O. HOWE thought the experimental method of Mr. Owen was the correct way to tackle the problem of high-frequency phenomena, and was preferable to taking oscillograph records at low commercial frequencies and attempting to deduce from them what will happen at very much higher frequencies. What is the limit to the number of times per second that the ball may be struck for the results still to apply to one impact only? From one point of view the results were disappointing, inasmuch as it had been necessary to introduce a mysterious stratum of molecular thickness, and the problem arises as to what these layers consist of; what are their properties, and why is the thermal effect largely confined to them?

Dr. H. S. ALLEN asked if any attempt had been made to remove surface films from the contacts. Prof. Millikan had recently obtained very simple results in photo-electricity by working in a high vacuum so as to remove all films of moisture. Could this not be done in Mr. Owen's experiments?

Dr. ECCLES said that the subject of contact resistance was of wide importance, apart from its application to electric wave detectors. It had been investigated by Wheatstone and Heaviside in other connections—microphones, for example. It was important also in connection with the contacts at dynamo brushes. There had always been a desire in wireless telegraphy circles for high-frequency characteristic curves. Doubtless, if oscillograph records could be obtained for frequencies of 10^{-} second, they would be very like what Mr. Owen gets by his point to point method. He would have been glad if the author had tried similar contacts—*e.g.*, two carbons, two galenas, or even two metals. In these cases there would be no thermo-electric phenomena to confuse the issue. He was not convinced on the question of the molecular layer. The author states that "in actual practice the mean diameter of the area of a good rectifying contact is, as a rule, far greater than 10^{-4} cm." Now, if one pictures a piece of metal resting on the zigzag surface of a crystal, it is obvious that actual contact will only occur at points and ridges, and it is surely impossible for anyone to assert what the order of the area of contact is. He preferred to think that the effects were due to the heating of the surface layers of the stuff, due to concentration of the current flow into the narrow regions where actual contact exists. Usually, the harder the crystal the better the rectification obtained, due possibly to the greater concentration of current in the smaller and sharper contact points. He thought perhaps too much stress was laid on the high frequency characteristic. When an oscillation passes through the contact of a crystal touching a metal plate, it is the after-effects of the heat developed which produce the thermo-electric currents that affect the telephone. Therefore, while of scientific interest, the high-frequency characteristics are not very essential from the point of view of wireless telegraphy.

Mr. F. E. SMITH thought Dr. Allen's suggestion a valuable one. About 14 years ago a Paper was read to the Society showing that films of liquid remained attached to solids even up to temperatures of 300° C.

Mr. OWEN, in reply to Prof. Howe, thought there was no mystery connected with the contact layer. We cannot assume complete continuity of material at a contact, as in a weld, since there is never any difficulty in pulling the elements apart. With respect to the repeated impacts, the time between the impacts was never less than about 8,000 times the duration of contact. The point raised by Dr. Allen required investigation. It was scarcely necessary for him to reply to most of Dr. Eccles' remarks, as they really constituted an independent contribution to the subject.

On account of the lateness of the hour, Mr. B. W. Clack's Paper "On Diffusion in Liquids" was postponed until the next meeting.

WEST OF SCOTLAND LINKING-UP.

A meeting took place at 3 p.m. at the Technical College, Glasgow, on Friday, the 3rd inst., when the chair was taken by the Convener, Mr. J. K. Stothert, Mr. F. H. Whysall being acting Secretary.

The following is a list of names of engineers and representatives to whom circulars were sent, and those marked * were present :—

*R. Allan Brown .. Falkirk Corporation Electricity Department.
*G. F. Moller ... Lanarkshire Tramways.
*Glynn Salter .. Hamilton.
*Archd. Page .. Glasgow Corporation Electricity Department.
*W. W. Lackie .. Glasgow Corporation Electricity Department.

*James Wishart ...	Motherwell Corporation Electricity Department.
*H. E. Ferguson ...	Clyde Valley Electric Power Company.
*C. F. Parkinson ...	Paisley Corporation Electricity Department.
*Fred Coutts ...	Paisley Tramways.
*W. C. Bexon ...	Kilmarnock Corporation Electricity Department.
*Ian C. A. Murray ...	Balfour, Beatty & Co., Edinburgh.
*H. Dixon	Dumbarton Electricity Works.
*E. C. Churchward ...	Scottish Central Electric Power Co.
*Roland Marshall ...	Corporation of Ayr Electricity Department.
*F. H. Whysall ...	Corporation of Greenock Electricity Department.
*J. K. Stothert ...	Glasgow.
Resident Engineer	Cambuslang Electricity Works.
S. Williams ...	Wishaw Electricity Department.
James Dalrymple ...	Glasgow Tramways.
J. White	Kilmacolm Electricity Department.
D. A. Starr	Clyde Valley Electric Power Co.
A Scott Moncrieff ...	Dumbarton Electricity Department.
C. P. Sparks ...	Airdrie & Coatbridge.

Letters of apology were read from: Messrs. D. A. Starr, A. Scott Moncrieff, Geo. Balfour, and C. P. Sparks.

The Convener called upon the acting Secretary to read a letter from Mr. Chamen, Chairman of the National Electric Power Supply Joint Committee, and the letter convening the meeting. Mr. Stothert then explained to the meeting his position in the matter, after which he called on the Acting Secretary to read the Board of Trade circular R.C. 1334, dated May 25, 1916, on Inter-Connection of Electric Supply Undertakings.

Mr. Lackie as a member of the National Electric Power Supply Joint Committee explained their attitude and the objects of the movement. He called attention to an ordnance map (1 in. to the mile) which had been prepared by Mr. Whysall, and on which the Glasgow, Greenock and Clyde Valley Undertakings were already drawn in, for the inspection of those present.

After some discussion it was decided that all those present, or invited to the meeting, should constitute the Committee. Mr. Stothert then explained that he desired to retire from the business, and it would be necessary for the Committee to appoint a Chairman. Mr. Lackie proposed, and Mr. Moller seconded, that Mr. George Balfour of the Scottish Central Electric Power Co., and of Messrs. Balfour, Beatty & Co. (Ltd.), be appointed Chairman of the West of Scotland Linking-Up Committee. The proposal was unanimously adopted by the meeting. Mr. Stothert was asked to continue the occupancy of the Chair for that meeting.

Mr. Stothert proposed, and Mr. Ferguson seconded, that Mr. F. H. Whysall be appointed Vice-Chairman and hon. Secretary. This was unanimously adopted.

Mr. Page suggested that a Sub-Committee be appointed to start work and the following names were put forward and approved, as constituting the Sub-Committee: Messrs. Brown, Bexon, Churchward, Lackie, Parkinson, Starr and Wishart.

A vote of thanks to the Governors for the use of the room was proposed by Mr. Ferguson and seconded by Mr. Coutts.

Mr. Moller moved a vote of thanks to Mr. Stothert and the Secretary was instructed to confirm the business of the meeting in writing and to write to the various authorities in the area for particulars necessary for the consideration of the Sub-Committee and the drawing out of the necessary map showing the way in which the area is at present served, on the understanding that when this information is received, the Secretary will notify the Chairman with a view of convening a meeting of the Sub-Committee to consider what further steps shall be taken.

MINISTRY OF MUNITIONS OF WAR AND SUPPLIES OF MATERIALS.

The Ministry of Munitions announces that the arrangements that have been in force for controlling supplies of steel, tinplates, &c., are to be extended to other materials, and for the convenience of the public an explanation has been issued of their extended application.

To obtain, whether for home use or export, supplies of copper wire, cable containing copper, Bessemer and open-hearth steel, corrugated sheets, tin-plates, tinned sheets, terne-plates, black-plates and lead-coated sheets, it will be necessary either to quote a Government contract reference and number, if the materials are required to execute a Government contract, or to procure a permit reference number and priority classification from the Ministry of Munitions, Priority Branch, 28, Northumberland-avenue, W.C. In applying for such a permit, full particulars of the requirements and purpose should be given. This Government contract reference and number or permit reference and number and priority classification must be quoted to the suppliers, who are forbidden to deliver any of the aforesaid materials without being furnished with a Government contract number or reference number and priority classification covering the material ordered.

Where one of the following can be quoted to the suppliers no permit reference number and priority classification from the Ministry of Munitions are needed :—

1. Admiralty contract reference and number, or Admiralty priority section permit reference and number;
2. War Office contract reference and number;
3. Ministry of Munitions contract reference and number.
4. Commission Internationale de Ravitaillement or Commission Française sanction reference and number with Ministry of Munitions priority classification;
5. Board of Trade (Marine Department) (in case of mild steel only) permit reference and number declaring merchant shipping to be munition work;
6. Post Office contract reference and number (in the case of copper or copper alloys only).

In the above cases (1–6), suppliers, on receipt of the contract or permit reference number and a declaration by the customer that the materials ordered are required solely to fulfil the orders covered by the reference number quoted, are entitled to deliver on the basis of priority classification A 4 (war work). If a higher grade of priority is required, application must be made to the Priority Branch of the Ministry of Munitions, stating the ground of special urgency. The reference, date and grade of contract permit or priority classification should be passed on to sub-contractors (if any), so that they, like the main contractor, can quote the necessary particulars referred to above, on any orders that may be placed with the merchant, stockholder or the manufacturer of the materials. This means that once a permit has been granted for a certain plant such permit covers all parts and materials necessary for completing the plant unless instructions to the contrary are entered on the original permit. As a general rule, the customer should make the application for permit and priority classification, and not the stockholder or manufacturer of the materials. References need not be insisted upon in the case of urgent Admiralty telegraphic instructions for immediate repairs to ships.

In cases of machine-tool firms and electrical firms the order can be covered by quotation of the reference and date of permit accorded by the machine tool department or electrical branch of the Ministry of Munitions respectively for the machinery or parts for which the material is ordered. None of the aforesaid materials can be supplied except for orders or contracts coming within Class "A" or Class "B"; only shell discard quality steel and iron are allowed to be supplied in Class "C" or Class "C" priority instruction 6. If required for use within the United Kingdom, shell discard quality steel can be obtained without any permit. If for export, shell discard quality steel can be obtained only where the orders have been classified by the Priority Branch, and the reference number of the classification certificate and specific particulars of destination must be quoted to suppliers and the War Trade Department.

In all applications full particulars should be given under the following headings :—

1. A precise description of the articles or materials required.
2. The exact quantities thereof. If required for different orders or purposes, the quantities required for each order or purpose respectively. If required for stock or "running account," the minimum quantities needed for a period of three months and the respective quantities in hand at present.
3. The name of the firm or firms with whom the order or orders are or are to be placed respectively.
4. The respective war, national or other object to be served, and proof of urgency and importance.

A priority certificate is required even though the goods are merely to be transferred from one branch of a firm in the United Kingdom to another branch of the same firm in a foreign country or British possession. Merchants, manufacturers and the general public are earnestly requested to assist the Ministry of Munitions in particular and the nation in general by refraining from applying for permission to obtain the materials mentioned herein unless the same are required for war or other urgent national objects. It is essential that supplies should be conserved for direct war work and work of urgent national importance.

EXPORT OF COPPER WIRE, CABLE, &C.

The Ministry of Munitions has issued also the following notice in regard to the export of copper wire and cable containing copper, Bessemer and open hearth steel or corrugated sheets, tin-plates, terne-plates, black-plates, tinned sheets and lead-coated sheets :—

1. With a view to conserving supplies of copper wire or cable, Bessemer and open-hearth steel, corrugated sheets, tin-plates, terne-plates, blackplates, tinned sheets and lead-coated sheets, the Director of the War Trade Department announces that it has been arranged with the Ministry of Munitions that export licences will not be granted unless a Ministry of Munitions priority certificate (Class "A" or Class "B") permitting manufacture or sale from stock has been obtained, or unless the reference and number of an Admiralty contract or permit or War Office contract for the completion of which the copper wire or cable, steel, tin-plates, &c., are required can be quoted. Export licences will not, as a general rule, be issued in respect of copper wire or cable, steel, tin plates, &c., for which a Class "C" certificate is quoted.

2. In the case of allied countries (France, Russia, Italy, Serbia, Portugal, Roumania, Belgium, Japan), priority certificates are only given in very exceptional cases by the Ministry of Munitions unless the application is supported by the Commission Internationale de Ravitaillement, whether the consignment is intended for a Government contract or not. Applications should, therefore, be made direct to the Commission Internationale de Ravitaillement, India House, Kingsway, London, W.C., which, if prepared to support the case, will communicate with the Ministry of Munitions, and arrange for the issue of a priority certificate. If the copper wire or cable, steel, tin-plates, &c., are for Government work and export is allowed, the permits for export will be issued by the Commission Internationale de Ravitaillement. If the goods are not for Government work, and the applicant is in a position to quote a priority

certificate ("A" or "B"), or contract reference and number, he should make an application to the War Trade Department for the grant of an export licence, and if the export is allowed a licence will be granted by that department.

3. In the case of Sweden, Norway, Denmark, Holland and Switzerland, application should be made in the first instance to the War Trade Department, which, if there is no immediate reason for refusal, will arrange direct with the Ministry of Munitions for the issue of a priority certificate. The applicant should not communicate direct with the Ministry of Munitions, and the priority certificate will be forwarded to the applicant by the War Trade Department with the export licence. This exception does not apply to Bessemer and open-hearth steel nor to corrugated sheets.

4. In the case of all other destinations, including British possessions, application for a priority certificate should be made direct to the Ministry of Munitions, Priority Branch, 28, Northumberland-avenue, S.W. No application for an export licence can be considered by the War Trade Department unless the number of a Ministry of Munitions priority certificate under Class "A" or "B" (or, alternatively, an Admiralty or War Office contract number) is quoted.

5. A priority certificate is required even though the goods are already manufactured, and even though the goods are merely to be transferred from one branch of a firm in the United Kingdom to another branch of the same firm in a foreign country or British possession.

6. Applicants are warned that the issue of a priority certificate by the Ministry of Munitions is not a guarantee that an export licence will be issued by the War Trade Department.

7. If exporters have any doubt as to the reliability of the proposed consignee, they are recommended before proceeding to manufacture to consult the War Trade Intelligence Department, Broadway House, Tothill-street, S.W. (as regards foreign countries in Europe), and the Foreign Trade Department, Lancaster House, The Mall, S.W. (as regards foreign countries outside Europe.

CORRESPONDENCE.

SHOULD REVIEWS OF BOOKS BE SIGNED?

TO THE EDITORS OF THE ELECTRICIAN.

This letter is a plea for the signed review. Many years ago, when quite a young man, I received a book from one of your predecessors with the request to review it. I was much oppressed by the responsibility such a task involved, and applied for guidance to a friend, a man of the world with much literary experience. He assured me that there was no difficulty in reviewing; anyone could do it. "You glance through the preface, read a few pages here and there, then write something about the contents in general terms and finish up with some complimentary remarks about the author and the publisher. It does not much matter what you write as long as it is favourable, because very few people beside the authors read reviews." My friend was, of course, wrong; it matters a good deal what is said in a review, not only to author and publisher, but more so to the potential reader, who may be caused to waste his money and space on the book shelves as a consequence of a laudatory review.

Most reviewers are benevolent, but there are also those of the other sort. The term benevolent does not mean abstaining from adverse criticism. It only means just criticism. Let me illustrate by an example the unsigned review of my book, which appeared in your last issue. There is a misprint, a sine having been put where a cosine ought to stand. The benevolent reviewer would have drawn attention to the misprint, and if he had called it a result of gross carelessness on the part of the author he would have been quite right. Your critic did [illegible]. He spoke of muddled mathematics and liberties taken with [illegible]. I use certain symbols which are simpler than those generally (though not exclusively) used by English writers. These symbols are used by Continental scientists. The benevolent reviewer would have thought it worth while to allude to [illegible] would have discussed the question whether [illegible] preferable to the English symbols or the reverse. Your reviewer simply alludes to their German origin. These are trifling matters, not helpful to the reader or fair to the author, but I doubt whether such things would appear or be treated in the same spirit in a signed review.

If your readers will carefully read the unsigned reviews appearing in the technical press they will find that a good many have been written on the lines recommended by the cynical man of the world whom I have quoted above. They are simply literary hack work. How can it be otherwise unless the reviewer is forced to put his name to what he writes? Reviewing is one of the most difficult and laborious parts of literary work. To write a fair review the writer must not only be intimately conversant with the subject, but he must have the patience to read the whole book carefully. Under present practice the reviewer gets along with the book a printed slip, in which the editor states that a review of so many words is desired. The exact number, 250, 500 or, perhaps, 1,000, is determined by the editor on some basis; possibly the size of the book, or its price, or the reputation of the author or the standing of the publisher. The correct basis for the length of the review should be none of these things, but merely the character of the contents. A small book may be full of original and good matter or of old matter treated in an original way, whilst a large and expensive book may be merely a rehash of old matter presented in the old manner, but with beautiful illustrations and in a handsome style. Which book should get the more exhaustive review? Of course, the former, and I have no doubt that editors generally try to determine the number of words allowed to the reviewer with reference to the intrinsic value and not the appearance of a book, but as the former can only be correctly judged after careful reading, the ultimate decision as to length of review should be left to the man who writes it.

The number of technical and scientific books is very large, and is still growing. Some guidance as to the exact character of every new publication is, therefore, essential, and honest, painstaking and exhaustive reviewing is imperatively needed. There should be an honourable understanding between editor and reviewer that the latter will read every line of the book on which he is going to give his verdict, and to make quite sure that the verdict shall be not only just to the author, but also helpful to the potential buyer, the present system under which a reviewer may damn or praise a book behind the veil of anonymity should be dropped, and every man should put his name to what he writes.

Birmingham, Nov. 11. GISBERT KAPP.

[This is an old subject to which we have given a good deal of thought. In practice the signing of reviews is not such a simple matter as it appears to Prof. Kapp. It often happens that a reviewer, though perfectly well qualified and perfectly honourable, is unwilling to sign a review. The reasons are not far to seek, and are not necessarily due to malevolence, as every author would have us believe. In fact, we feel that sufficient care is taken in selecting reviewers for THE ELECTRICIAN to put the idea of malevolence out of court. Nevertheless, it may well be that a reviewer would prefer to omit all criticism if the review were signed, possibly through being on friendly terms with the author, or being engaged in some particular branch, the association with which might be misinterpreted. Consequently, the signing of a review does not necessarily lead to the result desired by Prof. Kapp and equally by ourselves.

In regard to the review of Prof. Kapp's book, this is quite favourable, except in regard to minor matters. It seems to us that the only points which the reviewer might have expressed more tactfully are those in which he uses the words "muddled" and "liberties" in regard to some mathematical work.—EDS. *E.*]

THE MARCONI COMPANY AND GERMANY.

TO THE EDITORS OF THE ELECTRICIAN.

Having regard to the attempt which is being made in certain quarters to create uneasiness in the minds of the public in respect of the relationship which has existed between the Marconi Company and the German Telefunken Company, I think it in the national interest that I should make a plain statement of the facts.

The Belgian Company to which reference has been made, was formed in the year 1901, and secured from the Marconi Company the mercantile marine rights of certain countries in

Europe, including those of Germany and Austria. The company was purely Belgian and the shares were held in Belgium and England. The Belgian Company proceeded to install and operate apparatus on all the principal ships of the mercantile marines of Germany and Austria.

In the year 1910 the German Government made it known that they would no longer sanction the installation or operation of any wireless system on board any German ships other than the German system, under German control. In these circumstances the Belgian Company were threatened with a considerable loss from the apparatus it would be obliged to remove from the German ships, and also with the loss of the whole of its German business. It, therefore, came to an agreement with the German Telefunken Company for the formation of a company in Germany, which should take over the business of the German mercantile marine.

The Belgian Company, together with the Marconi Company, retained a 45 per cent. interest in the German Company, the Germans holding 55 per cent. The Beglian Company and the Marconi Company appointed members to the board of the new German Company.

Subsequently, the Austrian Government, probably at the instigation of the German Government, took a similar action, and the Belgian Company thereupon agreed with the German Company that the Austrian ship stations should be transferred to the German Company, to which the Austrian Government did not object.

In return, however, it was agreed with the German Company that their sphere of action should be strictly limited to ships of Germany and Austria, and that all ships belonging to other nations which had been installed by them, should pass into the hands of the Belgian Company, and should in future be the business of the Belgian Company alone.

The Belgian Company was thereupon re-constructed, and the capital divided into thirds, the Belgians holding one-third, the Marconi Company one-third, and the Germans one-third.

At the outbreak of war there were two Germans in the employ of the Belgian Company. They were immediately dismissed. The business of the Belgian Company was promptly taken in hand by the English directors, Capt. H. Riall Sankey and myself, transferred to Marconi House, and has been under the complete control of the English directors ever since.

There has not been since the outbreak of war a single German operator employed on any ship of the Belgian Company in any part of the world.

With regard to Australia, owing to the Australian and New Zealand Governments having placed large contracts in the hands of the Germans for the construction of powerful coastal wireless stations, the Germans were in a position of considerable advantage. The Marconi Company commenced proceedings for infringements of patents against the German Company and the Australian Government. Subsequently a settlement was arrived at with the Germans under which it was agreed that an Australian Company should be formed which should purchase the interests both of the Marconi Company and the German Telefunken Company. This Company had a capital of £140,000 of which the Marconi Company held one-half, the Australians some £62,000, and the Germans about £8,000. Thus, a complete control of wireless in Australia passed into Australian and English hands.

With regard to other countries in respect of which agreement existed with the German Telefunken Company, this was limited to an understanding in so far as the United States was concerned to the two companies abstaining from hostile action towards each other until January 31, 1913.

With regard to other countries, the nature of the agreement was purely commercial, and was brought about as a result of the strength of the Marconi Company's patent position. It served to prevent the German Company ousting the Marconi Company from every country in the world by reason of its ruinous prices which the German Company were quoting at no matter what financial loss, no doubt with the German Government behind them, for the purpose of obtaining German wireless stations throughout the world. Under such conditions it was impossible for the Marconi Company to compete. It is only in consequence of this agreement that British wireless stations now preponderate throughout the world.

I would point out that whilst it is true that the Marconi Company were interested in the German Company and had directors on the German Company's board, the English Marconi Company has never had any German director upon its board, nor have the German Company at any time held any interest in the English Company.

In view of the services rendered and being rendered by the Marconi Company to the country, I would submit that it is in the public interest that this statement should be given the fullest possible publicity in order that the wicked attempt which is being made to create a false alarm should be immediately frustrated. I would appreciate, therefore, the insertion of this letter in your valuable columns.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.),
Nov. 11. GODFREY C. ISAACS, Managing Director.

DUPLEXING THE SQUIER SYSTEM OF TELEGRAPHY.

TO THE EDITORS OF THE ELECTRICIAN.

In common, I imagine, with most of your telegraph readers, I have read with much interest the article "Duplexing the Squier system of Telegraphy," by Louis Cohen.

I was, however, rather surprised to see that the two methods explained were described as being new. The use in a terminal circuit of a closed loop possessing L and C, and made resonant to a frequency which it is desired to exclude from that circuit, is certainly not new. It was invented by John Stone Stone, and for precisely the same object to which it is now applied by Mr. Cohen, namely, to prevent outgoing and incoming alternating currents of frequencies n_1 and n_2 wasting their energies in each other's terminal circuits on a duplex alternating-current line.

Stone's methods of alternating-current telegraphy are set out in his U.S.A. patents 717,467 and 717,517 and his Paper, "The Practical Aspects of the Propagation of High-frequency Electric Waves Along Wires" ("Journal" of the Franklin Institute, October, 1912). Stone conductively couples his transmitting and receiving circuits to the line, though he states that they may be inductively coupled. A glance at Fig. 3 of the Paper will leave no doubt as to the identity of Stone's invention with the arrangements shown by Dr. Cohen. With conductive coupling the intermediate circuit H of Fig. 1 in Dr. Cohen's article is not necessary.

In his previous article in your columns (THE ELECTRICIAN, October 20, 1916) Dr. Cohen appears to believe that British telegraph engineers are not aware of the conditions to be fulfilled with a receiving terminal load in order that there shall be no reflection. If he had been acquainted with the I.E.E. "Proceedings," the columns of THE ELECTRICIAN and the Post Office Engineers' "Journal" for the last few years he would have known that this belief has no foundation.

Technical Department, H. H. HARRISON.
Creed & Co., Nov. 11.

P.S.—Readers who are interested in A.C. telegraphy will find F. K. Vreeland's U.S. patent 1,171,811 and that of E. P. Batzel worth reading.

THE AIR-GAP FIELD OF THE POLYPHASE INDUCTION MOTOR.

TO THE EDITORS OF THE ELECTRICIAN.

With regard to the questions which Mr. Biedermann asks in your current issue, I would answer as follows :

1. *Form of Time—M.M.F. Wave.*—The assumption of sine waves of impressed E.M.F. and magnetising current leaves us with certain unbalanced E.M.F.s, the frequencies of which are multiples of the supply frequency ; their origin is explained in sections 26-28 of my recent Paper. We may regard these as E.M.F.s impressed on circuits comprising the motor windings and the supply network, which will produce harmonics in the magnetising current when the connections of the windings admit of them. The most favourable case for the observation of this effect is that of a delta-connected three-phase motor,

which I dealt with very fully in an article in THE ELECTRICIAN of December 11, 1914 (Vol. LXXIV., pp. 318-321). In most windings the M.M.F. due to the harmonic currents is distributed very unfavourably, and since it is modified by damping currents induced in the rotor circuits it has only a very small influence in removing the effects of saturation due to the fundamental current wave. There is a marked difference between the induction motor and the transformer in this respect. I do not think that harmonics in the wave of magnetising current will appreciably affect the flux distribution in ordinary cases.

2. I have not made any complete calculation on the magnitude of the mutual induction due to the multiple fields, but from rough estimates I consider it is probably much less than Mr. Biedermann's figures suggest. In any case I think we are agreed that it is negligible.

London, Nov. 11. F. T. CHAPMAN.

FINAL-GRADE CLASSES IN "ELECTRICAL INSTALLATION WORK."

TO THE EDITORS OF THE ELECTRICIAN.

Glancing through a reprint of Mr. A. P. Trotter's recent, Paper read before the Association of Supervising Electricians we read that "elementary and advanced evening classes for electrical wiremen are held at the Northampton Institute, Clerkenwell, and at the South Western Polytechnic, Chelsea."

This subject, formerly termed "electric wiremen's work," and now much more appropriately called "electrical installation work," is, of course, of fundamental importance, and is sought after by many other kinds of students besides wiremen.

While we know that grade I. classes are held at several different centres, it seems that we are to gather from Mr. Trotter's remarks that there are only two places in London where the final grade is dealt with.

If this be so, it is not too much to say that the authorities at other polytechnics and institutions appear to be rather neglecting an extremely necessary feature of their electrical side. Under its old name, the subject has been in the City Guilds' programme for the last 10 years.

"Electrical installation work" is going on in practice in every district in London, and advanced as well as elementary instruction in the subject should certainly be available at every polytechnic and technical institute. We are not thinking here of the junior evening technical classes held at various Council schools. In their case it is obviously only possible to give very elementary instruction.

We venture to disagree with a previous statement in Mr. Trotter's Paper: "The demand for trade classes in any special subject must precede the supply." As Mr. Trotter was addressing supervising electricians, we presume he was not thinking of "soap manufacture" or "leather tanning" or "cotton spinning," but of "electrical installation work." Now, why should this be looked upon as a special subject, when the work is going on all round us? Not one person in a hundred would trouble to ask for the establishment of a class that did not already exist at his nearest technical institute. One obvious reason is that the applicant would think to himself that by the time the class was established he would have learnt what he wanted some other way, or grown too old, or died. You might almost as well expect a person to ask someone else to open a shop because he wanted to buy something.

It surely stands to reason that classes in electrical installation work, in plumbers' work, in plasterers' work and in other work which is common in every community, should be conducted as a matter of course in every technical college in the country.

London, Nov. 10. A. P. LUNDBERG & SONS.

THE INSTITUTION BLACKBOARD.

TO THE EDITORS OF THE ELECTRICIAN.

May I call attention to the great inconvenience caused to those attending the reading of Papers at the Institution by the poor contrast between the colour of the "blackboard" and the chalk.

Before the recent improvement in the lighting of the lecture theatre we had to labour under the combined disadvantages of dark lights and a white blackboard. Now that the former trouble has been removed, perhaps it is not too much to expect that an endeavour will be made to rectify the latter.

It was impossible for anyone, except, perhaps, those in the first few rows, to read what was written by Dr. Russell in his Kelvin Lecture. I suggest that if the board must remain as it is, a remedy could be found in the use of charcoal in place of chalk as a writing material.

London, Nov. 10. R. D. GIFFORD.

"SUMMATION WATT" CAPACITY OF FIELD RHEOSTATS AND THE LIKE.

TO THE EDITORS OF THE ELECTRICIAN.

Referring to Dr. Garrard's letter of November 6th, unless such formulæ are based on a physical meaning (*i.e.*, on the area enclosed by a curve plotted between (rheostat current)^2 and rheostat ohms), it seems to me to be of little use advocating any formulæ for universal benefit, as the limitations of different designs vary very considerably. In other words, unless so based, a formula has no meaning except for comparison of an individual manufacturer's rheostats. On this theoretical "summation watt" basis their relative accuracy can be tried out by those of your readers interested, and without further discussion.

To obtain a very large "R" in an ordinary rheostat compared with field, or other external constant resistance, increasing the resistance beyond a certain point does not materially increase the actual "summation watt" capacity required.

The greater the resistance in a potentiometer the less the actual "summation watts" as the only variable (*i.e.*, constant watt loss) will be less.

Whether either of the above will in practice appreciably increase the size of rheostat (not the "summation watts") will depend entirely on the design and the particular case involved.

Nov. 13. L. BOOTHMAN.

PACIFIC CABLE BOARD.

The accounts for the year ended March 31, 1916, together with the report of the Board, have been issued.

The traffic receipts for the year were £310,028. 18s. 8d. (compared with £221,279. 11s. 8d. in 1914-15), and the total revenue was £310,516 (against £223,947. 17s. 1d.). The total expenditure was £ 05,896. 6s. 9d., and included head office expenses (£8,289. 19s. 3d.), cable stations (£101,597. 10s.), ship salaries and expenses (£19,605. 18s. 8d.), provident fund (£2,492. 18s. 10d.), and renewal account (£74,000), leaving £104,619. 13s. 3d. (against £76,686. 2s. 1d.) to meet interest and sinking fund (£77,544. 18s.) and interest and sinking fund on moneys provided for Sydney–Auckland and Doubtless Bay–Auckland cables (£9,150. 5s.). The net balance is £17,924. 10s. 3d., compared with a deficit of £7,915. 8s. 1d in 1914-15, and in accordance with the provisions of the Pacific Cable Act, 1901 (1 Edw. 7 c. 31, s. 4), this sum must be applied in reduction of the outstanding balance of the original advance of £2,000,000 for the capital of the Pacific cable. This is the first occasion since the Pacific cable was laid on which there has remained a surplus from revenue after the payment of the sinking fund annuities.

The net traffic receipts exceeded those of 1914-15 by £88,749. 7s., but in comparing the traffic receipts with those for the previous year it has to be borne in mind that the abnormal circumstances which have mainly contributed to the extraordinary increase of cable business were only experienced during seven months of the financial year 1914-15, and that during that period the Pacific cable was interrupted for two months in consequence of hostile action at Fanning Island. Special appropriations were made to the renewal account of £30,000 in respect of depreciation of securities and £14,000 as provision for payment for the new schooner for the Fanning Island service. After deduction of these special items, the expenditure shows an increase of £15 537. 0s. 9d. over that of the preceding year and £29,718. 6s. 9d. over the original estimate. This was due mainly to the following causes: (*a*) Increased establishment and heavy overtime charges to provide for the exceptional traffic; (*b*) the increased cost of material and transport, and the abnormal consumption of electrical and other stores; (*c*) the war allowance to the staff; and (*d*) the replacement of machinery, &c., destroyed at Fanning Island. The investments for account of the renewal fund were valued on March 31, 1916, at £229,756. The balance of cash at that date to the credit of this account was £11,704. 2s. 3d., which has since been invested. For the purpose of simplifying the accounts, the surplus cable remaining from the original Pacific cable contract which stood to the credit of the capital account was transferred in March, 1916, to the renewal account, and its value (£15,065) was transferred from the renewal to the capital account. All the spare cable in stock is now charged against the renewal account; its value at the close of the year was £66,267. 1s. 5d.

The section between Norfolk Island and Auckland was interrupted on Feb. 12 owing to a fault in the immediate vicinity of Norfolk Island. The "Iris" at that date was in the neighbourhood of Fiji, and was obliged to return to her depot at Auckland to coal before proceeding to undertake the repairs. She reached Norfolk Island on Feb. 19 and completed the repair in the early hours of the following morning. During the repair operations the Southport-Norfolk cable, which there runs very close to the Auckland cable, was accidentally hooked at a weak spot and damaged by the grapnel. This cable was repaired within a few hours. The repair work was carried out with commendable promptness and efficiency. The injury to the Auckland–Norfolk cable was caused by corrosion from marine growth and by rock chafe, and the weakness in the Southport-Norfolk cable was due to the same cause. Communication across the Pacific was not interrupted except for the few hours during which the Southport cable was out of commission. Traffic which normally circulates via Norfolk Island–Auckland was sent via Norfolk Island–Southport–Sydney. The other cables were maintained without interruption and in excellent condition. All the cables have been worked continuously at high pressure throughout the year, and the long sections have carried far more traffic than it was originally anticipated their capacity would permit. Under the present conditions they are occupied day and night during every day of the week. The cable between Sydney and Auckland, which was laid at the end of 1913 has proved of great value in assisting to handle so large a volume of business. The land line between Montreal and Bemfield, which the Board leases from the Canadian Pacific Railway Co., suffered few interruptions of more than minor importance during the year. During the five years which have elapsed since the Board took over the operation of the line between Montreal and Bemfield the service on this portion of their system has been increasingly satisfactory. The lease of the land line which expired in September, 1915, has been renewed for a further period of five years at an increased rental.

Since the close of the year the Board have established in Melbourne a public office for international business. The office is in direct connection with the Board's cable station at Sydney by a special wire allocated by the Commonwealth Government for the exclusive use of the Board. In July, 1915, the Commonwealth Government found themselves in a position to allot the necessary wire between Melbourne and the Australian terminus of the cable, and shortly afterwards they invited the Board to establish direct dealings with the public. A similar invitation was extended to the Eastern Extension Telegraph Co. The offer came at an unfavourable time for new departures owing to war conditions and heavy pressure on the staff; but in spite of the many difficulties the office was opened to the public on April 17, 1916, adequately and efficiently staffed. The Board are indebted to Mr. J. Milward, their manager in the Pacific, for the satisfactory manner in which the arrangements were carried out at a time when there were many other calls on his activity. The Melbourne establishment will involve an increase of approximately £6,000 in the Board's annual expenditure.

The Board's house property at the stations has been maintained in good repair. Owing to late delivery of machinery, and to transport difficulties, the reinstatement of cold storage and electric lighting plant at Fanning Island was much delayed. The installation of the new plant was carried out under the supervision of an expert refrigerator engineer sent to Fanning Island by the contractors. It was successfully completed at the end of July, 1916, and since then it has given satisfactory results. Boat communication with Fanning Island was provided during the year by the charter of the auxiliary schooner "Flaurence Ward" in May, 1915, and the steamer "Kestre" in September, 1915, and by calls by the "Iris" in October, 1915, and January, 1916. As there are still no prospects of obtaining by other means a satisfactory boat service with Fanning for the provisioning of the station and for the transport of staff, mails and material, the Board decided to replace the auxiliary schooner "Strathcona," and they have accordingly placed a contract in Sydney for the construction of another schooner. Under Capt. Holmes, the efficiency of the Board's repairing vessel and the discipline of the ship's company have been well maintained.

During the early part of 1916 the Right Hon. Sir Geo. H. Reid, P.C., G.C.M.G., retired from the office of High Commissioner for the Commonwealth of Australia, and thereupon, to the regret of his colleagues, ceased to be a member of the Board. Sir Geo. Reid had been associated with the Board since February, 1910. His place on the Board has been taken by the Right Hon. Andrew Fisher, P.C., who succeeded him as High Commissioner for the Commonwealth. The general health of the staff has continued satisfactory. The Board are glad again to express their high appreciation of the loyalty and zeal with which their staff have supported them and enabled an efficient service to be maintained by the Pacific cable during a year of abnormal conditions and strain. It is still necessary for the staff to work at high pressure and to undertake long hours of extra duty without opportunity of relaxation even on Sundays, or of obtaining furlough. There have been considerable additions to the staff during the year, owing partly to the opening of the new station at Melbourne and to the engagement of additional clerks at Sydney. Additions have also been made to the complement of telegraphists at other stations, but as there is great difficulty at present in obtaining the services of trained operators it has not been possible entirely to relieve the pressure on this grade. Mr. Wm. Bent, who had been a superintendent in the Board's service since January, 1902, retired in September, 1915, on grounds of health, anticipating by only three months the date when he would, under ordinary circumstances, have retired in accordance with the age limit fixed by the Board. The post of superintendent at Suva-Fiji, vacated owing to Mr. Bent's retirement, has been entrusted to Mr. J. E. Dicketts. The special allowance towards the increased cost of living due to war conditions, which was granted to the staff during the year 1915, is being continued during the current year on the same basis. Sixteen members of the head office staff are now serving with H.M. Forces. The Army Council have issued certificates for all the operators employed in the Dominions by the Board, stating that these officers are considered to be doing duty which is indispensable to their country, and that in present circumstances their return to this country for service in the Army is not desired by the Army Council.

During the year nearly eight and a quarter millions of paying words of international traffic were transmitted across the Pacific cable, or considerably more than double the volume handled during the last normal year—*i.e.*, 1913-14. In addition there was a considerable quantity of non-paying matter. This latter class of traffic now forms an appreciable proportion of the total matter passing along the cables. It consists of (*a*) free messages to, from and concerning wounded members of the field forces, including messages between banks transmitting remittances for wounded soldiers; (*b*) service messages dealing with administrative matters or making corrections to telegrams; (*c*) the unpaid matter which is supplementary to every paid message—*i.e.*, preambles, date and time, &c. In additional to the international traffic, the Board carried during the year nearly two million paying words between Australia and New Zealand and between Australasia and the Pacific Isles. While the deferred traffic transmitted during the year 1915-16 was more than double and the week-end traffic more than treble the volume handled during the previous year, the ordinary traffic showed a decrease of approximately 30 per cent. This is accounted for by the continued restrictions on the use of codes, many messages, which under ordinary circumstances would be sent at full rate in code, having been diverted to the cheaper plain language services. Included in the week-end telegram classification is the E.F.M. traffic ("Expeditionary Force Messages," or messages to and from soldiers, sailors and nurses at week-end rates, but subject to no minimum charge). The increasing number of Australasian soldiers in Europe has caused this traffic to grow to very considerable dimensions. On two occasions during the year under review the Atlantic cable companies were obliged, owing to interruptions on their system, temporarily to withdraw cheap public services. The first occasion was in November, 1915, when the week-end service was suspended for a week; and the second in January, 1916, when both the deferred and week-end services were withdrawn for several weeks. The cheap E.F.M. messages and the "free wounded soldier" messages were carried during all periods of suspension of other services. Owing mainly to the presence in Europe of large Australasian forces, the combined volume of public and E.F.M. week-end telegrams for Australasia reached such large proportions during July of this year that the carrying capacity of the cable was insufficient to deal with the quantity of traffic tendered for transmission, and, while other classes of traffic were disposed of without abnormal delay, a large number of week-end telegrams accumulated to the Canadian terminus of the cable, causing serious congestion. It became apparent that this congestion could not be relieved if the Board continued to accept traffic of all classifications, and it was, therefore necessary to suspend the week-end service in the outward direction on July 18, and further to suspend the deferred press rate on Aug. 7 and the deferred rate from Canada and the United States on Aug. 14. The deferred rate from Canada and the United States was reinstated on Aug. 18, but so far it has not been possible to reintroduce the outward week-end and deferred press services, as under present conditions this would inevitably result in further congestion. These services are being maintained fully in the homeward direction.

LEGAL INTELLIGENCE.

Infringement of Electric Lamp Patent.

On the 9th inst., Mr. Justice Sargant granted, on the application of the British Thomson-Houston Co., an injunction against the A. & A. Electrical Co. (Ltd.), restraining them from infringing plaintiffs' patent for improvements in incandescent lamps. Plaintiffs complained of the sale by defendants of six half-watt lamps.

Mr. A. J. Walter, K.C., appeared for plaintiffs, who claimed for their invention that an air efficiency of 5 watts per candle-power could be obtained, whereas if any previous lamp was run at that efficiency it could be destroyed in a short time: that the filament could be raised to a much higher temperature than practicable in a vacuum lamp without vaporisation or deterioration or excessive shortenting of useful life: that by adopting their invention lamps could be manufactured to be run at a greater efficiency than anything done before; and that it had resulted in a reduction of the consumption of electricity by more than 50 per cent.

Defendants did not appear, and his Lordship, besides granting the injunction, made an order for delivery up of any infringing lamp.

Electrically-Propelled Bath Chair.

At Hampstead (London) Petty Sessions, on Nov. 8, Mr. Prosper Elieson was charged with driving a motor car without a licence and also with using an unregistered motor car. Mr. Ernest Thompson, one of the managers of Messrs. J. & A. Carter, bath chair and ambulance manufacturers, was also summoned for aiding and abetting Mr. Elieson.

A POLICE SERGEANT said that on Oct. 13 he saw Mr. Elieson driving "a four-wheeled motor car bath chair" at High-street, Hampstead. It was propelled by electricity and was travelling at about 4 miles an hour. Defendant Thompson was walking beside the vehicle. When asked why the chair was not registered or did not have registration plates, or if he was in possession of a motor driver's licence, Mr. Elieson replied that he was an invalid, that he did not know he required a licence or that it was necessary to register the chair. He also said it belonged to Carter's, and was out on trial. Mr. Thompson stated his firm had written to the L.C.C. about the vehicle, but they had received no permission to use it from anyone; they were simply giving it a trial.

INSPECTOR PARKER said that, as far as the police were concerned, it was a motor car. The L.G. Board had shied at giving an opinion, and the President of the Board had written that the question whether a particular vehicle was a motor car within the meaning of the Motor Car Acts was one that could only be determined authoritatively by a Court.

Mr. THOMPSON gave evidence for the defence, and said that Messrs. Carters were specialists in invalid carriages and ambulances. The weight of the vehicle in question was 2¼ cwt., and it was propelled by a ¼ H.P. electric motor. The vehicle could be used as an ordinary bath chair. His firm was anxious to know whether it would be an infringement to use the vehicle without registration, and they had had considerable correspondence with the Customs, the L.G. Board and the L.C.C. The vehicle was the first of its kind put on the road in this country. The extreme speed was 5 miles an hour, but the average speed would be about 2½ miles an hour. The vehicle was so constructed that if it met any opposition it instantly stopped. The plate was left off accidentally.

Mr. RITCHIE (for the defence) said that Messrs. Carters had, after numerous experiments, brought the vehicle to a state of perfection, and the question arose as to whether it came within the provisions of the Motor Car Act. It was absurd to call a bath chair a motor car, and he argued that the Motor Car Acts did not apply.

After consultation, the CHAIRMAN announced that the magistrates had decided that the vehicle was not an ambulance. It was a vehicle driven by electric power, and on the summons for the unregistered motor car a fine of 10s. would be imposed, while on the summons for driving without a licence a similar penalty would be imposed. The summonses for aiding and abetting would be dismissed.

Mr. RITCHIE asked the magistrates to state a case, and the Chairman replied that they would be pleased to do anything that was desired.

PARLIAMENTARY INTELLIGENCE.

MARCONI-TELEFUNKEN ASSOCIATIONS.

In the House of Commons on Thursday last Sir R. COOPER asked the President of the Board of Trade whether directors of the Marconi Co. had seats on the board of the Deutsche Betriebs Gesellschaft für Drahtlose Telegraphie, of Berlin, and whether that Berlin company was a subsidiary of the Telefunken Co.?

In reply, Mr. PRETYMAN said he was informed by the Marconi Co. that certain of their directors were before the war on the board of the Berlin company, in which the Telefunken Co. held a majority of the shares.

Sir R. COOPER also asked whether an agreement was concluded in 1913 between Marconi's Wireless Telegraph Co. and the Gesellschaft für Drahtlose Telegraphie, of Berlin, or the Telefunken Co.; whether such agreement covered Australia, New Zealand, Spain and the United States; and, if so, had the agreement been operative since the beginning of the war.

Mr. PRETYMAN said he was informed by the Marconi Co. that in 1913 an agreement of a commercial nature was concluded between them and the Telefunken Co., that the agreement dealt in some matters with Australia, New Zealand and Spain, but did not embrace the United States, and that the agreement had not been operative since the beginning of the war.

Mr. RUPERT GWYNNE asked the President of the Board of Trade whether the Marconi Co. had omitted to publish since 1913 in its yearly accounts a list of its subsidiary companies, and, if so, could he state what subsidiary companies were associated with the Marconi Co.

Mr. PRETYMAN said he was informed by the Marconi Co. that they had not considered it in their interest to publish in their yearly accounts a list of their holdings in other companies since 1913, but that the information was at all times available to their shareholders.

Sir R. COOPER asked the First Lord of the Admiralty whether a full and strict inquiry was held into the loss by enemy submarines of every British merchant ship; and, if so, was special inquiry made as to the nationality and reliability of wireless operators on those ships, and whether he was aware of the intimate working arrangements and agreements between the British, Belgian and German wireless telegraph companies; and, if so, could he give an assurance that special precautions had been taken to ensure that wireless operators on all vessels of His Majesty's Navy were strictly loyal to the cause of Britain and her Allies?

Dr. MACNAMARA said the reply to the first part of the question was in the affirmative. As regards the second part of the question, the subject of nationality and reliability of all wireless operators in British merchant ships had been dealt with by the Postmaster-General in reply to another question. Operators in H.M. Navy were all necessarily British subjects. They had every reason to rely on the loyalty of naval operators, and no case had occurred to doubt their zeal and loyalty. No candidate was now accepted for entry to the Navy unless he was the son of British born parents on both sides.

THE BOARD OF TRADE AND THE CABLE MAKERS' ASSOCIATION.

In the House of Commons on the 9th inst., Sir J. HARMOOD BANNER asked the President of the Board of Trade whether it was intended to continue the prohibition on electric manufacturing companies in this country from competing in the purchase of enemy trading concerns, cable, electric and otherwise, unless they gave an undertaking that they were not members of the Cable Makers' Association; and would he say what was the intention in thus reducing the possible number of purchasers and also the price, and preventing an equal opportunity of all manufacturers to bid.

In reply, Mr. PRETYMAN said there was no such general prohibition, as was suggested in the question, but in two special cases the Board of Trade after consultation with one of the departments which was largely interested as a purchaser of electric cable, came to the conclusion that it was in the public interest that the competition which at present exists in the cable making industry should be maintained.

Enemy Controlled Companies.—In reply to a question in the House of Commons last week, Mr. Pretyman stated that 96 per cent. of the share capital of the Union Cable Co. was held by the Deutsche Kabelwerke, but the Public Trustee had now negotiated a sale of the shares to British subjects. The tenders made by the company to the Corporation of Coventry were investigated by the supervisor of the business last March, and he reported that the tenders were at a price which showed a fair trading profit. The company was subject to the same provisions with regard to income tax and excess profits tax as any other company.

Replying to another question, Mr. Pretyman said that he would lay on the table of the House a list of the enemy-owned shares in British companies which had been sold by the Board of Trade or the public Trustee.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

14,145 BLACKMORE. Electric indicating and lighting systems.
14,310 HUNT. Process for the production of cuprous oxide electrolytically.
14,377 NEULAND. Dynamo-electric machines.

Relates to a dynamo-electric machine wherein the commutator and armature windings are so arranged that, for each pair of pole windings, the ratio of the angular span of commutator over which a series of brushes collect current, to the angular span of commutator for this pair of pole windings is considerably in excess of the ratio of short-circuited to total armature conductors, whereby a large span or brush contact may be employed simultaneously with a large percentage fo conductors effective for generating voltage in the armature.

14,405 HELLER. Electrically-heated cooking utensils. (16/7/14.)
14,468 JONES. Electric arc soldering.
14,533 PRENTICE. Mounting of electrical apparatus in frames or cases.
16,395 WYNNE. Electrical switches.
16,466 COSTELLO. Electric contact thermometers.
17,366 SAYERS. Electric heating and cooking devices.
17,844 B.T.-H. CO. (G.E. Co. Starting and lighting sets for automobiles.
18,137 MARTIN. Dynamo-electric machines. (2/2/15.)

1916 SPECIFICATIONS.

2,063 LAMERIS. Electromagnetic driving gear for clocks. (101,652.)
2,556 QUASI-ARC CO. & STROHMENGER. Electrode holders for use in electric soldering and welding with fusible electrodes. (101,655.)
2,704 DEUTSCHE GASGLULICHT AKT. GES. (Auerges). Manufacture of electric incandescence lamps with metallic incandescence bodies. (100,387.)

Relates to a process for the elimination of moisture residues in electric metallic filament incandescense lamps, consisting of introducing into such lamps metal compounds which during the heating of the lamps, in the course of manufacture, are completely transformed by chemical decomposition into drying media which do not give off gases.

[illegible],745 SOC. FRANCAISE RADIO ELECTRIQUE. Alternators for the production of high-frequency electric oscillations. (100,184.)

Relates to a method of maintaining a constant load on the shaft of a high-frequency alternator, wherein an auxiliary generator is mechanically coupled with a high-frequency alternator, the generator being automatically loaded when the alternator is not excited in the course of the emission of signals.

[illegible],628 MARINI. Electrolytic method for removing oxide or rust from the surface of iron or steel. (Divided application on 11,230/15.) (101,667.)
[illegible],517 LAMKIN. Sparking plugs. (101,678.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 4, 1916.

14,057 DOWLING. Apparatus, solutions, &c., for conducting, &c., electric current, by means of a jet.
14,064 ASHCROFT. Electrolytic manufacture of magnesium metal.
14,065 ASHCROFT. Electrolytic manufacture of sodium potassium alloys.
14,068 H[illegible]. Re[illegible]ring train motion lines, &c.
14,0[illegible]1 GRYLLS & HEAP[illegible]. Arc lamps.
14,111 MCQUINN. Reflectors for electric lamps.
14,113 SHAW. Electric conductors.

October 5, 1916.

14,163 BRIT. WESTINGHOUSE ELEC. & MFG. CO. [illegible] Circuit interrupting systems. [illegible] U.S.)
14,169 RA[illegible]. Electrically-propelled vehicles.

October 6, 1916.

14,215 WALKER. Electrolytic cells.
14,218 FELT (B[illegible]). High-tension [illegible].
14,246, 14,217 GUINNESS. Ignition apparatus.
14,[illegible] FESSENDEN. Sound producing or transmitting apparatus. (27/6/16. U.S.)

October 7, 1916.

14,[illegible]2 HARRISON. Non-[illegible] sparking plug.
14,276 BRIT. WESTINGHOUSE ELEC. & MFG. CO. Circuit interrupters. (9/10/15. U.S.)
14,[illegible]0 DAVIS & H[illegible]. Stand for current testing apparatus.
14,291 DAVIS & H[illegible]. Recording attachment for current measuring and testing apparatus.
14,293 B[illegible] (LTD.). S[illegible], particularly applicable to line insulators.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

Edison-Swan Report.

Notwithstanding the increased cost of and difficulty in getting raw materials, suitable labour, &c., the Edison-Swan Electric Co. appears to have had a successful year. The gross profit was £65,700, compared with £57,000 in 1914-15, and the net profit £24,100, against £14,100. After paying debenture interest, and providing for depreciation and reserve on a more liberal scale than the previous year, a sum of £4,000 is carried forward. We note that the general expenses have been reduced from £17,000 to £12,500, a feat which cannot have been easy to accomplish in these times, and we are pleased to notice that this old and well-known British company has made much progress in extending connections, and that the export side of its business has been further developed. It is claimed that this branch is now established on a firm basis, and that when normal conditions supervene it will furnish a still more remunerative source of revenue. No doubt there will be an increasing demand for the company's manufactures in the British colonies, in Russia and in other foreign countries after the war, and we believe that it is doing the right thing by keeping up its export connections.

* * * *

Steel Contracts and Prices.

The Minister of Munitions has withdrawn as from November 1st the general permit hitherto in force for dealing in pig iron and steel, and in substitution therefor he permits all persons to buy, sell, &c., or enter into negotiations for the sale or purchase of various specified kinds of pig iron and steel (which are set out with the authorised maximum prices in a schedule in the "London Gazette" of Nov. 10).

It is ordered that any sale not being a contract entered into prior to Nov. 1 shall be at a price not exceeding those specified in the schedule, unless it be a sale under a special permit granted by the Minister, a sale of material for under 2 tons of high-speed tools, or a sale to a manufacturer of finished steel purchased by him, or a sale or purchase of material, the export of which has been duly sanctioned.

* * * *

The Imperial Institute and Commercial Inquiries.

It is announced that an inter-departmental Committee (presided over by Mr. Harcourt) has arranged the respective spheres of work and co-operation, in dealing with commercial inquiries of the new Commercial Intelligence Department of the Board of Trade and the Imperial Institute.

In future the Technical Information Bureau of the Imperial Institute will answer all commercial inquiries respecting the sources of supply, technical uses and value of raw materials within the Empire, and will be responsible for supplying all information required in order to bring the producer overseas in touch with the manufacturer at home.

Inquiries as to immediate supplies may be addressed either to the Board of Trade or to the Institute, but the Commercial Intelligence Department of the Board of Trade will, as a rule, be prepared to deal with inquiries for immediate supplies of well-known raw materials which can be obtained at once through ordinary trade channels. In answering those inquiries in which special statistical or trade information is required in addition to technical information the Board and the Institute have arranged to co-operate. Investigations of the possible industrial uses of raw materials will, as heretofore, be dealt with by the Imperial Institute.

Anglo-Russian Trade Relations.

At the meeting of the Sale Managers' Association on the 11th inst., Mr. W. H. Beable delivered an interesting address on Russia.

Mr. Beable supplied much interesting information about the Russian Empire, its population, resources, manufacturing and commercial districts, transit facilities, &c. The facts and statistics given by the lecturer were presented in a striking manner, and those present were impressed by the potentialities for expansion of our great ally

He said that the importations into Russia had been in round figures 100 millions a year, of which roughly 60 per cent. was contributed by Germany and 10 per cent. by England. The demand after the war would be tremendously increased. The most pronounced movement in Russia to-day was, and after the war would be, the developemnt of Russia's own manufacturing industries. She would never again allow herself to be found in the position she was in to-day, cut off from practically all supplies, except that of food. The feeling against Germany was very bitter, but even the friendship for England and France would not be permitted to allow those countries to exploit her as had been done by the enemy. The first and greatest demand after the war would therefore be the supply of plant, equipment, machinery, &c., for the creation and maintenance of manufacturing industries. There would also be required immense quantities of general merchandise. Sympathy was the keynote of the Russian character, and it applied to business, as everything else in Russia, and the bond of sympathy with England, created by a common sacrifice, gave this country a great opportunity. But what we did must be done in the two years immediately after the war, and preliminary preparations at least, must be done now. Three things would operate strongly in our favour. Firstly, the discriminating duties that would undoubtedly be levied by Russia in favour of the Allies; in the second place, there would be for some time a very strong prejudice against the enemy in favour of ourselves; in the third place, the competition of Germany and Austria would be still further lessened by their inability to give the long terms of credit, which had been one of the most formidable elements of competition in the past. There was a general feeling in this country that in order to do business with Russia we must slavishly follow German methods. It was thought that we must make inferior goods, take enormous risks, give long credits, adopt a spy-system, in which the Germans were past-masters, and generally do many things that were repugnant to the English idea of business ethics. After a very exhaustive inquiry, he was convinced that those opinions were to a very great extent wrong. We must, in the first place, approach Russia in a sympathetic manner, entering into its aims and aspirations, convincing her that we only want to do business on permanently and mutually advantageous conditions; that we want to help her develop her own industries and to supply her with such goods as she cannot advantageously manufacture herself, at any rate for the present. We must be prepared to meet Russian conditions to some extent; we must be ready to (at any rate) deliver goods to a Russian port, instead of f.o.b. England; we must print our catalogues in the Russian language and give the equivalents of English weights, measures and currency in Russian terms. The manufacturer who insisted that he only wanted business with Russia on his own lines and his own terms, who insisted upon quotations in sterling, and English weights, upon prices at factory with cases and packing extra, with cash against documents in England, would never do business with Russia, and it is better for him to spend his energies in other directions. The question of credit had been the greatest stumbling block to trade between this country and Russia. The Germas would not be able to give the same credit and other facilities after the war. Further, for more than two years the Russians had been accustomed to pay in cash for all their purchases, not only in England and America, but also between one another. A prominent Moscow cotton manufacturer told him that aftr the war practically all business from his factory would be done on much shorter terms of credit than before, and that the precedent created now would make them only too glad to buy at three or four months' credit. The most effective contribution to shorten credit, however, lay in the abolition of vodka. That measure was producing and would produce the most marvellous change that Russia had seen for centuries, changes even greater than the influence of the war itself. Money was, and would be plentiful, and the necessity for long credit no longer existed, except in certain exceptional cases. Three, four or possibly even in some cases six months' credit would be required, if only from the fact that the distances were so great that it often took several weeks before the receipt of the goods shipped. If possible, bills should be obtained for purchases. There was no cheque system in Russia as there was in this country; payments even for the largest amounts were usually made in cash, and the Russian waited for somebody to come and collect the money. If it was not considered desirable to trust the agent with the collection of monies to be banked at once to the credit of the firm, then it was necessary that someone should go out once or twice a year, when, as a rule, he would have no difficulty in getting in the money due. A good plan would be for a number of firms to combine together and appoint a responsible man entirely for the purpose of collecting accounts. The appointment of agents was one in which the greatest blunders had been made, and through which the greatest catastrophes have occurred. British manufacturers seem in many cases to have ignored the most elementary caution in the appointment of these agents. With German goods out of the market there were thousands of people in Russia looking out for British agencies, some of them with very high-sounding names. The majority of them were utterly irresponsible and very dangerous to do business with, while others, of course, were men and firms of the highest reputation and integrity. The utmost caution should be taken in appointing agents, or even in quoting agency terms. Another great mistake is to give the agency for the whole of Russia to one person, especially if it was for any definite period of time. In some specific cases, such for instance as textile machinery, the ground could be covered fairly well from Moscow, and in dealing largely with the Government of Petrograd would be the natural seat of the agent. But as a rule, for anything like general merchandise, there should be agents at both Petrograd and Moscow, at Kharkov or Ekaterinoslav, at one of the Black Sea ports, at Rostov-on-Don, in the Lower Caucasus, at Kkaterinburg and in Siberia. Since a contract giving the agency for Russia, ipso facto, included Siberia, that should be borne in mind. No agencies should be given for any period without some guarantee of sales, otherwise the firm may find that it is simply being nursed for the benefit of German competitors. Generally speaking, there were two classes of agents; one was the firm with ample financial resources of its own, who bought and paid for the goods in its own name, selling at its own prices, and of course reserving the sale of the goods in Russia or the distribution allotted to it. The other was the purely commission agent, who sold goods in the name of the firm, which were invoiced direct to the customer. In that case, the financial standing of the agent was not of so much question as his integrity and ability, for those two elements involved risk and bad debts. An agent selling on commission was liable not to take as much caution in the financial responsibility of the purchaser as he should do, unless he is made responsible for at any rate part of any losses that might be sustained. It was extremely desirable that a representative of the firm should go out occasionally, get into personal touch with the customers, look after overdue accounts, and generally to see if he was getting the best service from the agent. Another excellent plan is to get a bright young fellow trained for the purpose, and who had at least an elementary knowledge of Russian, and send him to Russia with samples, prices, &c. Still another plan was to send out a traveller or travellers, once or twice a year; and where the business warranted it, that was perhaps the best plan for many trades. He should, of course, have a very fair knowledge of Russian, and should be a sympathetic rather than a clever man. In other lines of business, local factories could be set up with decided advantage, as naturally, in that way, the heavy customs duties were avoided. Where possible it was, however, better that those factories should be devoted to the manufacture of the heavier parts, while the more intricate parts were made in this country, and sent out to be assembled in Russia. The British Consular system in Russia was not organised to render any very great assistance in the development of British trade. In the whole of the territory he had been describing, there were but five paid Consulates, and two of those were in charge of acting Consuls. The whole Consular system seemed to be based on certificates, and the making of commercial reports and investigations was a secondary matter. In great mining districts, with immense potentialities, such as Ekaterinoslav, there was no Consul whatever. The Commercial Attaché at the Embassy at Petrograd had no assistants, not even a typist, and no office of his own. The entire expense of the Consular system in Russia probably did not exceed £10,000 a year, and yet we expected for this amount, distributed over an Empire so vast and a population so great, to capture a good portion of the 60 millions a year trade that Germany had hitherto done with Russia. Mr. Beable said "We want more and better paid Consuls, we want men of commercial experience, we want larger staffs in our chief Consulates, and we want them more closely allied to and connected with the Board of Trade, rather than the Foreign Office. We want a Commercial Attaché or Commissioner independent of the Embassy, and with an office of his own. There were possibilities of business in Russia beyond the dreams of avarice, and we could get [illegible] if we approached the question in the right spirit, and if we adopted the right method."

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES

From [illegible] 10, 1916

IMPORTS.

[illegible]

EXPORTS.

[illegible]

AFRICA.—*Durban.* Wire and cable, £4,146, elec. machinery, £1,107; unenumerated, £28,091. *Cape Town:* Wire and cable, £1,769; Telegraph material, £812; elec. lamps, 2,700 n.o.; unenumerated, £1,599. *Port Elizabeth:* Wire and cable, £5,351; unenumerated, £956. *Delagoa Bay:* Elec. machinery, £771; unenumerated, £103. *Madagascar:* Unenumerated, £74. *Mauritius:* Elec. machinery, £13; wire and cable, £293; telegraph material, £135; unenumerated, £626. *Zanzibar:* Elec. machinery, £22; wire and cable, £49; telegraph material, £85; unenumerated, £161. *East London:* Elec. machinery, £404; wire and cable, £61; unenumerated, £700. *Beira:* Unenumerated, £59. *Chinde:* Elec. lamps, 250 n.o.

MALTA.—Telegraph material, £10; unenumerated £50.

EGYPT.—*Port Said:* Elec. machinery, £30. *Alexandria:* Unenumerated, £394. *Port Sudan:* Telegraph material, £36; unenumerated, £64

ADEN.—Telegraph material, £16.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. lamps, 1,500 n.o.: unenumerated, £1,264. *Calcutta:* Elec. machinery, £59; elec. lamps, 5,096 n.o.; unenumerated, £1,364. *Madras:* Unenumerated, £230. *Karachi:* Elec. machinery, £84. *Ceylon:* Unenumerated, £360. *Singapore:* Elec. machinery, £367; unenumerated, £405. *Bangkok:* Telegraph material, £69; wire and cable, £24; unenumerated, £25. *Sourabaya:* Wire and cable, £100; unenumerated, £310. *Kilindini:* Elec. machinery, £60; wire and cable, £261; unenumerated, £722. *Padang:* Unenumerated, £30.

CHINA.—*Shanghai:* Wire and cable, £28; elec. lamps, 200 n.o.; elec. machinery, £223; unenumerated, £287. *Hongkong:* Wire and cable, £311; elec. machinery, £76; unenumerated, £530. *Tientsin:* Elec. lamps, 400 n.o. *Hankow:* Elec. machinery, £156; elec. lamps, 50 n.o.; unenumerated, £115.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. lamps, 85 n.o.; unenumerated, £417. *Valparaiso:* Wire and cable, £156; telegraph material, £90; unenumerated, £185. *Rio de Janeiro:* Unenumerated, £649.

JAVA.—*Batavia:* Wire and cable, £400; unenumerated, £52. *Samarang:* Unenumerated, £25.

SUMATRA.—*Medan:* Unenumerated, £268.

HOLLAND.—*Amsterdam:* Wire and cable, £2,539; unenumerated, £359. *Rotterdam:* Wire and cable, £926; unenumerated, £343.

FRANCE.—*Dieppe:* Unenumerated, £104. *Paris:* Unenumerated, £58. *Treport:* Elec. machinery, £96; unenumerated, £167. *Boulogne:* Unenumerated, £300.

DENMARK.—*Copenhagen:* Elec. machinery, £280; unenumerated, £165.

PORTUGAL.—*Oporto:* Unenumerated, £244. *Lisbon:* Telegraph material, £50; unenumerated, £37.

RUSSIA.—*Vladivostock:* Elec. lamps, 9,500 n.o.

CANADA.—*Montreal:* Elec. machinery, £40; unenumerated, £177.

U.S.A.—*New York:* Unenumerated, £620.

JAPAN.—*Kobe:* Elec. machinery, £591. *Yokohama:* Elec. machinery, £1,235; unenumerated, £61.

WEST INDIES.—*Demerara:* Unenumerated, £36.

TOBAGO.—Unenumerated, £14.

MOJI.—Unenumerated, £54.

FOREIGN GOODS (duty paid and free).

Melbourne: Elec. meters, £157, unenumerated, £1,309. *Durban:* Unenumerated: £200. *Amsterdam:* Unenumerated, £124. *Belawan:* Unenumerated, £156. *Bombay*, Unenumerated, £150. *Cape Town:* Elec. lamps, 210 n.o.; unenumerated, £127. *Geelong:* Unenumerated, £225. *Hongkong:* Elec. lamps, 10,144 n.o.; unenumerated, £11. *Mauritius:* Unenumerated, £12. *Port Elizabeth:* Unenumerated, £19. *Sydney:* Unenumerated, £119. *Valparaiso:* Unenumerated, £254.

IN TRANSIT.

Melbourne: Elec. lamps, £597. *Hongkong:* Elec. lamps, £1,645.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

It is pleasant to learn of British firms who are making arrangements for extension of business to cope with orders that are likely to mature when the war is over. We have received particulars from Messrs. Creed & Co., Ltd. (of Croydon) of arrangements that have been completed for a general expansion of their business.

In this connection it is interesting to note that Messrs. Creed & Co. have purchased the wireless telegraph patents, plant, &c., of the Indo-European Telegraph Co. and the Galletti Wireless Telegraph & Telephone Co. The Indo-European Telegraph Co. have subscribed for a considerable number of shares in Creed & Co., and two of their directors (Sir William R. Brooke, K.C.I.E., formerly director-general of telegraphs of India, and Mr. T. W. Stratford-Andrews, the managing director of the Indo Company) have been elected to the board. Mr. Stratford-Andrews has taken over the managing directorship of Messrs. Creed & Co. Mr. Creed, who is known to all telegraph men, remains chairman of the company, and will advise the board on technical matters. Mr. Donald Murray, whose systems of printing telegraphy are well known, has sold his patents and business to Messrs. Creed & Co., and has joined the board. The company has also been fortunate in securing the services of Mr. H. H. Harrison, whose knowledge of telegraph matters is second to none. The technical staff of the company has been added to. Amongst others, Mr. Rivers Moore will devote his services to technical research, and Mr. Morse will look after the wireless side of the undertaking. The company has already started a research department, and there will be showrooms, where specimens of the various apparatus manufactured by the company can be viewed under working conditions. We hear that the Indo-European Company had already made very considerable developments in the design and construction of wireless sets of comparatively low power, and these sets are now undergoing the important process of standardisation.

The London office of Messrs. Fraser & Chalmers is to be removed to Moorgate Hall, Finsbury pavement, E.C.

Cable for Sale.—Leeds Corporation electricity department advertise for sale some paper and lead covered concentric and three cored cable. Inquiries to the manager, Mr. C. Nelson Hefford

Patent Development.—The proprietor of patent No. 25,632/1906, relating to "Magneto electric generators," is prepared to sell the patent or to grant licences thereunder. Particulars from Messrs. Boult, Wade & Tennant, Patent Agents, 111 and 112, Hatton-garden, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

London County Council.—At the meeting on Tuesday sanction was given to Poplar Borough Council to borrow an amount not exceeding £4,236, repayable within 25 years, for laying mains.

Newport (Mon).—The Borough Electrical Engineer has been instructed to invite tenders for additional plant at Mill-parade substation

As a result of a conference between the Chief Constable and the Borough Engineer, the street lighting has now been extended, with the result that there are altogether 176 electric lamps and 140 gas lamps lighted every evening.

Stafford.—It is proposed to lay an electric cable along Foregate-street at a cost of about £1,000.

Walsall.—Owing to the second turbo-alternator for the new generating station having been requisitioned, and the consequent necessity of having to run the plant at Birchills without stand-by, it will be necessary to keep the Wolverhampton-street station fully manned and running until a second set is installed at Birchills.

GENERAL.

Bradford.—Owing to the collapse of scaffolding at the electricity works on Tuesday, one rivetter was killed and two others were seriously injured. The men were in the employ of Messrs. Newton, Chambers & Co.

Callington.—The Urban Council has decided to ask for a L. G. Board inquiry into the proposal to introduce public electric lighting.

Huddersfield.—It is reported that the electricity department has been very busy during the past year.

There has been an increasing demand for electrical energy for power, and the output for lighting and domestic purposes has been restricted as much as possible. The coal supply is again giving great trouble to the Electricity Committee, and the increased price of same has necessitated a further increase in the price charged for energy of 12½ per cent. on the pre-war charges, after the current half-year. The three-phase motors connected during the past year equal 4,050 H.P., bringing the total three-phaso motors up to 12,756 H.P. The single-phase motors connected during the year were equal to 95 H.P., bringing the total single-phase motors connected to 2,723 H.P., making a total of 15,479 H.P. connected. The number of consumers connected to the mains is 6,656.

Increased Charges for Electrical Energy.—Increased charges for current are to be made at the following places:—

Wolverhampton Council is increasing its charges by 10 per cent., making a total of 20 per cent. over pre-war rates.

Huddersfield Council has decided to increase its charges for current to 12½ per cent. over pre-war rates.

Johnstone.—Last week the Council discussed the question of the lighting of the town and Bailie M'Laughlin submitted the report of the committee appointed to consider the matter.

Bailie M'Laughlin said that it had been proposed to obtain current from the Paisley Tramways Company and have some lamps lit in the centre of the town. The cost would be about £70, and that seemed to him quite satisfactory, as the ordinary lighting account would have been three or four times that amount.

The committee's recommendation was agreed to, it being explained that Paisley Town Council would require to give its consent, as that body supplied the current to the Tramway Company.

National Electricity Supply.—Newport (Mon.) Electricity Committee has considered the memorandum circulated by the Joint Committee, and in connection with the same have passed the following resolution:—

That so far as this Committee is concerned they view the proposal sympathetically, and that the Borough Electrical Engineer be authorised to take part in the proposed Committee for this area of supply, and to report upon from time to time as to progress made in the scheme, without however, pledging the Committee to any course of action until they have had full opportunity of considering it.

Reigate.—At the recent meeting of the Council it was stated that for the half-year ending Sept. 30 the electric supply undertaking had lost £594 in revenue from lighting.

The reduced demand had enabled the staff for the first time in the history of the undertaking to shut down the whole of their steam plant and run entirely on oil, thus saving 93 tons of coal. If they could continue to run through the winter without the aid of steam, as there was reason to hope they might, the loss of revenue would in a measure be compensated for by the saving of coal.

Southend.—The charge for current to factories for power is to be 1d per unit.

All male employés at the electricity works who have been in the service of the Corporation for 12 months, are to be granted an extra war bonus of 2s. a week.

Windermere.—The Urban Council have authorised Messrs. Borwick & Sons, boat builders, to tap the Council's electric cable on the Promenade and to erect overhead wires along the trees to supply their works at the boat houses, subject to an annual way-leave charge of £3.

Wolverhampton.—The annual report of the Electricity Committee states that negotiations have taken place with several important outside industrial undertakings who have under consideration the question of building new works with a view to taking electricity supply in Wolverhampton and it is hoped that good results will follow.

The advantage and benefits to electric supply undertakings of increased power loads is being realised throughout the country, and the committee feel that every effort should be made, both in the interests of the undertaking and the town, to encourage the establishment of new industries.

TRACTION NOTES.

Accrington.—The General Purposes Committee have considered a proposal from the Health Committee to purchase an electrically-driven wagon, at a cost of £1,000, for the collection of refuse.

It is claimed that a motor wagon will effect a saving of 10 to 15 per cent. compared with the hire of team labour at the present price.

Birmingham.—The Board of Trade has extended for one year from Sept. 6 the time limited by the Birmingham Corporation Light Railways Order, 1912, for the completion of works, and by the Birmingham Corporation (Quinton) Light Railway Order 1913, for compulsory purchase of lands and completion of works.

On Tuesday Mr. Harrison Barrow was re-elected chairman of the Tramways Committee for the ninth time.

It was reported that the present daily suspension of the tramway traffic has involved a loss of from £2,000 to £3,000 a week.

Central London Railway.—This company is applying for an extension for one year ending Aug. 15, 1918, of the time limited for compulsory purchase of lands, &c., under the company's 1913 Act.

Chesterfield.—It is estimated that the damage caused by the recent fire at the Corporation tramway depot is £3,000, and a claim for that sum has been made to the insurance company.

The carshed is to be repaired, two new tramcar bodies and two sets of electrical equipment are to be ordered, and the damaged tramcars are to be repaired.

L.C.C. Tramways.—The number of passengers carried on the Council's trams during the fortnight ended Nov. 1 last was 22,673,202, compared with 20,853,135 in the corresponding fortnight last year.

The receipts amounted to £94,498, against £88,075. The total traffic receipts from April 1 to Nov. 1 were £1,502,748, compared with £1,355,417 in the corresponding period last year, an increase of £147,331.

Newport (Mon).—In connection with the recent tramcar accident on the Stow Hill route, the borough electrical engineer (Mr. A. Nichols Moore) has reported on the question of making arrangements for preventing a similar accident in future.

Mr. Nichols Moore has submitted to the Board of Trade proposals for doubling the track round the curve at Clifton-place and the interlacing of the track between Charles-street and the curve, with the object of doing away with objectionable facing points in Charles-street. The Board of Trade have given their sanction to the work, which will cost about £850. The Tramways Committee has, however, decided that the laying of the interlacing line be deferred for the present. The cross-over in front of the Westgate Hotel is to be renewed, at a cost of £429.

Stockton.—The Council has appointed a Sub-committee to inquire into the power of the Corproation under the various Acts of the Imperial Tramways Co. for constructing tramways in the Borough.

Walsall.—In order to deal more satisfactorily with the question of missed fares, instructions have been given that the fares of all passengers who propose to travel on the top deck shall be paid to the conductor when the passenger boards a car.

TELEGRAPH AND TELEPHONE NOTES.

Telegraph Cable Lodge.—Bro. W. W. Howell was installed W.M. of this masonic Lodge by W. Bro. T. A. Bullock on Wednesday, 8th inst., at the Hotel Cecil. Officers invested by the new W.M. included the following brethren: T. A. Davies, S.W.; W. Lloyd, J.W.; T. A. Bullock, P.M. (P.G.S.B.), treasurer; H. St. L. Smith, P.M. (L.R.), secretary; F. O. Thompson, P.M. (L.R., D.C.); J. H. Stephens, S.D. and Stanley Brown, J.D.

U.S.A.-Japan Radio-Telegraph Service.—Yesterday (Thursday) the Japanese Government and the Marconi Wireless Telegraph Co. of America inaugurated a commercial wireless service between California, Honolulu and Japan

EMPIRE NOTES.

Australasia.—The ratepayers of Pukekohe (N.Z.) have approved of the borrowing by the municipality of £12,000 for electric lighting and other improvements.

The annual report on the N.S.W. Government railways and tramways for the year ended June 30 states that the total earnings on the railways were £8,006,078 (increase £389,567), and train mileage was 21,556,034 (increase 1,135,011). On the tramways the earnings were £1,991,628 (increase £5,588) and car-miles 26,451,442 (decrease 391,532).

Glen Innes (N.S.W.) ratepayers have expressed disapproval of the erection by the Council of a proposal to establish electricity works, and have resolved to obtain a report on the subject from Mr. J. F. Donoghe.

Water Power in Canada.—The Minister of the Interior (the Hon. W. J. Roches) has recently reported that apart from the northern territories, practically all the Yukon Territory and the northern and eastern portions of Quebec (where the resources are not yet exploited), some 17,746,193 H.P. are available in water powers in the Dominion.

Developed water powers aggregate 1,712,193 H.P., of which Nova Scotia has 21,412 H.P., New Brunswick 13,390 H.P., Prince Edward Island 500 H.P., Quebec 520,000 H.P., Ontario 789,466 H.P., Manitoba 56730 H.P., Saskatchewan 45 H.P., Alberta 33,305 H.P., British Columbia 265,345 H.P., and the Yukon Territory 12,000 H.P. 8,000,000 H.P. are available within range of the present markets and within 15 years will be in use.

MISCELLANEOUS NOTES.

Alleged Blackmail.—At Bow-street Police Court on Saturday, Thomas Absalom Jackson was committed for trial on a charge of having on various dates between Oct. 8 and Nov. 1 offered to prevent the printing and publishing of matters concerning Marconi's Wireless Telegraph Co. (Ltd.) and Mr. Godfrey Isaacs with intent to extort money. Prisoner, who reserved his defence, was allowed bail in two sureties of £750 each.

Callender's Staff Service Gazette.—The last issue of this Gazette (No. 8, 1916) is devoted mainly to an account of the doings of members of the staff with the Forces, letters from many of whom are published. There is also a contribution from Sergt. F. W. Atwood entitled "The Trial of Strength"; and a reproduction of a photograph of the late Mr. W. O. Callender, founder of the company, accompanies the issue.

Damages for Refusal to Work.—At Smethwick on the 9th inst., John Bowerman, a telpher driver, was summoned by the Shropshire, Worcestershire and Staffordshire Electric Power Co., who claimed £10 damages from defendant for refusing to perform his work and unlawfully absenting himself.

Mr. F. CHAPMAN, who appeared for plaintiffs, described the case as one of the most reprehensible he had had to bring before the Court. The necessity of maintaining the supply of electric current was urgent, and he said the demand upon the company was over 300 per cent. more than before the war. Defendant was responsible for the supply of coal to the bunkers, but as the result of his neglect the steam was reduced, and the whole of the supply was jeopardised. Two works had to stop for two hours.

DEFENDANT said the foreman told him to clear off because he took a piece of machinery to be repaired.

The magistrate gave £7 damages and costs.

Daylight Saving.—The Departmental Committee of the Home Office appointed to enquire into the operation of the Summer Time Act have begun the taking of evidence.

The Committee, which is presided over by Mr. W. J. Wilson, M.P., are charged to inquire into the desirability of making the Act permanent, and whether it should be in any way modified or extended.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding-up of [illegible] controlled by alien enemies.

Amongst those in the latest list are: Radium (Ltd.), 93, Mortimer-street, London, W., dealers in radium preparations (Controller, C. B. [illegible], 66, Basinghall-street, E.C.); Camer & Co. (Ltd.), 83, St. Paul's Churchyard, [illegible] makers, (Controller, P. [illegible], E.C.). A correction to the previous announcement [illegible] published, the word "Limited" being added [illegible] of the company.

Claims against [illegible] W[illegible], manufacturers of aluminium, &c., [illegible] City-road, London, E.C., [illegible] by Dec. 18 to the controller, Mr. G. [illegible], E.C.

Engineers' Wages.—The Committee on Production have increased the time rate of wages of [illegible] by 2s. per week, as from Oct. 19.

In March last the same men received an extra 4s. per week.

The engineers of the South-East Lancashire and Manchester district, who have already had [illegible] advance, have been granted a further 3s. from Nov. 7. The increase is for time workers only.

Exports to China.—A further list of firms and persons in China to whom goods may be consigned from the United Kingdom appears in the "London Gazette" of Nov. 7.

Swedish Exports Prohibited.—The following articles have been added to the list of goods which are now prohibited for exportation from Sweden to all Countries, and also in transit through Sweden:—

Chrome, antimony, nickel, molybdenum, vanadium, wolfram, aluminium, cobalt, manganese, cadmium; also alloys thereof, except ferro alloys, rough and manufactured; ores, except iron and zinc ore; ferro-molybdenum, ferro-titanium, ferro-nickel, ferro-cadmium; railway and tramway rails, high speed steel.

Trading With the Enemy.—The "London Gazette" of Nov. 10 contains further lists of additions to, removals from and alterations in the Statutory List of persons and firms with whom persons and firms in the United Kingdom are prohibited from trading.

Amongst the prohibitions are:—

Netherlands.—Esslerk (Ltd.) and Orenstein & Koppel (Rotterdam).

Sweden.—Nordiske Gummifabrik A/B (Trälleborg); and the other countries and districts dealt with in the list are Argentina, Bolivia, Brazil, Chili, Colombia, Denmark, Ecuador, Japan, Liberia, Morocco, Netherlands, East Indies, Norway, Persia, Peru, Portuguese East Africa, Spain and Venezuela.

Certain names are removed from the lists previously published regarding Brazil, Chili, Ecuador, Morocco, Netherlands, Netherlands East Indies, Portuguese East and West Africa, Portuguese Guinea, Fernando Po and Rio Muni, Spain, Sweden, United States of America and Uruguay.

In the variations in the list the following are now given as correct entries: *Japan:* Siemens-Schuckert Denki Kabushika Kaisha (65 Bojima Hamadori, Osaka; 48, Akashicko Tsukiji, Tokyo; 130, Tsutsui cho Kobe; Moji & Dairen). *Netherlands East Indies:* Technische Bureau Gebr. Altmann (Bandoeng) and the other countries, &c., for which alterations are announced are Argentina, Brazil, Chili, Denmark, Netherlands, Norway, Portugal, Spain, Sweden, U.S.A. and Venezuela.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (a) during October, 1916, and (b) the aggregate figures from Jan. 1 to Oct. 31, with increase or decrease compared with corresponding periods of 1915:—

Electrical machinery, (a) £51,579 (decrease £8,573), (b) £965,084 (decrease £319,668); including generators and motors other than for aeroplanes, motor cars and cycles, (a) £16,313 (increase £2,018), (b) 182,071 (decrease £40,977); and electrical machinery unenumerated, (a) £35,266 (decrease £10,591) (b) £783,013 (decrease £278,691); telegraph and telephone cables other than submarine, (a) £10,765 (increase £10,175), (b) £70,949 (increase £44,864); telegraph and telephone apparatus, (a) £5,337 (decrease £12,046), (b) £212,035 (increase £111,937); other electrical wires and cables, rubber insulated, (a) £15,174 (increase £7,210), (b) £106,981 (increase £24,202); with other insulations, (a) £1,664 (decrease £708), (b) £14,188 (decrease £29,148); carbons, (a) £6,309 (decrease £5,496), (b) £73,725 (decrease £55,175); glow lamps, (a) £22,462 (increase £5,791) (b) £243,109 (increase £119,641); arc lamps and electric searchlights, (a) nil (decrease £1,038), (b) nil (decrease £2,664); parts of arc lamps and searchlights (other than carbons), (a) £11,891 (increase £7,793), (b) £92,450 (increase £19,935); primary and secondary batteries, (a) £18,262 (increase £9,207), (b) £166,834 (increase £58,715); meters and measuring instruments, (a) £4,535 (increase £962), (b) £44,039 (increase £19,794); switchboards, (a) nil, (b) £257 (decrease £5,007); electrical goods and apparatus unenumerated, (a) £39,227 (increase £26,947), (b) £301,792 (increase £135,559). Total of electrical goods and apparatus other than machinery and uninsulated wire, (a) £135,566 (increase £48,797), (b) £1,326,359 (increase £473,462).

Exports.—The exports of electrical machinery, material, &c., (a) during October, 1916, and (b) from Jan. 1 to Oct. 31, with increase or decrease compared with corresponding periods of 1915, were as follows:—

Electrical machinery, (a) £134,091 (decrease £23,661), (b) £1,249,407 (increase £63,751); including railway and tramway motors, (a) £42,024 (increase £1,946), (b) £33,209 (decrease £66,024); other generators and motors except for aeroplanes, motor cars and cycles, (a) £62,825 (decrease £17,805), (b) £677,983 (increase £114,231); and electrical machinery unenumerated, (a) £67,002 (decrease £7,202), (b) £538,215 (increase £15,554); telegraph and telephone cables, submarine, (a) £21,488 (increase £5,939), (b) £101,046 (increase £110,752); other than submarine, (a) £55,963 (increase £32,911), (b) £146,436 (increase £95,703); telegraph and telephone apparatus, (a) £17,087 (decrease £1,339), (b) £210,189 (increase £38,713); other electrical wires and cables, rubber insulated, (a) £55,121 (increase £29,572), (b) £481,332 (increase £222,246); with other insulation, (a) £49,691 (decrease £9,090), (b) £682,369 (increase £273,951), carbons, (a) £1,420 (increase £529), (b) £9,408 (increase £2,263); glow lamps, (a) £17,135 (decrease £511), (b) £157,572 (increase £26,356); arc lamps and searchlights, (a) £1,407 (increase £1,114), (b) £7,978 (increase £3,843); parts of arc lamps and searchlights (other than carbons), (a(£2,278 (increase £1,332), (b) £15,102 (decrease £4,574); primary and secondary batteries, (a) £20,450 (increase £2,851), (b) £231,139 (increase £66,451); meters and measuring implements, (a) £18,973 (increase £5,898), (b) £178,403 (increase £52,931); transformers, (a) £9,097 (increase £5,777), (b) £87,665 (increase £33,611); switchboards, (a) £5,740 (increase £2,186), (b) £51,358 (increase £177); electrical goods and apparatus unenumerated (a) £88,938 (increase £11,815), (b) £602,571 (increase £121,097). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (a) £361,788, increase £118,918), (b) £3,559,668 (increase £1,013,561).

TENDERS INVITED.

Electric Cable and Wire.

The Commissioners of H.M. Works, &c., invite tenders for the supply of Electric Cable and Wire during a period of one year from Jan. 1, 1917. Forms of tender, conditions of contract, &c., from the Controller of Supplies, King Charles street, Westminster, S.W., and tenders, addressed to the Secretary, H.M. Office of Works, &c., Storey's-gate, London, S.W., by 11 a.m. of 27th inst. *See also an advertisement.*

Turbo-Alternator and Condensing Plant.

Durban Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-alternator and Condensing Plant. Specification (No. S.238) from Borough Electrical Engineer.

Motors, &c.

Cape Town (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

Motor-Generator, &c.

Dunedin (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

Telephone and Telegraph Material, Stores. &c.

The Directors of the North Eastern Railway Co. invite tenders for six and twelve months' supply of (1) Telegraph Apparatus and (2) Telegraph Wire and Line Stores. Forms of tender from Mr. C. H. Ellison, Telegraph Supt., York. Tenders to the Secretary at York by 9 a.m. Nov. 23.

Tenders are invited up to Dec. 22 for the supply to the Australian Commonwealth Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492

The Gt. North of Scotland Railway Co. require tenders by 10 a.m. Nov. 23 for six or 12 months' supply of Telegraph Material, Castings, Ironmongery, Rubber Goods, Oils, &c. Forms of tender from Stores Supt., 80, Guild-street, Aberdeen.

Sligo, Leitrim & Northern Counties' Railway Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Electric Telegraph Material, Wire, Rubber Goods, &c. Forms of tender from the Secretary, Enniskillen.

The Cheshire Lines Committee require tenders by 10 a.m. Nov. 22 for twelve months' supply of telegraph materials, carbons, &c. Specifications, &c., from Stores Superintendent, Warrington.

Carbons.

Buenos Ayres Municipality require tenders by Nov. 30 for the supply of Electric Carbons during 1917. Conditions of contract may be seen at 525, Avenida de Mayo, Buenos Ayres.

Meters, &c.

Johannesburg (Transvaal) Corporation require tenders by noon Dec. 9 for supply of 1,427 House Service Electricity meters, 7 Switchboard meters and 100 Time Switches (specification 104). Forms of tender from the Municipal Offices.

Bridge Work and C. I. Pipes.

Sheffield Electric Supply Dept. require tenders by 10 a.m. Nov. 17 for Reinforced Structural Work carrying bridge over the railway at Neepsend power station (Contract 203), and by 10 a.m. Nov. 21 for the supply and laying of c. i. Pipes (Contract 202). Specifications from General Manager and Engineer.

Electricity Supply Concession.

Extension of Time.—The time for sending in tenders for Generating and Supplying Electrical Energy for Lighting and Power in St. George (Grenada) and its suburbs is extended to Dec. 31. Particulars from Colonial Secretary, Grenada (British W. Indies)

Tramcar Motors, Materials, &c.

Johannesburg Corporation require tenders by noon Nov. 27 for 250 Field Coils for Tramcar Motors (contract 192); and by noon Jan. 3 for Iron Axles and Bushes (contract 163). Specifications, &c., from the Municipal Offices (Room 53).

The Dirección General de Obras Públicas, Ministerio de Fomento, Madrid, requires tenders by noon Nov. 24 for the Construction and Working for 60 years of an Electric Tramway in Saragossa. An option on the concession is held by the Sociedad Los Tranvias de Zaragoza.

Electrical Stores, Lamps, &c.

Sydney (N.S.W.) Council require tenders by 3 p.m. Jan. 8 for (*a*) 33,000 volt Switchgear; (*b*) Conduit and Fittings; (*c*) Fuses; (*d*) Insulators; (*e*) Insulator Straps and Bolts; (*f*) Lamp Holders; (*g*) Mica; (*h*) Switches; and (*i*) Wire Flexible, &c. Specification of (*a*) and particulars with regard to other items may be obtained at the Town Hall, Sydney.

The North-Eastern Railway Co. require tenders by 9 a.m. Nov. 23 for six and 12 months' supply of Electric Wire and Cables, Electric Lighting Fittings, Iron and steel Castings, Wire, Oils, &c. Specifications from Stores Superintendent, Gateshead.

The Tyne Improvement Commissioners require tenders by Nov. 23 for six and 12 months' supply of Incandescent Lamps, Arc Lamp Carbons, Rubber Goods, Castings, Oils, &c. Forms of tender from the Manager, Bewick-street, Newcastle-on-Tyne.

Electric Crane and Coal Transporter Plant.

The N.S.W. Railway and Tramway Department require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Tenders are invited for the supply, delivery and erection in Melbourne, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Ppty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders by noon Dec. 11.

Carbon Brushes and Cut-outs.

Johannesburg Municipal Council require tenders by noon Nov. 27 for the supply of 12 gross of Carbon Brushes for Electric Motors. (Contract No. 178.)

Johannesburg (Transvaal) Council also require tenders by noon Nov. 27 for the supply of 1,000 sets of Single Pole Ironclad House Service Cut-outs (Contract 187).

Specifications from the Municipal Offices.

Converter Plant, Batteries, Booster Plant and Switchboards.

Sydney (N.S.W.) Council require tenders by 3 p.m. Jan. 22 for (A) Converter Plant (three-phase to c.c.), (B) Two Storage Batteries, with switches and accessories, (C) Booster Plant, (D) l.t. c.c. Switchboards. Specification, &c., from the General Manager of the Electric Lighting Department.

Wiring.

Messrs. David John & Co. (Ltd.), Brewers, Pentre, Rhondda Valley, require tenders by Nov. 20 for Wiring (82 points) in tubing at their brewery. Forms of tender from the company.

TENDERS RECEIVED AND ACCEPTED

Metropolitan Asylums Board.—The Board have accepted the following estimates:—

Lund Bros. & Co., rearrangement of electric lighting at Mead station, £41. 17s., and wiring Eastern, North Western, Western and Brook stations, £65. 10s.; Crypto Electric Co., four electric motors, Eastern, North Western, Western and Brook stations, £49. 5s.

Marylebone (London).—The Electric Supply Committee recommend the acceptance of the tender of the British Westinghouse Electric & Mfg. Co. for a balancing attachment for a rotary converter at Manchester-square at £165.

The Committee have accepted the offer of British Insulated & Helsby Cables for the supply of cables for six months ending March 31 next.

Bradford.—The Guardians have accepted the tender of Smith & Croft (at £25. 16s.) for wiring the laundry and garage.

Sheffield.—The Council has accepted the following tenders:—

Electricity Department.—A. Reyrolle & Co., 20 panels of high-tension two-phase sub-station switchgear, £2,709; Staveley Coal & Iron Co., 10,000 3 in. c.i. cable pipes, £7 10s. a ton; C. A. Parsons & Co., two turbo-alternators, switchgear and alterations to pipe work, £19,000 plus 5 per cent. for contingencies.

Tramways Department.—Dawson & Jones, alterations and additions to Town Head-street depot to convert same into motor-bus garage, £3,619; Meade-King, Robinson & Co., motor spirit for tramways and motors.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Adelaide (S. Australia).—The report on the working of the Municipal Tramways Trust for the half-year to July 31 contains the following particulars.

The total amount repaid to H.M. Government on account of all sales of the old horse car properties is, for the Adelaide system £54,105, and for the Port Adelaide system £94; total, £54,199. Losses on conversion (practically goodwill) are, on the Adelaide system £223,534, and on the Port Adelaide system £2,429; total £225,963. The total advances from H.M. Government on account of construction amount to (including Port Adelaide) £1,557,639, less repayments for sinking fund £203,683, the balance repayable being £1,353,956. Capital expenditure in excess of advances by H.M. Government is £327,471, which represents the extent to which the reserves, including sinking fund, have been utilised for construction purposes. The reserves are: For renewals, £107,581; sinking fund, £203,683; insurance, £8,984, and appropriation account carried forward, £3,876; total, £324,126. On the Adelaide system revenue was £162 280, and gross profit was £64,750. On the Port Adelaide (H.C.) system receipts were £866, and gross profit was £16. With interests and discounts the total gross profit was £65,409, and net surplus for the half-year was £712. The gross revenue for the half-year was £163,146, plus £642 for bank and Treasury interest and discounts, &c., making £163,789, or £10,506 more than the corresponding half-year of 1915. The surplus revenue over operating expenses was 8·98 per cent. on the capital cost. In addition to meeting the whole of our obligations to date, the whole of the interest on purchase money, amounting to £91,835, has been paid.

Barking.—The electric lighting accounts of the District Council for the year ended March 31 show gross capital expenditure £66,791 (increase £2,889) of which £32,741 has been repaid.

Revenue was £12,663 (against £13,139 in previous year), working and administration costs were £11,216 (£10,930), and total costs including capital charges were £15,661 (£15,093), the net result being a deficit of £2,997 (£1,954). Total income was equal to 2·405d. (2·214d.) per unit sold, and total costs were 2·130d. (1·842d.) exclusive and 2·974d. (2·543d.) inclusive of capital and special charges. Units generated were 1,628,577 (1,792,851) and sold 1,263,944 (1,424,331). Total maximum demand was 620 kw. (625 kw.).

The light railway accounts show total capital expenditure £82,216, of which £31,967 has been repaid. Revenue was £3,743 (£4,046), and working and general expenses were £4,140 (£5,018). Interest and instalments of principal required £4,046 (£3,700) and, after taking into account receipts for loan of boilers to electricity department, sale of two cars, &c., the district fund is to be drawn upon to the extent of £3,260 (£3,753).

Bath.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £190,913 (increase £2,757), of which £95,069 is outstanding.

Revenue was £26,490 and total expenditure £13,529, leaving £12,961 to carry to net revenue account. After providing for interest £6,108, sinking fund £6,488 and wages of workmen on capital work £77, and writing off £436 on meter suspense account and £88 decrease in value of stores, a debit balance of £150 is carried forward. Units generated were 2,707,610 and sold 1,950,161. Total maximum supply demanded was 1,091 kw.

Bootle.—The electricity supply department's accounts for the year ended March 31 show total capital expenditure £192,669 (increase £9,[illegible]), of which £115,687 is outstanding.

Revenue was £31,888 (compared with £29,491 in previous year), working costs were £20,983 (£16,106), leaving gross profit £13,905 (£13,188). Interest and sinking fund required £11,500 (£10,171) and the net profit was £2,405 (£3,014). Fuel cost 0·4d. (0·3d.), total working costs were 0·78d. (0·71d.) and capital costs were 0·43d. (0·49d.). Units generated were 7,029,000 (5,732,000) and sold 6,133,000 (5,173,000). Total maximum supply demanded was 2,695 kw. (2,480 kw.)

Mr. T. D. Cather (borough electrical engineer) says in his report the [illegible] one effect of the war has been to increase the demand for energy for power to a considerable extent. It became necessary to consider the expediency of putting down two additional boilers, [illegible] both the turbines at March lane to be operated together, and with the plant at [illegible] all supplies could be maintained, but without an adequate reserve. The influence of the Daylight Saving Act was [illegible] on the entire lighting supply is only 10 per cent. of the whole output. It was anticipated that owing to the growing cost and difficulty of obtaining material and labour, the charges for current will have to be increased (for the first time) before the current financial year was far advanced.

Darlington.—The accounts of the electricity supply department for the year ended March 31 show gross capital expenditure £131,709 (increase £21,723), of which £93,678 is outstanding.

Revenue was £27,170, gross profit £12,123, and net profit £2,918, after providing for capital charges, depreciation (£5,654), &c. Units generated were 6,910,423 (compared with 5,528,543 in previous year) and sold 5,533,593 (4,455,418). The maximum total supply demanded was 2,595 kw. (2,405 kw.) and the load factor 24·30 (21·14) per cent. There are 233,414 (222,686) equivalent 8 c.p. lamps connected.

Capital expenditure on the light railways amounts to £77,929, of which £51,975 is outstanding. Revenue was £14,660, and working expenses were £9,601, leaving gross profit £5,059. The net deficit for the year was £1,087, after setting aside £4,224 for depreciation. Total revenue per car-mile was 9·211d. (8·487d.), and working expenses were 6·033d. (5·675d.). Passengers carried were 4,439,278 (4,234,783), car-miles run 384,956 (387,714), and units used 500,401 (504,546) 1·314 (1·301) per car-mile.

East Ham.—The electricity department's accounts for the year ended March 31 show total capital expenditure £152,210 (increase £938), of which £41,288 has been repaid).

Revenue was £26,709 (compared with £28,568) and working expenses were £20,053 (£17,281), leaving gross profit £6,656 (£11,287). Interest required £4,375 (£4,766) and sinking fund and loan instalments £5,705 (£5,391), the net result being a deficit of £3,424 (compared with £1,130 profit). Fuel cost 0·61d. (0·45d.) per unit sold, and total operating costs were 1·16d. (0·97d.). Units generated were 1,566,333 (4,708,030) and sold 4,162,750 (4,276,391). Maximum load was 1,890 kw. (1,784 kw.) and load factor 27·6 (30·1) per cent.

The tramway accounts show gross capital expenditure £196,683 (increase £400), of which £79,182 has been repaid. Revenue was £66,884 (£60,232) and operating costs were £53,485 (£51,619), leaving gross profit £13,399 (£8,613). Interest required £4,905 (£5,279) and sinking fund and principal £6,542 (£6,858), leaving net profit £1,952 (compared with a deficit of £3,524). Operating costs were 7·89d. (7·76d.) per car-mile. Average fare charged per mile was 0·66d. Passengers carried were 20,427,941 (18,916,971), car-miles run 1,626,104 (1,596,984) and units used 2,437,216 (2,461,677).

Falkirk.—The accounts of the electricity supply department for the year ended May 15 show gross capital expenditure £68,588 (increase £6,307), of which £10,115 has been repaid.

Revenue was £11,145 and working and general expenses were £7,339, leaving gross profit £3,505. Interest, sinking fund, property and income tax, &c., required £3,665, of which £159 is taken from reserve. Units generated were 2,050,717 (1,693,378) and sold 1,309,458 (1,154,263). Total maximum supply demanded was 900 kw. (as in previous year.)

Harrogate.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £134,071 (increase £459), of which £63,419 has been repaid.

Revenue was £20,202, and working and general expenses were £9,437, leaving £10,765 gross profit. Interest required £3,658, instalments of loans £1,834 and sinking fund £2,835, and of the remaining £3,603, £1,784 has been placed to reserve, £1,000 contributed in aid of rates, and £819 to capital expenditure. Units generated were 2,019,908 and sold 1,474,234. Total maximum supply demanded was 800 kw.

Newcastle-on-Tyne.—The accounts of the Corporation tramway department for the year ended March 31 show gross capital expenditure £1,355,846 (increase £23,713). £380,733 has been repaid and £142,120 placed in sinking fund

Revenue was £331,461 (compared with £302,611 in previous year), and operating costs were £192,649 (£160,458), leaving gross profit £138,812 (£142,153). The Tyneside Tramways Co.'s proportion of receipts was £6,766, interest required £25,685 (£26,418), rents, leased lines, &c., £1,515 (£1,491), income tax, £10,834 (£3,412), special depreciation £182 (£68), repayment of loans £31,968 (£30,908), and sinking fund £13,317 (£12,418), and of the remainder £9,582 (£19,381) has been devoted to relief of rates, £116 (£6,599) to purchase of motor 'buses, £13,144 (£4,365) paid to employés on active service and £2,000 (£935) placed to reserve, the surplus being £23,860 (£21,825). Traffic revenue per car-mile was 13·45d. (12·40d.), and total operating costs were 8·056d. (6·668d.). Passengers carried were 72,751,631 (65,085,452), car-miles run 5,739,502 (5,775,325), and units used 11,615,648 (11,367,733) 2·110 (1·968) per car-mile.

Mr. E. S. Hatton (engineer and general manager) says in his report, the undertaking has contributed £89,098 in all to relief of rates. The absence of street lighting and the employment of newly trained men and women have resulted in a considerable increase in accidents. There are 275 women employed as conductors and 67 as cleaners. The net surplus (£23,860) has been carried to reserve and renewals fund, which stands at £77,461, after expending £21,052 for renewals during the year.

Newport (Mon).—The accounts of the electricity department for the year ended March 31 show total capital expenditure £331,150 (increase £9,578), less £13,726 written off for superseded plant, &c., and capital outstanding is £183,622.

Revenue was £51,274 (compared with £44,614 in previous year), working expenses were £30,339 (£23,007), and gross profit was £20,935 (£21,607), to which is added £238 (£211) interest from bankers and

£1,689 (£1,640) dividends on sinking funds. Interest required £9,067 (£9,133), sinking funds £13,711 (£13,078), war allowances £580 battery renewal, &c., £350 (£350), insurance of apparatus on consumers' premises £20 (£20), and management of stock, &c., £127 (£134), the net result being a deficit of £993 (against a profit of £743). Units sold were 5,015,074 (4,789,240). Revenue per unit sold was 2·18d. (1·98d.), and costs were 1·21d. (0·96d.).

Capital expenditure on the tramways is £196,246 (increase £61), of which £150,610 is outstanding. Revenue was £45,140 (compared with £42,704), working expenses were £30,460 (£30,956), leaving gross profit £14,679 (£11,747), or £15,713 (£12,005) with accrued interest. Interest on capital required £5,686 (£5,694), sinking fund £4,488 (£4,357), and management of stock £129 (£136), leaving net profit £5,408 (£2,417). Average total revenue per car-mile was 11·76d. (10·62d.), and working expenses were 7·93d. (7·70d.). Passengers carried were 10,017,515 (9,410,109), car-miles run 921,133 (964,895), and units used 1,159,261 (1,178,500).

The borough electrical engineer (Mr. A. Nichols Moore) states that the deficit (£993) on the electricity undertaking is entirely accounted for by capital expenditure on mains and services charged to revenue and two years' payments of war allowances which were provided for in the year's accounts. There was a steady increase in the demand for current for heating and cooking. Mr. Moore says the wisdom of making a 20 per cent. advance in price of current has been amply demonstrated.

COMPANIES' MEETINGS AND REPORTS.

West India & Panama Telegraph Co. (Ltd.)

The seventy-ninth ordinary general meeting was held at Winchester House, Old Broad-street, London, on Wednesday, under the presidency of Sir Alexander Freeman King, K.C.B., the Chairman of the Company.

The SECRETARY (Mr. J. Winser) read the notice convening the meeting, &c.

The CHAIRMAN said : Gentlemen, there is no need to take up your time by making a detailed comparison of the figures in the revenue account presented to you to-day, inasmuch as the form in which the accounts are published shows clearly the comparisons for the corresponding period. I woulfi, however, like to refer to one item of expenditure, always an important one to us, and that is the cost of repairs to cables, as deatled under abstract C. As stated in the report, the cost under this head is £7,633 in excess of that the half-year to June, 1915. Over £2,300 ofo this increase was due to new cable being used in repairs, which is not, in itself, a matter for much regret, because the system is, of course, thereby strengthened to that extent. Now and again we have a set-off to the cost of repairs in an opportunity to let out out repairing ship to connecting companies, but during last healf-year such an event did not happen. In the esrult the profit for the half-year was £11,578, as against £9,229 in the corresponding period of the previous year, an increase of £2,349, and, as stated in the report, we are able to resume paying a dividend on the ordinary shares. The traffic receipts, so far, during the current half-year compare favonrably with those of the December period of last year. The hurricane season in the West Indies, which commences usually in the month of August, was of special severity this year. In that month Jamaica suffered seriously. Our land-lines were blown down in many places, but owing to the exertions of our staff in the island, communications were restored in two or three days. In Dominica there was considerable loss of life and much damage, and telegraphic communication was cut off for several hours. For us, however, the most disasts the hurricanes struck St. Thomas and the adjacent island of St. Croix on Oct. 9, causing great damage in both islands. The small house and sheds at our depot at Krum Bay, St. Thomas, were totally destroyed, and our wharf was damaged, but I am glad to say that we are covered by insurance. Our mortgage debentures, issued 25 years ago, fall due for payment on Dec. 31 next. The issue is only a small one—namely, £90,000, the share capital being £1,275,000. It is shortly our intention to issue a circular inviting the present holders to renew them for a period of 10 years. The debentures are a first charge as a floating security upon the whole of the Company's property. They will be renewed at the saKl rate of interest—namely, 5 per cent. per annum—but, in view of the state of the money market, it is felt that the present holders might not be eager to renew them at par, at which preice they were issued, and that some inducement in the form of a cash payment must be offered for their renewal. Coupons for a half-year's interest payable on June 30 and Dec. 31 in each year will be attached to each bond, and the bonds will be redeemable at the Company's opyion upon six months' notice at £105 per bond. The bonds are issued to bearer, but can be registered at the Company's office, and should a registered holder so desire it, the registration can be cancelled at any time, and the bonds would thus again become negotiable. I would like to say that, should all the bonds not be renewed, some would be available not only for any present holders who may wish to increase their holdings, but also for shareholders ; and I shall be glad if those desirous of having them will write to the office by the 25th inst., when a circular will be sent with forms of application attached. I now move that the directors' report and accounts be adopted and that the dividends of 6s. per share on the first preference shares, 6s. per share on the second preference shares, and 6d. per share on the ordinary shares (the last free of income tax) be declared.

Mr. H. W. BIRKS seconded the motion, which was carried unanimously. The proceedings then terminated.

DRAKE & GORHAM (LTD.)—Mr. B. M. Drake, who presided over the annual meeting last week, stated that, considering the proportion of their men who were with the Forces, the shortage of country house installations and the allowances they were making to absentees, he thought they would agree that the way in which they had been able to adjust their organisation to meet the altered conditions should be a source of satisfaction to the shareholders. Government contracts included work for the War Office on a number of camps in all parts of the country, contracts for the Ministry of Munitions, H.M. Office of Works, Royal Flying Corps, Army Service Corps, Ordnance Survey and the Canadian Expeditionary Force. They had also been actively employed at the various works of Messrs. Sir W. G. Armstrong, Whitworth & Co., Cotton Powder Co. and Messrs. Palmers' Shipbuilding & Iron Co. on electrical work for Admiralty requirements. He referred last year to the large electric generating station which they had been erecting for the United Alkali Co. and he was pleased to say that it had been satisfactorily put to work, and he had every hope that when the results were ascertained it would lead to further work of that character. They had installed power and light at the Sullivan Works, for the United Alkali Co., Messrs. James Bentley & Co.'s finishing works and extensions at Messrs. Porritt Bros. & Austin's works, also lighting in warehouses and works for several companies and firms, including the L. & N.W. Railway, Lord Wandsworth Institution, &c. Among private clients for whom work had been carried out were the Dukes of Richmond and Gordon, Marlborough and Wellington, the Marquis of Londonderry, Earl Ducie, Lord Boyne, Lord Armstrong, Lord Joicey and others. Their factory had done well, and every credit was due to the works manager, who had increased his output by nearly 75 per cent. A large proportion of that work had been for special war requirements. He might say that the question of making extensions was under consideration. The wholesale department, the operations of which were curtailed by the lighting restrictions and cessation of building work, had been able to apply its energies to the execution of Government orders, and both the turnover and profits had increased considerably. Every effort was being made to organise that and other departments with a view to trade after the war, as they looked forward to receiving export orders in connection with the reconstruction work which would be necessary in Belgium, France, Russia and elsewhere. Their electric vehicle department had been able to demonstrate on an extended scale the economy and convenience to be obtained from electric haulage. Vehicles had been supplied to the Chester and Manchester Corporations, Broughton Copper Co., Ford Motor Co., Messrs. Brunner, Mond & Co., Messrs. Deakins (Ltd.), Messrs. J. & J. M. Worrall, Ainsworth & Son, and others. They had also repeat orders from Messrs. Richard Johnson & Nephew, Messrs. Greenall, Whitley & Co., and Messrs. Levinstein. As Edison batteries were reported to have run over 60,000 miles in this country without renewals, it was clear that battery-propelled vehicles would play an important part in the world's carrying trade. In regard to their branch in Manchester, it gave him pleasure to congratulate the staff on the improvement which they had been able to show both in turnover and profit. As regards the future, there might well be hard times ahead, and the labour problem was very acute ; but they had made a good start for the current year, and although it was unfortunate that it had been found necessary by heavy taxation to curtail trade extensions and, consequently, earning capacity in the near future, they might rest assured that they should all do their best to meet whatever difficulties might be in store for them.

EDISON SWAN ELECTRIC CO. (LTD.)—The directors' report for the year ended June 30 states that, after providing for interest on both classes of debenture stock, and depreciation upon freehold properties and plant, there is a net profit of £24,146. 12s. 1d., which, added to £4,878. 16s. 3d. brought forward, makes a total standing to the credit of profit and loss of £29,025. 8s. 4d. The directors propose to deal with this sum by transferring £25,000 to reserve account, and carrying forward £4,025. 8s. 4d. The capital expenditure during the year, before providing for depreciation, has amounted approximately to £16,000, the major portion of this having been expended upon additional plant and machinery. The directors have to report that the company's trade has shown a further considerable improvement during the past year. In consequence of this expansion all available cash is required in the business, and considerable further sums could have been profitably employed. Under these circumstances, the directors regret that they are not in a position to recommend the payment of a dividend upon the shares. The high cost of labour and materials has again seriously affected the profits derived from the manufacture and sale of drawn wire lamps, it being impracticable to increase the selling price of these to meet such extra cost. The engineering side of the works has been almost wholly employed upon Government work. The export business shows a still further expansion, and this branch of the company's trade being now established upon a firm basis, it is hoped that when normal times succeed the present, still better results will be obtained. The board regret to state that Messrs. Welton, Jones & Co., who have acted as the company's auditors since its incorporation, do not seek re-election, finding that they are unable to carry out the work entailed by the audit, in consequence of the serious depletion of their staff. The directors suggest the appointment of Messrs. Broads, Paterson & Co. to fill the position.

FRASER & CHALMERS (LTD.)—The profit for the year to June 30 (after providing for expenses and depreciation on buildings, plant and machinery) was £24,668, compared with £12,058 for the previous year. The merchandise business in South Africa has shown substantial improvement, and the prospects for the current year there, as well as at the other branches of the company, are good. The dividend of 7½ per cent. on the preference shares was paid in July last and the directors have decided to carry forward the balance.

MONTE VIDEO TELEPHONE CO. (LTD.)—The report for the year ended July 31 shows that, after providing for all charges in Montevideo and London, and making provision for income-tax and excess profits duty, the net profit is £25,985, against £25,776 for the previous year. The interim dividends paid in May last absorbed £4,343, leaving £21,642, to which is added £5,394 brought forward, making an available balance of £27,037. After applying £8,000 to depreciation of property and plant, and transferring £9,000 to reserve for renewals, the directors recommend payment of final dividends of 2½ per cent. upon the preference shares and of 3 per cent. upon the ordinary shares, making for the year 5 per cent. on the preference and 6 per cent. on the ordinary shares, leaving £5,694 to be carried forward. There has been a moderate increase in the number of subscribers during the year. The Board regret to announce that, owing to pressure of other business engagements, Mr. Laurence Philipps found it necessary to retire from the board. They are glad, however, to state that his brother, Lord St. Davids, has been elected to fill the vacancy. It has been found at times that the number of directors has been inconveniently small. The board therefore recommend as an additional director Mr. Albert Anns, formerly secretary of the National Telephone Co., and a resolution for his election will be proposed.

CITY NOTES.

MEMORANDA (Nov. 15).—**Bank rate 6 per cent. (since July 13, 1916). Consols 56¼.** Consols Pay Day, Dec. 1. **Stocks and Shares Ticket Days,** Nov. 29 and Dec. 13. Pay Days, Nov. 30 and Dec. 14. Price of Silver, 34 1/16d.

REUTER'S TELEGRAM CO. (LTD.)—It is announced that an offer to purchase the undertaking of Reuter's Telegram Co. (Ltd.) has been made by the Hon. Mark Francis Napier, the chairman of the company, with whom are associated Lord Glenconner, Viscount Peel, and the Right Hon. Sir L. S. Jameson, Bart. It is stated that one of the principal objects of the acquisition of the undertaking is to ensure that Reuter's Agency shall continue to be independent of any alien or undesirable control, and that its conduct and administration shall be entirely British.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 14, the following as the present basis prices of—

New Metals.	Per lb.
Solid Drawn Brass Tubes	16¼d.
Solid Drawn Copper Tubes	19¾d.
Brazed Copper Tubes	19¾d.
Brazed Brass Tubes	18¼d.
Brass Wire	15¾d.
Copper Wire	19d.
Rolled Brass	15¼d.
Brass Sheets	16¾d.
	Per ton.
Copper Sheets	£168 0 0
Spelter	56 0 0

	Per ton
English Lead	Nominal.
Antimony	Nominal.
Old Metals.	Per ton.
Clean Copper Scrap	£118 0 0
Clean Brass Scrap	68 0 0
Braziery Copper Scrap	91 0 0
Old Lead	28 5 0
Old Zinc	39 0 0
Hollow Pewter	132 0 0
Black Pewter	92 0 0
Gun Metal	90 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Nov. 14, the following approximate prices of Scrap Metals:—

	Per ton.
Aluminium Cuttings	£110 0 0
Clean Mixed Brass	68 0 0
Clean Copper	118 0 0
Braziery Copper	92 0 0
Gun Metal	95 0 0

	Per ton.
Old Lead	£4 under English lead price
Old Zinc	38 0 0
Hollow Pewter	130 0 0
Shaped Black Pewter	90 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80, Commercial Tinman's Solder, £100, Blowpipe Solder, £110.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 14.

Shrs.	Last Dividend	NAME.	Price, Tues., Nov. 14	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
[illegible]	6[illegible]	B[illegible] & P[illegible] E. L. Ord.	8[illegible]	7 1 2	Mar., Sept.
[illegible]	4½	[illegible] 4½ [illegible] P[illegible]	7[illegible]	5 16 2	Feb., Aug.
[illegible]	[illegible]	[illegible]	9[illegible]	6 1 6	Feb., Aug.
[illegible]	[illegible]	B[illegible] & K[illegible] Or[illegible]	6[illegible]	7 6 9	Mar., Sept.
[illegible]	[illegible]	[illegible]	6[illegible]	5 9 10	Mar., Aug.
[illegible]	4	[illegible] E[illegible] C[illegible] Deb. St.	80[illegible]	4 19 5	..
St.	4	[illegible] W[illegible] E[illegible] & City Deb.	79[illegible]	5 0 8	Jan., July
[illegible]	[illegible]	[illegible] 4½ P[illegible]	3[illegible]	6 10 11	..
[illegible]	4½	[illegible]	[illegible]	7 8 2	Aug., Feb.
[illegible]	4	[illegible]	3[illegible]	[illegible] 18 6	Jan., Dec.
[illegible]	4½	[illegible]	[illegible]	6 8 7	Mar., Sept.
[illegible]	[illegible]	[illegible]	87	5 3 [illegible]	Jan., July
[illegible]	[illegible]	[illegible] E[illegible]	[illegible]	6 14 [illegible]	Feb., Aug.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 19 9	Mar., [illegible]
[illegible]	4	[illegible] 4 [illegible]	97[illegible]	4 17 [illegible]	Jan., [illegible]
[illegible]	[illegible]	[illegible]	7[illegible]	[illegible] 13 2	Jan., Dec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 14 2	Mar., [illegible]
[illegible]	4	[illegible]	[illegible]	[illegible] 17 9	Feb., Aug.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 11	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 6 6	May, Nov.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 3 1	July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 11 9	Feb., Aug.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 4	Jan., July
[illegible]	[illegible]	[illegible] 4 [illegible]	[illegible]	7 [illegible] 2	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 0	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 4 8	Mar., Aug.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 17 [illegible]	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	5 1 0	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 0 6	Mar., Sept.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 14 11	Mar., Sept.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 3 10	Apl., Oct.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 1[illegible] 7	Mar., Sept.

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Nov. 14	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6¾	6 5 6	Feb, Aug
5	7%	Do. do. Pref.	5 29/32	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	72½	6 4 7	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1¼	6 8 0	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6	5 16 8	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways and Tramways.			
St	5%	British Elec. Traction 5% Debs.	82½	6 1 3	Apl, Oct
St	6%	Do. 6% Cum. Pref.	77	7 15 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	65	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82½	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	74¼	5 7 6	Jan, July
St.	4%	City & S. London Deb.	67	5 19 1	May, Nov
St.	5%	Do. Pref. 1896	70½	7 1 4	Feb, Aug
10	1⅛%	London Electric Ry. Ord.	2 1/16	6 1 3	Jan, July
St.	4%	Do. 4% Pref.	62	6 9 0	Mar, Sept
St.	4%	Do. 4% Debs.	70¼	5 13 11	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	22½	4 6 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	59	5 18 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	57	6 2 10	Feb, Aug
St.	3½%	Do. 3½% A Debs.	61½	5 13 10	Jan, July
St.	3½%	Do. 3½% Debs.	64	5 9 5	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15⅛	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	69⅞	6 7 3	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105½	5 13 9	Jan, July
St.	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	68	5 17 8	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2 15/16	5 2 2	Apl, Oct
1	6%	Do. 6% Pref.	1 11/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1 13/32	4 19 7	Mar
100	5%	Do. Prior Lien Debs.	89½	5 11 9	Jan, July
1	6%	Do. 6% Pref.	15/16	6 8 0	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	11¾	7 8 11	Aug, Feb
[illegible]	3/0	Do. 6% Cum. Pref.	5 5/32	5 16 4	Jan. July
.	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅜	6 6 4	April
100	6%	Do. 6% Prior Lien Debs.	99	6 0 11	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	13	7 13 10	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A. £3 pd.	⅜	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1 3/32	6 17 2	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
10	6%	Do. 6% Pref.	9 15/16	6 0 9	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16 7/16	6 1 8	Feb, Aug
5	5%	Do. 4½% Cum. Pref.	4 3/16	5 7 6	..
St.	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	12 11/16	7 18 7	Feb, Aug
10	5%	Do. Pref.	7¾	6 9 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	36½	6 5 10	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	1 13/16	6 9 0	May, Aug
1	5%	Do. 5% Pref.	29/32	5 10 4	May, Aug
St	4%	Do. 1st Debs.	77½	5 3 3	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¾	4 10 2	June, Dec
St.	4⅛%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St.	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95½	6 5 8	Fb,My,Aug,N
St	1½%*	Do. Def. Ord.	23½	7 1 2	Fb,My,Aug,N
[illegible]	4%	Commercial Cable 4% Debs.	70¾	5 13 1	Ja, Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6¼	6 8 0	Ja,Ap,Jly,O
St.	8%	Eastern Tel. Co. Ord.	142	5 12 8	Ja,My,Jly,O
St.	3½%	Do. 3½% Pref.	64¾	5 8 4	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	75½	5 6 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	13 11/16	5 16 11	Ja,Ap,Jly,O
10	22%	Gt. Northern Tel. Co. With Coup. 11	37¾	5 16 7	Ja, My, Jly
25	13%	Indo-European	51¼	6 6 10	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2 13/16	3 11 1	April
1	7%	Do. 7% Pref.	2 5/16	3 0 6	July
10	⅜%	West India & Panama Ord.	1 1/16	3 10 6	May, Nov
10	6%	Do. 1st Pref.	7 11/16	7 16 1	May, Nov
10	8%	Western Telegh. Co.	14 13/16	5 7 2	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	76½	5 4 7	June, Dec
..	4½%	Western Union 50-yr. Bds.	99½	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	13/16	7 7 8	Nov
1	10%	Oriental Telephone Ord.	2¼	4 8 11	Apl, Oct
St.	4%	Do. Db. St.	78½	5 1 7	Jan, July
St	4½%	Teleph. Co. of Egypt Db. St.	83	5 8 5	Jan, July
[illegible]	8%	United River Plate Ord.	6 11/16	5 19 8	Apl, Oct
[illegible]	5%	Do. 5% Cum. Pref.	4 5/16	5 13 6	Jan, July
St.	4½%	Do. Deb. Stk.	80½	5 11 10	Jan, July
		Financial and Investment.			
1[illegible]	6%	Globe Teleph. & Trust	12¼	4 18 0	Sp,Dc,Mr,Jn
[illegible]	6%	Do. 6% Pf.	10¼	5 18 6	Sp,Dc,Mr,Jn
1[illegible]	5%	Mackay Companies' Common	65½	5 17 6	Ja,Apl,Jly,O
..	4%	Do. $100 Pref.	70	5 14 3	Ja Apl,Jly,O
100	6%	Submarine Cable Trust Cert.	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4 [illegible]	6 1 6	Mar, Sept
St	5%	Do. 5% Debs.	94½	5 5 10	Jun, Dec
10	6[illegible]	Bombay E.S. & T. 6% Pref.	10[illegible]	5 15 8	..
St.	4½%	Do. 4½% Debs.	83	5 8 5	Jan, July
[illegible]	9%	Calcutta E.S. Corp. Ord.	6 [illegible]	6 19 9	May, Nov.
5	5%	Do. 5% Pref.	4 [illegible]	5 16 0	Mar, Sep

* Plus 3/6 bonus. † Ex dividend or interest.

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NOTES.

War Savings Associations.

IN another column we give the substance of a letter we have received from the Committee for forming War Savings Associations, calling attention to the desirability of forming such bodies in every office, warehouse and business house in the City of London. We are quite in sympathy with this idea, and we feel that much good would result in extending some such movement to engineering and other works wherever the wages that are being paid are on a high scale. We believe that there are many cases in which the workers would be willing to save if they were given an easy means of doing so. The simplest method is for one or two of the staff to act as honorary treasurers to an investment fund, receiving contributions from the employés and investing them from time to time in Exchequer bonds or war-saving certificates. It is necessary to work out the details so as to provide for the possibility of an employé leaving any particular works and his receiving the amount which he has invested in such a case, but difficulties of this kind are not insuperable, as we know by experience, and the gain from the point of view of both the country and the workers may be very considerable.

Coal Loading Conveyors.

THE many conveyor installations at some of our principal ports may be taken as an indication that the conveyor lends itself admirably for the purpose of handling coal and minerals in considerable quantity. Elsewhere will be found descriptions of three installations which have obviously been designed with considerable care; in particular may be mentioned the equipment at Parkeston Quay, which is practically dust-proof, and which, therefore, may be used simultaneously with the embarkation of passengers and loading of cargo. From many points of view the conveyor is superior to the crane or hoist for the handling of coal. It imposes a reasonable load on the generating station, and is economical of current; it admits of a better utilisation of the land adjoining the docks, and it is an inexpensive machine both as regards first cost and cost of upkeep. The conveyor band at Middlesbrough, for example, is estimated to have a life corresponding to the handling of a million tons of coal. In normal times the cost of such a band would probably not exceed £300, so that the charge under this head per ton of coal handled amounts to about 0·07d. A further advantage of the conveyor, and one which will be appreciated by Harbour Boards, is the exceedingly simple character of the electric equipment. Although both the hoist and conveyor are largely used, and notwithstanding the fact that each possesses certain advantages, it is not unlikely that the solution of the coal-handling problem will necessitate the use of both appliances working in concert.

Welfare Work in Factories.

WE were glad to be present at a meeting of the Circle of Scientific and Technical Trades Journalists last week, when a Paper was read on "The Human Element in Factories," by Mr. B. S. ROWNTREE, Director of the Welfare Department, Ministry of Munitions. In our opinion, the importance of this subject cannot be over-estimated. The time has passed when men should be regarded merely as machines, and the sooner this point of view is thoroughly superseded the better for our national welfare, not only in times of war, but in times of peace, when a proper understanding between capital and labour will be essential. Of course, we need scarcely remark that enlightened employers have been in existence for a number of years, and have seen the desirability of work of this kind; but, nevertheless, there are many employers who have little or no belief in it, and it is only the calamity of war which has brought the whole question into prominence. Take, for example, the working of night shifts. How can efficient work be obtained or expected at night if there are no facilities for obtaining food? Yet even at Woolwich Arsenal the provision of food for night workers was left more or less to chance until taken up by voluntary effort. Considering the mutual distrust between capital and labour, it is not, perhaps, surprising that welfare work is looked upon with distrust by many of the workers. For this reason we are glad that Mr. ROWNTREE emphasised the fact that such work is not charity. It is merely part of the employer's duty to his employés, and as such he should not expect thanks for what he is doing. In our opinion, it behoves the employer to make the conditions of employment as satisfactory as he possibly can, and we hope that the present movement will be taken up so strongly by public opinion that those employers who do not see their duty in such matters will be compelled to follow the course of the more enlightened employer nevertheless.

The Effect of Daylight Saving.

In Mr. A. E. McKenzie's Address to the Manchester Local Section of the Institution of Electrical Engineers some interesting figures are given on the effect of the Summer Time Act on the Manchester electricity undertaking. It appears that an examination of four residential districts showed a saving of some 15 per cent. On the other hand, in some of the industrial and shopping districts there was an increase of some 8 per cent., which is not easy to understand unless the inhabitants of Manchester carried on their activities considerably later than usual on account of the more extended daylight. It is, of course, difficult to make accurate comparisons between one year and another in an undertaking which is continually growing, but it is estimated that the reduction in the lighting output in Manchester from the Stuart-street station for the period covered by the Act was equivalent to 1 per cent. of the total output, resulting in a saving of coal of about 600 tons. At the other Manchester stations the reduction amounted to 1¼ per cent., or a saving in coal of about 400 tons. In the case of smaller provincial stations depending very largely upon a lighting load, the decrease in the output may be much greater, as was shown in our last issue. Thus the decrease at Ealing was 23 per cent. It is clear that the saving in coal by this Act must have been considerable. On the other hand, it is obvious that the financial effect on many of the smaller electricity undertakings has been harmful and that some change in tariffs to meet this effect was almost inevitable. There has been, of course, an outcry on the part of the public where tariffs have been raised, but we think it should be realised that the Summer Time Act was passed not with a view to saving the public money but in order to save coal, and to enable the public to enjoy a larger measure of daylight. As such it has been eminently successful.

◆

The Late Silvanus P. Thompson. An exhibition and sale of water-colour sketches by the late Prof. Silvanus Thompson will take place at the Alpine Club, 23, Savile-row, London, W., from the 27th inst. to the 10th December. The exhibition will be open daily from 10 a.m. to 6 p.m., including Sundays.

Rapid Coaling at Cristobal. According to the "Panama Canal Record" the new coaling plant at Cristobal recently delivered 100 tons of coal to a ship in 38 minutes. The vessel came alongside the reloader wharf at 8.35 p.m., received 100 tons in her bunkers, and cleared at 9.13. Another ship received 50 tons in 3½ minutes.

Electrical Developments in Finland.—It is stated that a [illegible] is being formed in Esterbothnia [illegible] Finland to absorb all the small electrical con[illegible] and to erect a series of new large power [illegible]. [illegible] of the many waterfalls and extensive peat [illegible] electrical power will be generated [illegible].

Wiring Rules of the Institution of Electrical Engineers. [illegible] Electrical Society on November [illegible] the I.E.E. wiring rules was opened by Mr. H. [illegible] some of the recommendations [illegible] and [illegible] should be formed [illegible] to the [illegible].

Casting Steel in the Electric Furnace. In a Paper recently [illegible] American Foundrymen's Association Mr. T. S. [illegible] of a [illegible] Heroult furnace with [illegible] 22[illegible] and a similar 2-ton [illegible]. The author quoted some [illegible] produced in the electric [illegible] from the converter and open [illegible] per cent. of the ultimate tensile strength, and in the opinion of the author no tests on steel from the converter or open hearth, conducted in a similar simple manner and with steel of the same analysis, would equal these results.

War Savings Associations.—We have received a letter from Sir William Plender and Mr. E. Dexter, chairman and hon. secretary respectively of the Executive Committee for the formation of War Savings Associations.

The City Committee, under the presidency of the Lord Mayor, which is actively working with the object of getting war savings associations formed in every office, warehouse and business house in the City of London, whilst gratified with the number that have already been formed, recognises, nevertheless, that a great deal still remains to be done to bring this patriotic war savings movement prominently before everyone in the City.

The hope is expressed that none will refrain from joining associations on the ground that they can only contribute small sums. Finance is of vital importance in the prosecution of the war. It is, therefore, urged that those business houses in the City where war savings associations have not yet been formed, should at once communicate with the committee (at Scottish Provident Buildings, 3, Lombard-street, London, E.C.), where every information and every help will be given. The officials of existing associations, having found from their own experience how popular these associations are, have rendered invaluable help to the committee in suggesting and encouraging and helping in the formation of similar associations. In the City hundreds of such associations are already formed, and are working with most satisfactory results—proving that the members of same welcome the opportunity thus afforded them of taking their share in this great work. Inquiries from persons outside the City area should be addressed to their local central committee, or to the National War Savings Committee, Salisbury-square, Fleet-street, London, E.C.

OBITUARY.

John Gray Scott.—The death is announced of Prof. John Gray Scott, which occurred in Constantinople on the 12th July last as the result of electric shock.

In a communication from the President of the Robert College, Constantinople (Mr. C. S. Gates), it is stated that on the date in question the electric current was automatically cut off, and Prof. Scott went to the transformer station to see why it was interrupted. He was accompanied by a student to whom he gave some explanations. He closed the switch, which had opened, locked the door, dismissed the student and went away. About 20 minutes later he returned, opened the transformer station again and stepped in. At this station a current of 10,000 volts is received and transformed before sending it on to the College for lighting. In some inexplicable way he touched the live wire with his hand and received a shock which was instantly fatal. A servant heard a cry. Men ran to draw him out and worked to revive him, with the assistance of two American doctors, but there was no sign of life.

Prof. Scott was buried in the historic cemetery at Haidar Pasha (the Crimean Memorial Cemetery). He leaves a widow and a boy about 12 years. It will be remembered that the late Prof. Scott occupied the position of electrical engineer at, among other places, Leith and Croydon. He resigned his position at the last-named place in 1904 to become general manager and electrical engineer of the Hong Kong Electric Tramways Co. On the termination of that engagement, he returned to England, where he remained for some time, and subsequently proceeded to Constantinople to become professor of electrical and mechanical engineering at the Roberts College there.

Killed in Action.—The following are reported to have been killed in action or to have died of wounds:—

Capt. H. W. Trefusis (Northampton Regt.), aged 34, was killed on July 8. He was electrical engineer to the Borneo Company at Sarawak prior to the war.

Lieut. J. M'Gregor Hill (Northumberland Fus.) has died of wounds. He was a B.Sc. of Glasgow University, a master in a science school at Glasgow, and a son of Mr. John Hill, general secretary of the Boilermakers' Society.

Lieut. E. L. Barrow (S. Lancs Regt.), aged 27, was killed on Oct. 23. He was a B.Sc. of Victoria (Manchester) University, and was science master at secondary schools at Penzance and Luton prior to the war.

Sergt. S. Baron (K.R.R.), 21 years of age, has been killed in action. He was formerly an inspector on the Darwen tramways. Sergt. C. Clark (E. Lancs Regt.), formerly a Burnley tramway employee, and Sergt. R. Bennison (Loyal N. Lancs), a Bolton tramwayman, have also been killed in action.

PERSONAL.

Mr. Vernon Landop, general manager of the River Plate Electric Co., La Plata (Argentina), has been appointed local managing director to the Forestal Land, Timber and Railways Co. (Ltd.) Mr. Landop will continue to act as local director of the River Plate Electric Co.

At the invitation of the Cable Makers' Association, the post of Secretary, which became vacant by the death of the late Mr. A. H. Howard, has been accepted by Mr. Llewellyn B. Atkinson, M.I.E.E., A.M.Inst.C.E. Mr. Atkinson is a director of Messrs. W. T. Glover & Co. (Ltd.), and has for the past 13 years been closely associated with the work of the Cable Makers' Association, of which, in the year 1913, he was Chairman.

We understand that Capt. K. A. R. Smith, who, at the outbreak of war, was on the commercial staff of Edison Accumulators, has been awarded the Military Cross on the field for bravery. Before the war Capt. Smith held a commission in the volunteers for some years, and at the outbreak of hostilities he at once joined up with the fighting forces. Our congratulations to him and the Edison Company upon this award.

Mr. J. C. Mitchell (treasurer of the Underground Electric Railways Co. of London and Allied Companies) has been elected President of the Chartered Institute of Secretaries for the ensuing year.

Sapper (Corpl.) A. J. Towlson (London Field Company) has been presented with the Military Medal for executing a most important survey successfully under heavy fire. Sapper Towlson was up to the time of his enlistment (August 1914) a draughtsman in the employ of the India Rubber Company, Silvertown. He has been on service in France for the whole of the two years since he enlisted.

On the retirement of Mr. H. S. Styan, Mr. R. Meredith becomes chief engineer, Indian Government Telegraphs, and Mr. Sutherland, Deputy Director-General (Traffic).

Mr. G. P. Roy officiates as director, Indian Government Telegraphs (Engineering), Eastern Circle, vice Mr. Goodall, on leave.

Mr. H. J. Hawkins, formerly borough electrical engineer of Salford, has accepted an appointment at Karachi as chief engineer to a London firm.

At the new Birchills power station of the Walsall Borough Council, which we describe elsewhere, the position of Clerk of Works was held by Mr. Thomas Llewellyn, whose services on this work have been much valued.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the full time appointment of demonstrator in the department of electrical engineering and applied physics at the Northampton Polytechnic. Particulars and forms of application from the Principal, Dr. R. Mullineux Walmsley, St. John-street, Clerkenwell, London, E.C. *See advertisement.*

A capable engineer is wanted to take charge of an 8-hour shift in a Corporation power station in the Midlands with turbo-and reciprocating plant. Salary £140 per annum. *See an advertisement.*

Applications are invited for the position of chief engineering assistant in the Leeds electricity department at a salary of £350 per annum. Applications to the manager, Mr. C. Nelson Hefford, 1, Whitehall-road, Leeds, by 10 a.m. of Saturday, Dec. 9. *See an advertisement.*

A secretary is required for the Aeronautical Society of Great Britain. Salary £200. Applications to the Chairman of the Council, 11, Adam-street, Adelphi, London, W.C.

A London electric supply company advertises for an assistant engineer to take charge of a watch at one of its stations.

Mr. H. L. Cottam, of Colchester, has been appointed electrical engineer of the Horsham Council electricity works, at £220 per annum.

Wigan Corporation have appointed Mr. Robt. Owen, deputy city electrical engineer of Leeds, to the position of borough electrical engineer at a salary of £550 per annum, with house, lighting and fuel, or at a salary of £600 without house, light and fuel. There were 106 candidates for the position and this number was reduced to eight who were selected for interview by the Electricity Committee.

INSTITUTIONS AND SOCIETIES.

Association of Mining Electrical Engineers.—The Midland Branch of the Association of Mining Electrical Engineers held its first meeting at University College, Nottingham, on the 18th inst. Mr. A. R. Davis was elected President, and Mr. E. R. Hudson Hon. Secretary and Treasurer. It was announced that Mr. R. A. Sheldon had been awarded a prize for his Paper on "Electricity as a Haulage and Winding Power in Mines." A discussion on a Paper by Mr. Thomas Anderson on "Some Electrical Troubles and their Remedies" then took place.

Royal Society. At the meeting of the Society held yesterday the following Papers, among others, were read: "The Corrosion and Electrical Properties of Steels," by Sir Robert Hadfield, F.R.S., and Dr. E. Newbery; "The Scattering of Plane Electric Waves by Spheres," by T. J. I'a. Bromwich, F.R.S.; and "Numerical Results of the Theory of the Diffraction of a Plane Electromagnetic Wave by a Perfectly Conducting Sphere," by Messrs. J. Proudman, A. T. Doodson and G. Kennedy. A special general meeting was also held to receive the annual report of the Council.

The King has approved of the following awards this year by the President and Council of the Royal Society: A Royal medal to Dr. John Scott Haldane, F.R.S., for his services to chemical physiology, more especially in reference to the chemical changes of respiration; a Royal medal to Prof. Hector Munro Macdonald, F.R.S., for his contributions to mathematical physics.

The following awards have also been made by the President and Council: The Copley medal to Sir James Dewar, F.R.S., for his investigations in physical chemistry, and more especially his researches on the liquefaction of gases; the Rumford medal to Prof. William Henry Bragg, F.R.S., for his researches in X-ray radiation; the Davy medal to M. le Prof. Henri Louis le Chatelier, For. Mem. R.S., for his researches in chemistry; the Darwin medal to Prof. Yves Delage, for his researches in zoology and botany; the Sylvester medal to M. Jean Gaston Darboux, For. Mem. R.S., for his contributions to mathematical science; and the Hughes medal to Prof. Elihu Thomson, for his researches in experimental electricity.

Indian Science Congress.—The fourth annual meeting of the Indian Science Congress will be held at Bangalore in January next, possibly in the hall of the Indian Institute of Science, and the dates mentioned are the 10th, 11th, 12th and 13th.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 24th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington. Papers "On the Measurement of the Thomson Effect in Wires," by Mr. H. R. Nettleton; and "On the Thermo-electric Properties of Fused Metals," by Messrs. C. R. Darling and A. W. Grace.

MONDAY, Nov. 27th.

ROYAL SOCIETY OF ARTS.

5 p.m. At John-street, Adelphi, W.C. Howard Lecture on "Coal and Its Economic Utilization," by Prof. J. S. S. Brame (Lecture I.).

TUESDAY, Nov. 28th.

MANCHESTER LOCAL SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. At the Engineers' Club, Manchester. Paper on "The Parallel Operation of Electric Power Stations," by Mr. J. S. Peck.

WEDNESDAY, Nov. 29th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, W.C. Paper on "The Internal Combustion Engine," by Dr. Dugald Clerk, F.R.S.

THURSDAY, Nov. 30th.

GREENOCK ELECTRICAL SOCIETY.

7.45 p.m. At Masonic Rooms, 22, West Stewart-street, Greenock. Paper on "What is Electricity?" by Mr. J. L. Hogg.

1st LONDON ENGINEER VOLUNTEERS.

Headquarters: Chester House, Eccleston Place.
Officer Commanding: Lieut.-Col. C. B. CLAY, V.D.
Orders for the week:—

Officer for the week: Platoon Commander W. J. A. Watkins.

Next for duty: Platoon Commander H. de P. Birkett.

Monday, November 27th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class Recruits' Drill, 6.25-8. Lecture on Telephones, 7.30.

Tuesday, November 28th.—School of Arms, 6-7. Lecture 7.15, "Entrenching," Company Commander Castell.

Wednesday, November 29th.—Instructional Class, 6.15. Platoon Drill, Platoon No. 1.

Thursday, November 30th. Platoon Drill, Platoon No. 5 and 6. Ambulance Class by M.O., 6.

Friday, December 1st.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill, 6.25-8.25. Lecture on Telephones, 7.30.

Saturday, December 2nd.—N.C.O.'s Class, 2.30, Company Commander Bentley.

Sunday, December 3rd.—Entrenching at Otford, parade Victoria (S.E. & C. Railway Booking Office), 8.45 a.m. Uniform, Haversacks, Water Bottles. Mid-day ration to be carried. Railway vouchers will be provided.

Musketry. For all Companies, see Notice and Tables A and B at Headquarters.

NOTE.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

INSPECTION.—The Inspection by the County Commandant is unavoidably postponed for a few days.

THE PARALLEL OPERATION OF ELECTRIC POWER STATIONS.*

BY JOHN S. PECK.

The possibility of linking up electric power stations has often been considered, but it is only recently that the full advantages have been generally appreciated and that the problem has been attacked along broad lines. It is not proposed in this Paper to discuss the commercial questions involved in linking up, but to point out some of the engineering problems and to indicate what types of apparatus are available and the conditions under which they may be used.

Fortunately the great majority of stations in this country generate three-phase current at 50 periods, so that the problem of interconnecting is relatively simple. The problem of linking up systems of different frequencies is much more complicated than that of linking up systems of the same frequency, and each particular case requires careful consideration to determine the best method to adopt.

Alternators in Parallel.

When two alternating current generators having the same number of poles and the same rating are operated in parallel, they must, of course, run at exactly the same speed, and, if they are to divide the load equally, it is essential that the two engines (or turbines) driving them should have the same speed regulation—*i.e.*, the same drop in speed from no load to full load. Any two machines may be made to divide the load in any desired proportion by proper adjustment of the steam supply, while adjustments of the field rheostats simply cause wattless currents to flow between the generators. The effect of this current is to strengthen the field of the under-excited generator and to weaken that of the over-excited generator; thus the voltage across the two remains equal.

The operation of two or more stations in parallel is similar to the operation of two single generators in parallel, except for the fact that the interconnecting line possesses inductance and resistance. For all ordinary cases the resistance and inductance may be neglected, but the matter is treated in a general way in Appendix 1.

Stations of the Same Frequency, Voltage and Phase.

When the stations have the same frequency, voltage, and phase, the only interconnecting link required is a cable with the necessary switches, &c., for connecting together the 'bus bars of the two stations. It frequently happens, however, that the voltages of the two stations are not exactly equal, and it may be required to vary the voltage of either station independently of that of the other. For this reason it is desirable to have some form of voltage regulator in at least one of the stations, otherwise, when voltage adjustments are attempted, heavy wattless currents will flow between the stations and the voltages on the two systems will remain equal, except for the difference due to the drop of pressure in the cable.

The regulator may be either of the step-by-step or of the induction type.

In order to determine the sizes of cable, transformers and regulator required to interconnect two systems, it is necessary to know the maximum load which will have to be transmitted between them, and as this is the most important feature in parallel operation it will be considered in some detail.

It will be assumed first that the speed regulation of the two systems is adjusted so that each will carry its proper proportion of the total load on both systems. This is a justifiable assumption since the [illegible] can generally be adjusted to give approximately [illegible] conditions.

With [illegible] A and B, the following cases will be considered:

1. A and B of equal capacity.
   Unequal loads on the two stations.
2. A of greater capacity than B.
   Load on B greater than its proportion of the total capacity of the stations.
   Load on B less than its proportion of the total capacity of the stations.

1. LOAD ON INTERCONNECTOR BETWEEN TWO STATIONS OF EQUAL CAPACITY AND SAME SPEED REGULATION.

When A and B [illegible] and must run in synchronism [illegible]. Therefore, if the load on B's [illegible] A [illegible] half the difference will [illegible] and the [illegible] feeder must [illegible].

2. LOAD ON INTERCONNECTOR BETWEEN TWO STATIONS OF UNEQUAL CAPACITY BUT SAME SPEED REGULATION.

This case may be [illegible] except that instead of the total load [illegible] the two stations will be divided in proportion to their capacities. Knowing the load on the 'bus bars and on the generators of each system, the load on the interconnector is known at once.

It is evident that if the load conditions are known, it is a very simple matter to calculate the load on the interconnecting line. If the loads are steady the engine governors may be adjusted by hand to give the minimum or any other desired load on the interconnector, but where violent fluctuations occur manual adjustments of the governor are impossible, and account must be taken of this fact when designing the interconnecting line.

Where the engine governors of two systems are set for different speed regulations, they will divide the total load not in proportion to their generating capacities, but in direct proportion to their ratings and in inverse proportion to their speed regulation, assuming a straight line speed drop. Thus, if station A has a rated capacity of 10,000 kw. and B 5,000 kw., while A drops 2 per cent. and B 4 per cent. in speed from no load to full load, the two stations will share the total load in the proportion of (10/5) × (4/2) = 4—*i.e.*, A will deliver four times the load of B. If the regulations of A is 4 per cent. and that of B 2 per cent., then the proportion would be (10/5) × (2/4) = 1, *i.e.*, the two stations would deliver equal loads. This would be a very dangerous condition, as B would be heavily overloaded before full load was reached on A. This simply confirms what is well known in operating machines in parallel—namely, that when the regulation cannot be made equal on two machines, the larger one should have the closer regulation.

Thus, it is a simple matter to determine the distribution of load between two stations in parallel, provided the operating conditions and the speed regulation are known. The same methods may be used where there are several stations in parallel, and as soon as the loads on the different stations have been determined the load on the different interconnectors may be found.

In the above considerations it has been assumed that the drop in engine speed is proportional to the load, but, as a rule, the regulation curve is not exactly a straight line. Nevertheless, the distribution of load, as calculated by the methods given above, is sufficiently close for all practical purposes. In the actual parallel operation of alternators in a station, the loads are seldom divided exactly in proportion to the ratings of the different machines, but shift from one set to another with variations in the external load, depending on the governor adjustments. This causes, however, no trouble in the station as long as the sets share their loads properly at the full output of the station, and hand adjustment of the governors is necessary from time to time. In the operation of stations in parallel exactly the same problems are involved, and there should be no more trouble than in operating different generators in the same station in parallel provided that the interconnecting link is made of sufficient capacity to take care of any discrepancies in load adjustments due to governor peculiarities.

It is, of course, possible that in certain cases an automatic regulator could be used for adjusting the governor valves according to the load on the interconnector, but this is a refinement which is not likely to be required, as satisfactory operation can almost always be obtained without such a device.

Earthed Neutrals.

It is becoming standard practice in all large generating stations to earth the neutral point of the system. Where the 'bus bars of two earthed systems are directly coupled together there may be heavy high frequency currents flowing through earth between the stations, and these currents may cause trouble in telephone and telegraph circuits. There are several ways of overcoming this difficulty:—

(*a*) One station only may be earthed. In this case arrangements could be made so that when the interconnector is opened the unearthed system would be earthed.

(*b*) An insulated earth cable could be run from one system to the earth on the other system—*i.e.*, both systems would have a common earthed point.

(*c*) Transformers could be inserted in the interconnecting line.

(*d*) Reactances or resistances could be placed in the earth connection to limit the earth currents to a negligible value.

Stations of the Same Frequency, but of Different Voltage or Phase.

Where the stations are of the same frequency, but of different phase or voltage, it is necessary to introduce transformers into the interconnector. The voltage and phase transformation is made, where such is required, in the same transformers.

Fig. 1 shows the diagram of connections used for the transformers of a 4,000 kw. interconnector between two stations in London, one generating 2,200 volts two-phase and the other 11,000 volts three-phase. For varying the voltage between the two stations step-by step regulators are used. A drum-type oil-immersed regulator is used for changing from tap to tap.

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* [illegible]

Apart from the introduction of transformers, the operating conditions for stations having different voltages or phases are exactly the same as when the stations have the same voltage and phase, except where it is required to link up a single-phase system with a two or three-phase system. If it is desired to distribute the load equally on all phases of the three-phase or two-phase system, rotating apparatus is required. This may take the form of a motor-generator or of what is known as a phase converter. Several designs of phase converters have been proposed, but they all utilise the well-known fact that if one phase of a two or three-phase machine be supplied with current and the rotor be brought up to speed, then two-phase or three-phase current can be supplied from the four or three terminals of the motor.

This type of converting plant is used on the Norfolk and Western Railway in America for converting the single-phase trolley current into three-phase current for the motors on the locomotives. When running down grade the three-phase motors regenerate and supply single-phase current to the trolley through the converter. Similar plant is being installed in the sub-stations of a single-phase railway system for converting from three-phase to single-phase for supplying the trolley circuit.

STATIONS OF DIFFERENT FREQUENCIES.

When two stations of different frequencies are to be linked up it is necessary to use a frequency changer of the rotating type. This will usually take the form of a motor-generator, but in certain cases where continuous-current is required it may be advantageous to use a rotary converter for changing from one frequency to continuous-current, and another to change from continuous current to the other frequency. Under this condition it is, of course, possible to use both rotary converters for supplying continuous-current load from the two different systems. This condition will be considered later on.

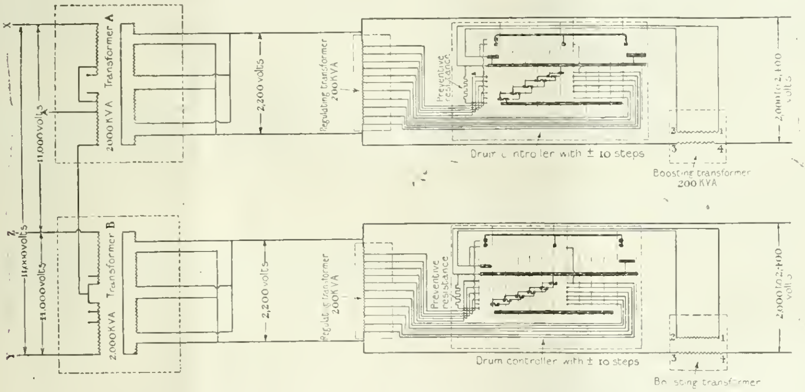

FIG. 1.—DIAGRAM OF CONNECTIONS OF TRANSFORMERS AND REGULATORS IN 4,000-KW. INTERCONNECTOR BETWEEN 2,200-VOLT TWO-PHASE SYSTEM AND 11,000-VOLT THREE-PHASE SYSTEM IN LONDON.

The motor-generator for frequency transformation may be either of the following two types :—

Synchronous motor and synchronous generator—called "synchronous motor-generator."

Induction motor and synchronous generator—called "induction motor-generator."

Each set has certain advantages and disadvantages.

SYNCHRONOUS MOTOR-GENERATOR.

Since each machine of the set must run in synchronism with the system to which it is connected, the two systems must run at speeds which are definitely fixed with reference to each other. In other words, the two systems are locked together through the motor-generator, which acts as a perfectly rigid coupling, and it is the strength of this coupling with reference to the loads likely to be thrown on it which requires careful consideration in all cases.

Since the synchronous set locks the two systems in step, the transfer of energy from one system to the other will be governed by the same conditions as when the systems are of the same frequency and paralleled by a direct cable connection. Thus the loads likely to be thrown on the converting set may be calculated in the same way as described above for systems of the same frequency.

Advantages of Synchronous Set.—(1) It is reversible and can supply energy in either direction without change from the normal speed ratio. (2) The motoring machine can be run at unity power factor, or even with a leading power factor, and thus assist in improving the power factor of the system. The generating machine may be run with an over-excited field, and so reduce the lagging current carried by other generators on the system.

Disadvantages.—(1) The set, acting as a rigid coupling, forces the two systems to run at a fixed speed ratio, and is therefore subject to heavy overloads under certain conditions. (2) Each machine must be synchronised with its own system, an operation requiring some skill, especially with certain ratios between the numbers of poles. (3) Where two motor-generators are operated in parallel, special arrangements are required in order to synchronise an unloaded set with one under load.

INDUCTION MOTOR-GENERATOR.

The induction motor-generator set may be likened to a slipping coupling between two prime movers, where the amount of slip depends on the load transmitted so that they are not required to operate at exactly the same speed.

The simplest way of understanding the working of the induction set is to take a concrete example. Assume two stations A and B, as in Fig. 2. Let the capacity of A be 10,000 kw., that of B 5,000 kw., and that of the motor-generator 1,000 kw. Assume the speed regulation of A and B to be each equal to 2 per cent., and the slip of the induction motor at full load to be 2 per cent. If there is no load on either station, and they are each running at normal speed, the set will run at synchronous speed and will transmit no load. If a load of 5,000 kw. is put on B's 'bus bars, the speed of B will tend to drop 2 per cent., and if it is assumed that A keeps its no-load speed, 1,000 kw. will be transmitted through the motor-generator. But the load on A through the motor-generator will cause the speed of A to drop slightly, and since the load on B is now reduced by the amount supplied by A, the speed of B will not be reduced by quite 2 per cent., and the slip of the motor-generator being less than 2 per cent., it will transmit less than 1,000 kw. To be exact it will be 770 kw. A method for determining the exact load on the frequency changer under different conditions will be found in Appendix II. If the load be increased to 10,000 kw, the drop in speed of B will be doubled, and the motor-generator will transmit approximately 1,600 kw., &c.

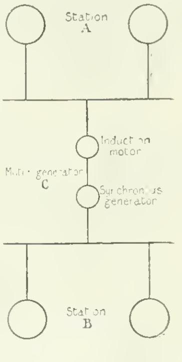

FIG. 2.

If with B giving a load of 5,000 kw., and the motor-generator transmitting 770 kw., the load on A be gradually increased, the speed of A will fall, and the load transmitted from A to B will be reduced until when the speeds of the two sets have dropped by the same percentage there will be no energy transmitted through the motor-generator.

As is well known, an induction motor will act as a generator if it is driven at a speed above the synchronous speed of the system to which it is connected. The load it will deliver as a generator when running at a certain speed above synchronism is the same as the load it will deliver as a motor when running with the same drop below synchronism. If, when motoring, full output requires 2 per cent. slip, then, when generating, full output will be obtained at 2 per cent. above synchronous speed.

Returning now to Fig. 2, if A and B are running without load and the motor at synchronous speed, and a load of 10,000 kw. is put on A's bus-bars, the speed of A will tend to drop 2 per cent. with reference to B's speed. This means that the induction machine is running approximately 2 per cent. above synchronism, since its speed is always fixed by B. It would, therefore, supply 1,000 kw. if B's speed remained constant. But a load of 1,000 kw. on B will cause its speed to drop 0·4 per cent., while the reduced load on A will mean less than 2 per cent. drop, so that the set will not be running 2 per cent. above synchronism, but something less than 2 − 0·4 = 1·6 per cent. Thus, it will deliver somewhat less than 800 kw. The exact distribution of load between the two stations may be calculated from the formulæ in Appendix II., but it is easily approximated with a degree of accuracy quite sufficient for practical purposes.

Advantages of Induction Motor-Generator.—(1) It is a flexible link, and permits a small set to be used between two large systems. (2) It is easier to start and put into operation. (3) By using an adjustable secondary resistance, it is possible manually to control over a considerable range the amount of energy transmitted by the set, though this involves a certain loss in efficiency.

Disadvantages.—(1) A comparatively large difference in speed between the two systems is required in order that it may transfer its rated output from one to the other. This large difference in speed often limits the induction set to transmitting in one direction only. (2) The induction machine requires a considerable lagging current, and no power factor control is possible on this machine without introducing some form of phase advancer.

The great advantages which the synchronous set possesses, of permitting power-factor control and of transmitting energy in either direction without change in speed ratio between the two systems, make it desirable to use the synchronous set in preference to the induction set whenever possible. The great danger in its adoption is the possibility of overloading it and pulling it out of step.

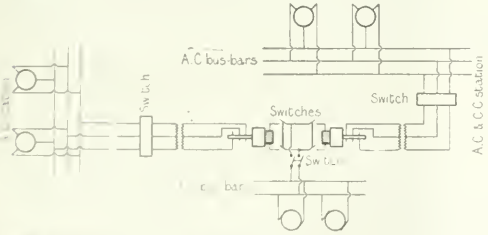

Fig. 3.—A Method of Interconnecting an A.C. System with a Combined A.C. and C.C. System.

In general, a synchronous set should not be used unless its capacity is reasonably large with reference to the smaller of the two stations which it couples together; just what this relation should be depends upon a number of conditions. Where the stations are large and the changes in load comparatively small and not very sudden, it would probably be satisfactory to use a synchronous set having a rated capacity of as low as 20 per cent. of the capacity of the smaller station. Under less favourable conditions it might not be advisable to use a capacity less than 40 to 50 per cent. of that of the smaller station. If the rating of the synchronous set is as small as 20 per cent. of the capacity of the smaller station overload protection must be provided and [illegible] may be expected.

With the induction set there is practically no limit as to size; for, no matter how small the set, the slip of the induction machine may be made large enough to prevent serious overloading, but it must be remembered that the greater the slip the greater is the variation of speed ratio required to obtain a given transfer of energy between the two systems.

INTERCONNECTION THROUGH ROTARY CONVERTERS.

It will [illegible] [illegible] that under certain circumstances it [illegible] [illegible] [illegible] two systems of different frequency [illegible] rotary converters. In general, this is only commercially [illegible] where continuous current is required at at least one of the stations. Fig. 3 shows two alternating-current stations of different frequency [illegible] [illegible] [illegible]. From the continuous-current [illegible] of the two [illegible] [illegible] [illegible] is taken to the [illegible] [illegible] [illegible] the stations. With this arrangement it is possible to [illegible] the continuous-current bus-bars from either or both [illegible] [illegible], or to supply alternating current from the [illegible] [illegible] [illegible] to either or both stations, [illegible] [illegible] [illegible] continuous current from [illegible] [illegible] [illegible].

When rotary converters are used the transfer of energy from one station to the other does not depend upon the speed of the generators, but is controlled by manipulating the voltage of the rotary converters, and means must be provided for accomplishing this result. This may be done by synchronous boosters or by transformer tappings, but, in general, reactance control will permit sufficient voltage variation to give the desired results.

In many large continuous-current stations extensions are made at present with turbo plant. Where the units are of considerable size it is customary to use a high-speed turbine and to gear it to a moderate speed continuous-current generator, or else to use a high-speed turbo-alternator and to convert to continuous current through a rotary converter. The latter arrangement offers a ready means of linking up with an alternating-current station should it ever be desired to do so.

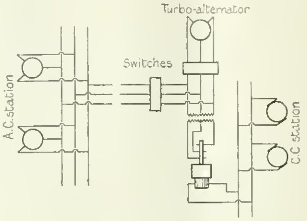

Fig. 4.—A Method of Interconnecting A.C. and C.C. Systems.

With an arrangement such as that shown in Fig. 4 it is evident that there are a large number of possibilities with regard to linking up alternating and continuous-current stations.

PRACTICAL EXAMPLES.

It is common practice to operate electro-hydraulic systems of the same frequency in parallel, and on the Continent and in America many large transmission networks are supplied from stations located long distances apart. In Great Britain an increasing number of systems of the same frequency are being operated in parallel, but there has been very little done towards linking up systems of different frequencies.

In South Wales a 40-cycle system is operating in parallel with a 50-cycle system through two 500-kw. induction motor-generators. One set has a 40-cycle induction motor and a 50-cycle synchronous generator. The other has a 50-cycle induction motor and a 40-cycle synchronous generator. These sets have worked very well in service, except that the heavy wattless currents taken by the induction motors limit the output of the stations and cables. A synchronous condenser is being installed which may work on either system. There are probably other cases with which the author is not familiar.

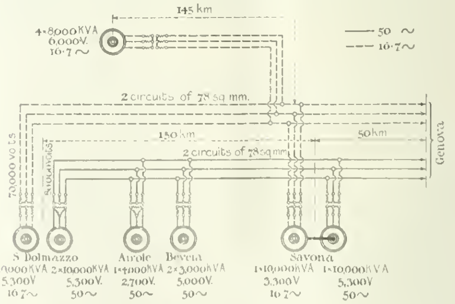

Fig. 5.—System of the Società Elettrica Riviera di Ponente (Ing. . Negri).

In France and in Italy there are some large systems of different frequencies connected through motor generators, and the author gives particulars of a very interesting installation at Savona, Italy, where a synchronous set is used for linking up two very large systems—one of 16⅔ periods and the other of 50 periods. The synchronous set consists of two 10,000 k.v.a. generators, one having two poles and giving a frequency of 16⅔ cycles, and the other 6 poles and giving a frequency of 50 cycles. Fig. 5 shows a diagram of connections, from which the magnitude of the system may be seen.

In this case the two machines are coupled to a steam turbine. The original plan was to use the set for feeding either or both systems, but as coal is now at an almost prohibitive price in Italy, the set does excellent service as a frequency changer.

SUMMARY.

1. Polyphase systems of the same frequency may be connected together directly or through transformers, and operated in parallel without difficulty, but where each station supplies its own customers it is desirable to have some form of voltage regulator to permit independent control of the voltage of each station. If the stations are located in the neighbourhood of telephone or telegraph circuits, are connected solidly, and have earthed neutrals, provision must be made to prevent high-frequency currents flowing through earth between the stations.

2. To interconnect a polyphase and a single-phase system of the same frequency a rotating machine of the phase-converter type or a motor-generator is required if the polyphase system is to be symmetrically loaded.

3. Systems of different frequencies may be interconnected through frequency changers, sets consisting of two synchronous machines or of one synchronous and one induction machine. The synchronous set is usually the more desirable, since it permits power-factor control and transmits energy in either direction without a change in the speed ratio between the two systems. It is, however, somewhat more difficult to operate, and to prevent danger from overloading it should have a fairly large capacity with reference to the smaller of the two stations which it interconnects. The induction set is much more flexible, and a small set can be used between two large systems, but it requires a considerable difference in speed ratio between the two systems for transmitting full load, and the induction machine takes wattless current from the system to which it is connected.

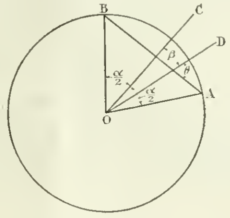

FIG. 6.

4. In certain cases where continuous current is required the rotary converter may be used with advantage as an interconnector between two stations of different frequencies, or between an alternating and a continuous-current system.

APPENDIX I.—THE EFFECT OF RESISTANCE AND REACTANCE UPON THE PARALLEL OPERATION OF ALTERNATING-CURRENT GENERATORS.

In a Paper entitled "Current-limiting Reactances in Large Power Stations,"* the effect on parallel operation of two alternators by inserting reactance between them was considered.

Where two stations are connected by a cable of considerable length the question of its resistance upon parallel operation must also be taken into account. The following treatment, though very incomplete, will serve to show the general effect of resistance upon the parallel operation of two generators or two generating stations.

In Fig. 6, let OA and OB represent the induced voltages of the two generators, assumed to be equal;

α the angle of displacement;

AB the resultant voltage due to displacement;

OC the direction of the cross current with reactance only in circuit;

OD the direction of the cross-current with reactance and ohmic resistance in circuit;

φ the angle between OD and the voltage AB which produces it;

R the resistance in the interconnecting circuit and in the generators;

$L\omega$ the reactance in the interconnecting circuit and in the generators.

Then,
$$AB = 2OA \sin(\alpha/2).$$
$$\text{Cross current} = \frac{2OA \sin(\alpha/2)}{\sqrt{(R^2+L^2\omega^2)}}.$$

Total synchronising power
$$= \frac{2(OA)^2 \sin(\alpha/2)}{\sqrt{(R^2+L^2\omega^2)}}[\cos(\alpha/2-\beta) - \cos(\alpha/2+\beta)].$$
$$= 2(OA^2/R)\sin(\alpha/2)\cos\alpha\,[2\cos(\alpha/2)\cos\beta].$$

But $\beta = (\pi/2-\varphi)$.

Therefore, total synchronising power
$$= [2(OA^2/R)\sin(\alpha/2)\cos(\alpha/2)\cos\varphi\sin\varphi]2,$$
$$= (OA^2/R)\sin\alpha\sin(2\varphi).$$
$$= (OA^2/R)\sin\alpha\,\frac{2L\omega}{\sqrt{(R^2+L^2\omega^2)}}\cdot\frac{R}{\sqrt{(R^2+L^2\omega^2)}}$$
$$= 2(OA)^2\sin\alpha\,\frac{L\omega}{R^2+L^2\omega^2}.$$

From these equations the following is apparent:—

1. The synchronising torque has a maximum value when $\alpha = 90$ deg. This, then, is the critical angle of displacement, as any further displacement will cause the machine to drop out of step.

2. For any value of α the synchronising torque is a maximum when $R=0$.

3. Without reactance there can be no synchronising torque.

4. For any value of R the synchronising torque is a maximum when $\sin(2\varphi)=90$ deg., or $\varphi=45$ deg.—*i.e.*, when $R=L\omega$.

5. Where R is small as compared with $L\omega$, its effect on the synchronising torque is negligible. Thus, if $L=100$ per cent. and $R=25$ per cent., the synchronising torque is decreased only about 3 per cent. If R is increased to 50 per cent., the synchronising torque is decreased only about 12 per cent.

The conclusions are, that, for any value of resistance likely to be found in practice, its effect may be neglected.

APPENDIX II.—METHOD OF CALCULATING THE LOAD ON AN INDUCTION SYNCHRONOUS FREQUENCY CHANGER.

Let a, b and c represent the rated outputs of A, B and C respectively (Fig. 2).

p_a, p_b represent the drop in speed (as a fraction of drop when supplying full load) for A and B.

p_c represent the slip of C (as a fraction of full-load slip).

L represent external load on B's 'bus bars.

Assume, first, that A and B have the same drop in speed when delivering full load, and that this drop in speed equals the slip on C for full load.

Then, neglecting losses,
$$L = bp_b + ap_a, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
and
$$c(p_b - p_a) = ap_a \text{ or } cp_b = p_a(a+c). \quad . \quad . \quad . \quad . \quad . \quad (2)$$

From these equations the loads on A, B and C may be calculated.

Assume $a=10{,}000$ kw., $b=5{,}000$ kw., $c=1{,}000$ kw., and $L=5{,}000$ kw. From (1) we have

$5{,}000 = 5{,}000\,p_b + 10{,}000\,p_a$; and from (2)

$1{,}000\,p_b = p_a(10{,}000+1{,}000)$, from which is obtained

$p_a = 0{\cdot}0769$ $\quad ap_a = 769$ kw. = load on C.

$p_b = 0{\cdot}846$ $\quad bp_b = 4{,}230$ kw. = load on B.

If A and B have different speed regulations and C has a slip different from the speed drop of A and B, the same formulæ may be used by assuming the regulation of one station (B, for example) as a standard, and increasing or decreasing the ratings of A and C in proportion as their slip is less or greater than that of B.

For example, assume the speed regulation of B to be 3 per cent.
" " " A to be 2 per cent.
" slip of C to be 4 per cent.

Then the loads will be distributed as though speed drops were all equal, and as though the rating of A were $10{,}000 \times (3/2) = 15{,}000$ kw., and that of C were $1{,}000 \times (3/4) = 750$ kw. Therefore, assume

$$a = 15{,}000, \quad b = 5{,}000, \quad c = 750.$$

From (1) $\quad 5{,}000 = 5{,}000\,p_b + 15{,}000\,p_a$.

From (2) $\quad 750\,p_b = p_a(15{,}000+750)$.

From which is obtained

$p_a = 0{\cdot}0416$; $\;15{,}000 \times 0{\cdot}0416 = 625$ kw. = load on C.

$p_b = 0{\cdot}875$; $\;5{,}000 \times 0{\cdot}875 = 4{,}375$ kw. = load on B.

If there is a load on the 'bus bars of both stations, then the station which would have the smaller drop in speed for the load connected to its 'bus bars should be taken, and the load on the other station determined for the same drop of speed. The difference between the actual load on the 'bus bars and the calculated load is that which must be distributed between the two stations, and the load on the frequency-changer may be calculated according to the methods given above.

For example, take the conditions assumed in the last example, except that there is a load of 5,000 kw. on A's 'bus bars as well as 5,000 kw. on B's 'bus bars.

Now, 5,000 kw. on A gives a speed drop of 1 per cent. and a drop of 1 per cent. in speed gives a load of 1,666 kw. on B. Therefore, the load which must be divided between the two stations is 5,000 − 1,666 = 3,333 kw.

All of the above examples assume a straight-line speed curve, and the same no-load speed on both stations.

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* "Journal" I.E.E., 1914, Vol. LII., p. 520.

COAL-LOADING CONVEYORS.

Summary.—Descriptions are given of modern electrically-driven coal loading conveyors, one of which has a capacity of 700 tons an hour, and another is capable of delivering 200 tons an hour.

The principal methods in use in America for the handling of considerable quantities of coal and ore have been very fully described in these columns during the last 18 months.* It is the purpose of this article briefly to describe a number of typical conveyor equipments which are giving satisfactory service at home ports.

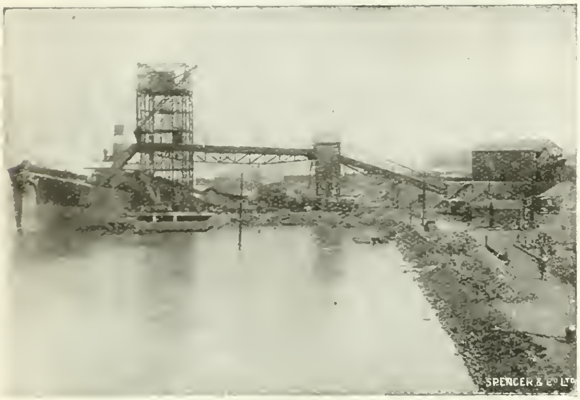

Fig. 1.—Coal-loading Plant at Port Talbot Docks.

In the valuable discussion which followed the reading of Messrs. W. Dixon and G. H. Baxter's Paper† on "Modern Electrical Dock Equipment, with Special Reference to Electrically-operated Coal-loading," Mr. Roger T. Smith stated that the conveyor possessed the following advantages over the hoist for the shipment of coal:

(i.) That for the same output, the initial cost of the conveyor is from a quarter to half the initial cost of the hoist;

(ii.) That the load-factor at which the machine works is 80 to 90 per cent., because the maximum load is the same as the average load;

(iii.) That there is a greatly reduced weight on the tower supporting the free end of the conveyor (which rises and falls) as compared with the weight of the hoist, thus lessening the cost of foundations or the cost of the jetty, if a jetty is necessary;

(iv.) There is a possible saving in land for sidings, because instead of all the sidings having to come end-on, as is necessary for the hoist, they are much better arranged parallel to the quay; and

(v.) There is an enormous reduction in the maximum demand on the power supply.

To these may be added:—

(vi.) The electrical machinery and control gear are of a more simple character for the conveyor than for the hoist.

The simple character of the electrical apparatus for a conveyor is an advantage that will be appreciated by those having but little knowledge of electrical machinery.

The three equipments described below were designed, constructed and erected by Messrs. Spencer & Co. (Ltd.), of Melksham, who are well known as specialists in this class of manufacture, having built many plants of the kind to the order of railway and dock companies at home and abroad.

Coal-Loading Plant for Port Talbot Railway and Docks Co.

In order to cope successfully with the present demand for shipping coal without delay and in a proper and unbroken condition, the Port Talbot Railway & Docks Company have installed at their docks a complete plant capable of dealing with 700 tons of coal per hour.

The plant, which is illustrated in Figs. 1 to 3, consists essentially of an inclined, troughed band conveyor, about 207 ft. long by 42 in. wide, carried on a fixed steel girder and a hinged jib towards the water side. The conveyor delivers to vessels by means of a telescopic shoot, provided at its outer extremity with a revolving lip. This arrangement gives adaptability to all sizes of craft and to the rise and fall of the vessels, and whilst obviating breakage of the coal by gentle action in its transit, also reduces to a very great extent the necessity of trimming the cargo.

The conveyor is fed at the shore end from a large steel hopper beneath the rail level (Fig. 3). The contents of the railway wagons are emptied into this receiving hopper by means of a double set of patent hydraulic tipping gear with two hinged rising and falling cradles, so that the wagons need not be turned, no matter which end the delivery door may be on arrival of the truck at the point of discharge. A series of gratings is provided in the hopper for the elimination of fine coal and dust, which is taken by subsidiary shoots to an elevator delivering to railway wagons on another set of rails. The prevention of breakage to the coal during handling being such an important point, several features for this purpose have been introduced in the design of this

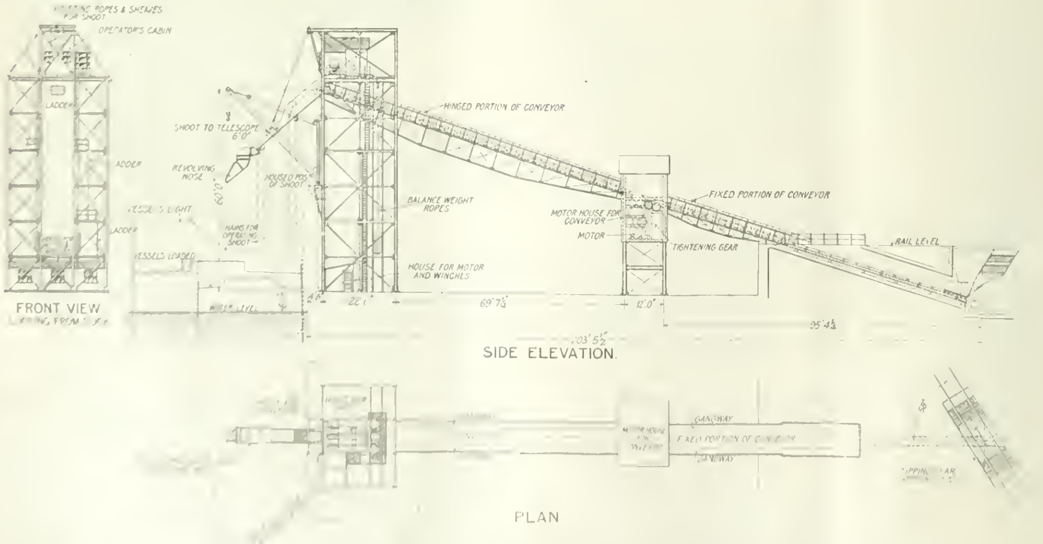

Fig. 2.—General Arrangement of Coaling Plant at Port Talbot, Capacity 700 Tons per Hour.

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* The Electrician, Vol. LXXV., pp. 575 and 617, and Vol. LXXVII., p. 843.

† Proceedings, Inst. Mechanical Engineers, 1911.

plant. Notably we may mention the device for spreading aside of the rails over the receiving hopper when tipping a truck, in order to secure an unobstructed area at the hopper top; also the provision of a steel plate apron at the hinged end of the wagon-cradle and working with it so that a continuous surface is formed from the level of the wagon floor, down which the coal may slide easily into the hopper.

The plant is driven by electrical power, the motor and driving gear being situated in a house between the fixed and hinged portions of the conveyor, and the leading-out operations are controlled from the driver's cabin erected above the steel structure upon the edge of the quay.

Coaling Plant at Parkeston Quay.

The loading-out plant at Parkeston Quay has been installed in order that the coaling of the Royal Mail and Cargo Steamships owned by the Great Eastern Railway Company might be carried on more expeditiously and economically than has hitherto been the case. It embodies several features of interest, and as it was desired to avoid delay, that coaling operations might proceed simultaneously with the embarkation of passengers and loading of goods, the necessity for eliminating all dust and noise, as far as possible, was added to the usual points to be considered in mechanical coal handling, involving extra care and expense with various details.

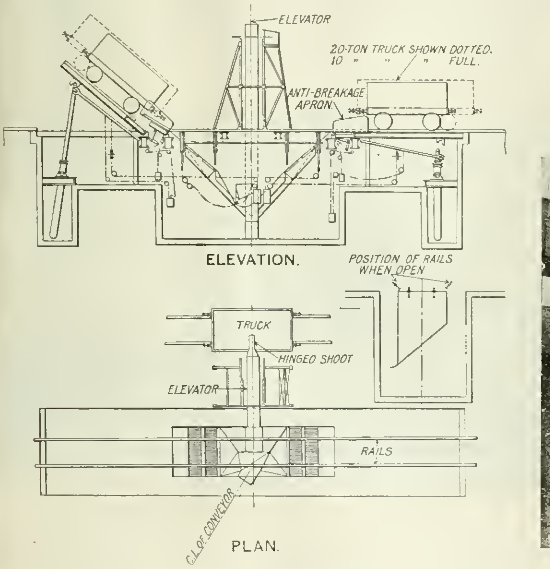

Fig. 3.—Details of Tipping Gear and Hopper Pit.

As will be seen from Figs. 4 and 5, the plant consists essentially of a truck-tipping apparatus over a receiving hopper which feeds a system of band conveyors and delivery shoots to the bunkers of the vessels It is capable of continuously delivering coal at a total rate of 200 tons per hour or 100 tons per hour at each of the two end loading-out stations. This enables two steamers berthed alongside the quay to be coaled at the same time.

The tippler is of the "Huntley" side-tipping type, constructed to deal with railway wagons up to 20 tons capacity, at the rate of 12 trucks per hour. Each truck to be emptied is run on to a partially-balanced cradle and is then lifted on its side, its contents falling through a grid of coarse mesh into the receiving hopper. This cradle is operated by an electrically driven hoist, with magnetic brake and requisite control switches. The whole of this apparatus is protected from the weather by a suitable steel-framed housing.

The intake hopper is provided with two outlets, each having an adjustable door and a shaking jigger, the latter driven by eccentrics actuated by a variable-speed electric motor.

The two longitudinal conveyors are fed from the before-mentioned outlets of the hopper and have centres of their terminal shafts about 250 ft. and 420 ft. respectively. They are of the endless troughed-band type, the belts being 30 in. wide, and are fitted with the requisite driving gears and appliances for adjusting the tension of the belts. The two cross conveyors receive the coal from the longitudinal conveyors and deliver it to the end loading-out stations. They are of similar type to the above-named conveyors, provided with driving and tension gears and each about 115 ft. centres. These four conveyors are all enclosed in suitable steel-framed gantries, supported on steel trestles, and covered with galvanised sheeting. The gantries are fitted with dust-tight flooring and the necessary glazed and framed windows, doors and ladders. At the points where the longitudinal and cross conveyors connect two junction houses are arranged which contain the electric motors, and the requisite driving and speed-reduction gearing for actuating the conveyors.

The two-end loading-out stations each consist of a steel-framed structure, well braced and trussed, supporting the outer ends of the cross gantries and containing the attendant's cabin from which the operations of coaling are controlled. The loading-out jibs are attached to the above structures with massive trunnion bearings and swivelling post, so that the jibs have both horizontal and vertical movements.

Each jib is fitted with a troughed-band conveyor (of similar style to the others), about 42 ft. centres, enclosed in steel-plate casing for weather protection with access doors. The slewing and vertical motions are performed by means of steel wire ropes with suitably geared and electrically-driven winches. At the outer end of the jib a swivelling steel shoot is provided; this is carried in a circular ball bearing for horizontal rotary movement and is also pivoted so as to be capable of being raised or lowered as needed. The jibs have been designed with this amount of flexibility so as to avoid altering the steamer's position after she has been properly berthed, and that the bunkers may be supplied at any state of tide or varying depths of the vessel's water line. To obviate any obstruction, the jibs are, when not in use, housed clear of the quay edge.

Weighing-out of the bunker coal is done by two "Blake-Denison" continuous weighing and recording machines, situated near the feeding points over each cross conveyor.

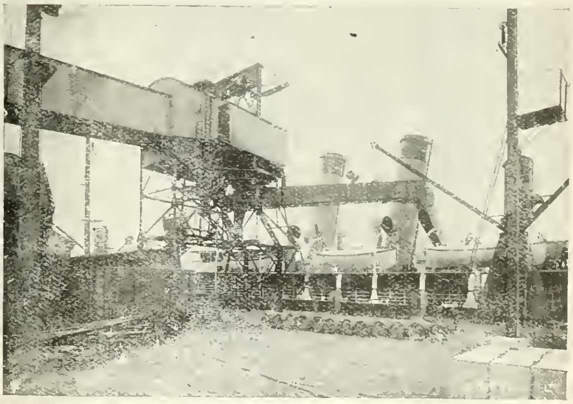

Fig. 4.—Coal-loading Conveyors at Parkeston Quay.

The appliances for distribution of the electrical power are all suitable for 220-volt continuous current circuit, and include all the necessary starting and control gear and switches.

Belt Coal-Conveyor at Middlesbrough.

A belt conveyor of an interesting type was put into service some time ago for shipping coal at the dock point on the north side of the North Eastern Railway Company's dock estate at Middlesbrough. In this installation, which is illustrated in Figs. 6 and 7, a coal-carrying band 42 in. broad and 310 ft. long travels up a long incline fixed at an angle of about 20 deg. to the ground level. It is fed from a hopper constructed in the embankment and under the railway line, which hopper is capable of holding about 30 tons of coal. The feed on the band is regulated by means of a screw throttle door manipulated from the rail level. The coal is made to fall gently on to the band and is carried smoothly up to the delivery end of the machine. The coal-laden band is supported by a number of closely-spaced sets of curving rolls, the breadth of band thus forming an arc of a circle having a radius of 3 ft. 4 in.

A continually-revolving brush in length equal to the breadth of the band is placed in contact with the band immediately the stream of coal has been delivered into the hinged shoot and loading jib. The band now brushed clean again assumes the flat shape on the returning or bottom side, and soon after leaving the brush it is led round two large pulleys, its path while doing so forming an irregularly shaped S. The

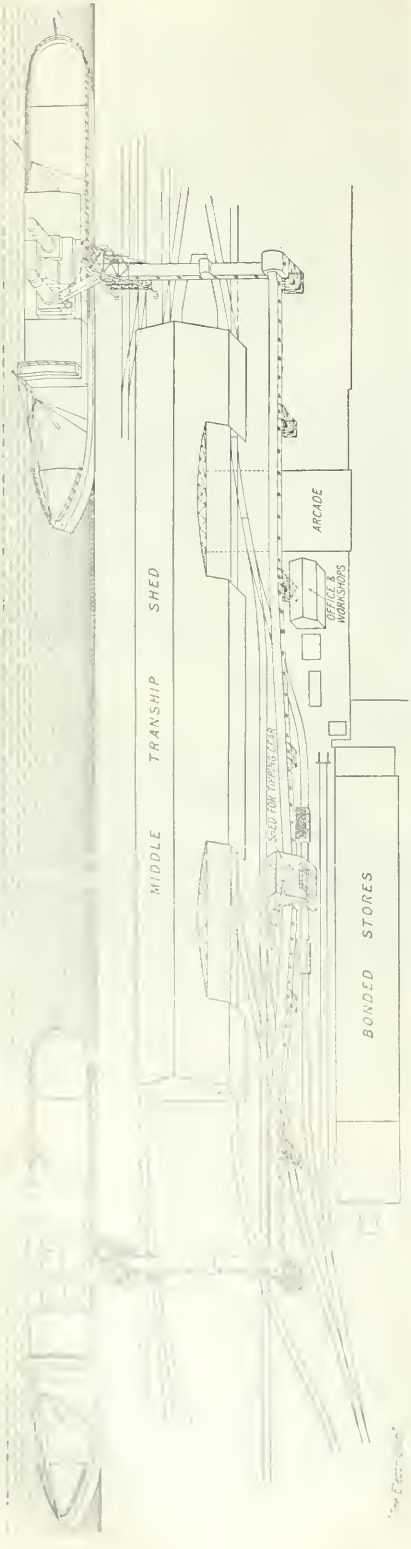

Fig. 5.—General Arrangement of Coaling Conveyors at Parkeston Quay, G.E. Railway.

object of this is to give the band with its load such a firm grip as to ensure that no slipping is possible during the running. Numerous sets of return rolls are spaced along the entire length to the feeding end of the belt in the hopper. Should the band at any time tend to run otherwise than centrally, such tendency is at once corrected by means of the sets of guide edge idlers, which are fixed at, and almost in contact with, the band edges.

As with continuous working, the band will get slack and sag in time. Provision has been made for effectively taking up this slack by means of a tension gear which has a large range. The band itself is of the composite kind. Its life is computed at two years' continuous running under full load or the equivalent endurance load of having carried 1,000,000 tons of coal. A line of guard plates is fixed along each side of the band to prevent any coal from falling off or being blown off by high wind. The whole is roofed in by radial-shaped galvanised sheets extending from the tunnel in the embankment to the entrance of machinery room in the tower.

This band is driven by a shunt-wound direct-current motor running at a speed of 750 revs. per min. with a voltage of 400. The loading jib which receives the stream of coal from the band through hinged connecting shoots is carried at the inner end by two trunnions resting in cast-iron brackets, which in turn are bolted to a pivoted frame. At a distance equal to about three parts of its length, the jib, which weighs 17 tons, is supported by a transverse steel bridle, in the centre of which is carried a cast-iron sheave. Through this sheave is rove the hoisting wire rope, which is led up to a set of sheaves in the bonnet or topmost structure, and is thence taken downward and attached to the cast-iron hoist drum. This drum shaft also carries a worm, which gears with a worm-wheel on to which the hoist motor is directly connected. The motor is a series-wound machine of 10 B.H.P. running at a speed of 550 revs. per min. The bridle also carries two stout wire ropes, attached one on each side of the sheave, which are led up to the bonnet in the same way as the hoisting rope, and which, after passing round sets of guide sheaves, have each a line of 22 counterbalance weights attached. When the jib is lowered right down into the lowest position the lines of weights are all in direct counterbalance and the lowest balance weight of the line is attached to a gudgeon pin or dead end. In the process of hoisting the jib, the weights are automatically passed over one by one from the direct line of counterpoise to the line of the dead end by which they are supported. As the hoisting proceeds and the weights are taken up by the dead end the line of weights on each side of the structure gradually assume the U shape or festoon form, until, when the jib is housed and almost perpendicular, only two weights a side remain in direct counterbalance. Thus, at whatever point in the arc described during the travel of the jib there is always the correct number of weights in direct counterbalance, the others being suspended from the dead end. The jib has also a lateral travel of 12 deg. each side of the centre line allowed for by the pivoted frame and limited by an ingenious arrangement of wire guy ropes. This is necessary to meet the fore and aft ranging of the ship taking in the coal, cargo or bunker.

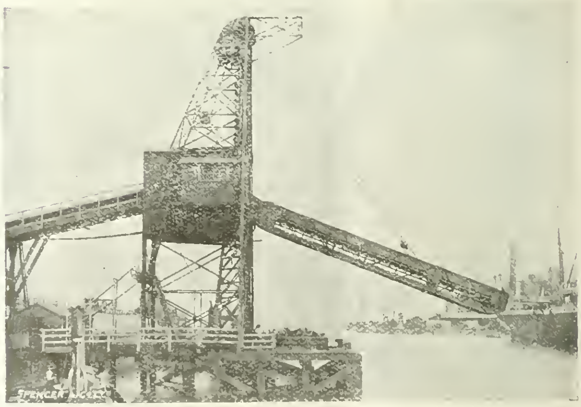

Fig. 6.—Coal-loading Plant at Middlesbrough.

The highest position of the jib at which coal can be shipped is 18 deg. above the horizontal. The coal is conveyed by means of an endless belt of steel plates or trays running the whole length of the jib, 54 ft. centres, driven by means of a friction clutch on the main shaft in the tower, and operated from the driver's cabin in the structure. From this position the driver controls the whole of the operations, electrical and mechanical, the handles for which are all grouped within easy reach, whilst from the cabin window he can watch and guide the movements of the jib. When the jib is sufficiently low for the stream of coal to fall down it, there is, of course, no need to run the belt of steel trays. At the extreme end of the jib another throttle door is fitted to limit the opening for coal. It also is controlled by a single wire rope from the driver's cabin. The whole of the running parts of the mechanism are lubricated by Stauffer cups and grease with only one or two exceptions. It is claimed that the whole equipment requires no more for its safe and efficient control than a man of average intelligence exercising ordinary care.

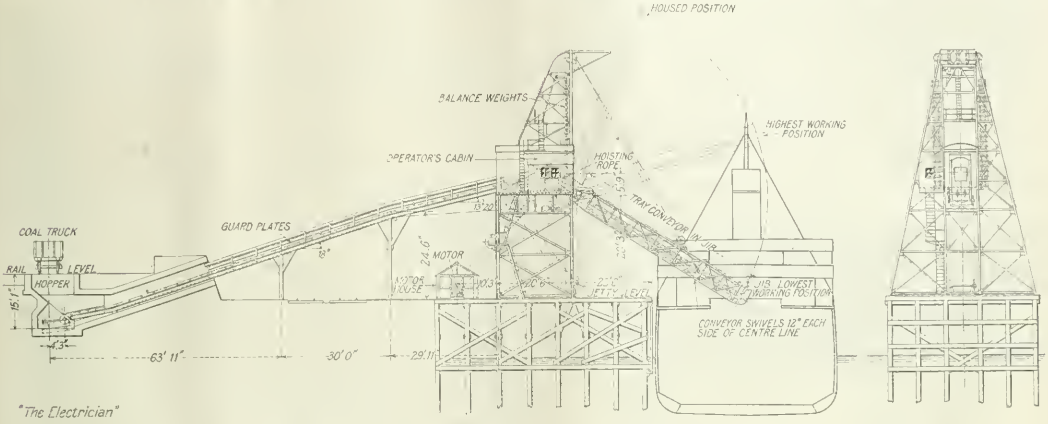

Fig. 7.—General Arrangement of Coaling Plant at Middlesbrough.

THE STANDARDISATION OF SWITCHGEAR AND INSTRUMENT CONNECTIONS.

BY CHARLES C. GARRARD.

It is very desirable that an agreement be secured at a very early date as to the proper authority for issuing, and the validity of, British Engineering Standard Specifications. The specifications issued by the British Engineering Standards Committee naturally carry great weight, and it is reasonable to expect that buyers outside Great Britain will regard them as being issued with authority, and as being accepted by British manufacturers.

This is, however, not always the case, the adoption and use of the specifications being quite voluntary. Moreover, in some cases they are not agreed to by the representative manufacturers' associations concerned. It would doubtless tend to make matters clearer if with each specification a list of associations, institutions, &c., were given who had agreed to work to the specification in question, in a similar manner to the list which was issued of the fire insurance offices who had accepted the Wiring Rules of the Institution of Electrical Engineers. This difficulty has been intensified in the case of electrical machinery by the fact that the manufacturers (*i.e.*, the British Electrical and Allied Manufacturers' Association) have issued their own standardisation rules, which differ from the E.S.C. Specification No. 72 dealing with the same subject. The general circulation of these two sets of quasi-official rules will cause very great confusion, and is to be regretted.

In the following article several points in connection with the standardisation of switchgear and instruments are dealt with, and if the suggestions made are found to be acceptable it is suggested that they be embodied in the revised standardisation rules as and when issued.

Three-phase Connections.

Everybody who has had experience with three-phase switchboards knows that if extreme care be not taken in laying out and making the connections it is extremely difficult to trace through the various cables and wires, this being especially the case with the secondary connections of the instrument transformers. The Standardisation Rules laid down by the B.E.A.M.A. have dealt with this matter to a certain extent, and the following is a résumé of their requirements with sundry developments, which follow directly from the regulations in question.

Colouring of 'Bus Bars on Three-phase Boards.

To be coloured red, white (or yellow) and blue. Red and blue to be on the outside.

Horizontal 'Bus Bars or Connections.—Red phase on top, or the bar farthest away, as viewed by the operator from the main control position.

Vertical 'Bus Bars or Connections.—Red phase to the left or the bar farthest away as viewed by the operator from the main control position.

Connections to 'Bus Bars.—If of bare copper, to be painted same colour as the 'bus bars to which they are connected.

Fine Wiring or Cable Directly Connected to 'Bus Bars.—These should be coloured to correspond with the 'bus bars along their entire length.

Fine Wiring Secondary (Low-tension) Connections of Current Transformers.—These must be coloured to correspond with the 'bus bar to which they are connected, but as it is possible to reverse one phase by reversing the secondary current transformer connections it is necessary to distinguish between the two. This can be done as follows: The wire connected to the (so called) low-tension positive terminal (marked t_1) shall be coloured the same as the 'bus bar to which the transformer is connected (say, red). The wire connected to the negative (t_0) low-tension terminal shall be coloured with two colours (in alternate daubs)—viz., the 'bus-bar colour and white (in this case red and white).

Fine Wiring Secondary (Low-tension) Connections to Potential Transformers.—The primaries of potential transformers are generally connected across phases; thus the primary connections should be coloured the same as the respective 'bus bars to which they are connected.

The low-tension (secondary) connections will also be coloured to correspond with the high-tension winding. Thus, if T_1 be connected to the red phase, then t_1 would be coloured red, and so on.

CONNECTIONS OF 'BUS BARS TO ALTERNATOR.

The respective 'bus bars must be connected to the machine so that the phase relationship of the currents in the 'bus bars bear a definite relation to each other. This requirement is not specified in the B.E.A.M.A. rules, but the obviously correct method is to arrange that the direction of phase rotation should be red—white—blue That is to say, that the voltage of the red phase should first rise to a maximum, to be followed (1/150th of a second afterwards if the periodicity be 50) by the white phase, and then by the blue phase, and so on.

It is very desirable that the terminals of the alternator should also be marked red, white and blue, the phase rotation of the alternator being the same, and then the red terminal could always be connected to the red bar, and so on. Putting aside for the moment the possibility of this, it should, however, be always possible to at least arrange that the phase rotation of the 'bus bars should be as stated above, and it would be desirable for the B.E.A.M.A. Rules regarding 'bus bars to have this additional requirement incorporated in them.

Markings of Terminals of Three-phase Alternator.—In accordance with the B.E.A.M.A. Rules, the three terminals are marked A, B, C (the neutral if brought out N); the order of phase progression must be in the order A-B-C.

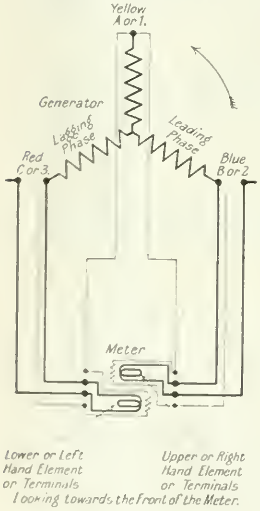
Yellow
A or 1.
Generator
Lagging Phase
Leading Phase
Red
C or 3
Blue
B or 2
Meter
Lower or Left Hand Element or Terminals
Upper or Right Hand Element or Terminals
Looking towards the Front of the Meter.

FIG. 1.—NATIONAL PHYSICAL LABORATORY CONVENTION FOR MAKING AND TESTING OF THREE-PHASE METERS. (From E.S.C. Report 37, revised August, 1915, page 18.)

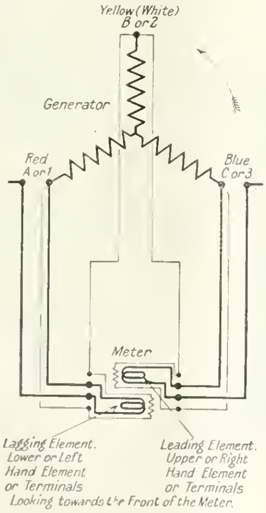
Yellow (White)
B or 2
Generator
Red
A or 1
Blue
C or 3
Meter
Lagging Element.
Lower or Left Hand Element or Terminals
Leading Element.
Upper or Right Hand Element or Terminals
Looking towards the Front of the Meter.

FIG. 2.—SUGGESTED MODIFICATION OF THE NATIONAL PHYSICAL LABORATORY THREE PHASE WATTMETER CONVENTION.

THREE-PHASE WATTMETER CONNECTIONS.

These should be made in accordance with the National Physical Laboratory Convention, given on p. 18 of E.S.C. Specification No. 37, revised August, 1915, (*see* Fig. 1). In considering the diagram it must be borne in mind that it is intended to represent the generator winding rotating in respect to the field poles in the direction indicated by the arrow Thus, the voltage will come to a maximum in the red phase, then in the yellow phase (*i.e.*, after 1/150th of a second if the periodicity be 50) and then in the blue phase, and then again in the red phase Thus the phase progression is in the order red—white—blue The blue phase lags 240 deg. after the red phase, or leads 120 deg on it which, of course, amounts to the same thing

Referring to Fig 1 it will be seen that the A terminal is marked yellow (white), the B terminal blue, and the C terminal red The order of phase progression is A—B—C, *i.e.*, yellow—blue—red—yellow—blue—red, which is the same as red—yellow—blue, as suggested above for the 'bus bars. It will be recognised, however, that if the terminals of the alternator are to be coloured it is essential that the red terminal of the alternator should be connected to the red 'bus bar, and so on, otherwise confusion will result. If this cannot be done it would be much better not to colour the alternator terminals at all, but simply retain the markings, A, B, C, and allow the connections to the 'bus bars to be made as may be convenient, only insisting that the phase progression should not be reversed.

For the sake of simplicity, however, there is very much to recommend the arrangement of colouring the alternator terminals, so that like colours shall always be connected together. If this be agreed it would be very desirable to slightly alter the N.P.L. Convention, and call the red terminal A (or 1), the yellow terminal B (or 2), and the blue terminal C (or 3) (*see* Fig. 2).

This would not alter the diagram in any essential, and the author would recommend this action being taken. The actual cable connections between the alternator and the switchboard would not cause any difficulty if this course be decided upon.

Before leaving the subject of the N.P.L. wattmeter Con-Convention (Fig. 1) it might be as well to explain that the chief need of a general agreement to work to is due to the errors to which three-phase meters are liable if used with different phase relationships between their elements to those with which they were adjusted. The next paragraph will explain this.

EFFECT OF ALTERATION OF DIRECTION OF PHASE ROTATION ON ACCURACY OF THREE-PHASE METERS.

We are here considering three-phase meters operating on the 2 wattmeter principle, and consisting of two elements connected as in Fig. 1. If the meter were a perfect one, accurate on all power factors, &c., it would not matter how it was connected up as long as the two current coils were in two phases with the corresponding shunt coils connected from these two phases respectively to the third phase. Meters, however, are, as a rule, not perfect, and especially are liable to vary in their constant with the power factor of the load and according to whether the current lags or leads on the voltage. It is the function of the manufacturer to strike a happy mean between these various sources of error, and to secure as unvarying a constant as possible.

Referring now to Fig. 1 and assuming, for the moment, that the load is non-inductive, it is clear that in spite of this, there will be a difference in phase between the current in the main meter coils and the voltage applied to the corresponding shunt coils. Taking the upper or right-hand meter element the current in its main coil (the load being non-inductive) will lead 30 deg. on the voltage applied to its shunt coil. On the other hand, taking the lower or left-hand meter element the current will lag 30 deg. (the load being non-inductive) on the voltage applied to its shunt coil terminals. When adjusting the meter care is taken that these phase relationships are adhered to.

It will be clear, however, that if the meter be connected up with the phase-rotation reversed the current in the upper or right-hand element will lag on its voltage instead of lead, with consequent liability that the constant of the meter will be somewhat different to that to which the meter has been adjusted in the test room. Care must be taken to guard against this by connecting the meter exactly according to the diagram in Fig. 1.

Another source of error guarded against by connecting up with correct phase rotation is that due to inter-action between the two meter elements. Theoretically both elements should be without effect upon each other, and meter manufacturers strive to attain this ideal, which has the great practical advantage of allowing a three phase meter to be tested on single-phase current, each element separately. Actually, however, the ideal is seldom reached, and in practice one element will slightly influence the other. In order that the effect may be the same in actual work as on the test bench it is necessary to connect up with the same phase rotation in both cases.

THE USE OF INSTRUMENT TRANSFORMERS WITH WATT-HOUR METERS.

Paragraph *h* of Appendix I. of the E.S.C. specification No. 37 for Electricity Meters (revised August, 1915) reads as follows (page 23):—

(*h*) *Additional Apparatus Connected to Transformers.*—" *The connection to the secondary windings of transformers, of trip coils, ammeters, and similar apparatus in series with the meter coils is liable to affect the rate of registration of meters and is undesirable. When the practice is unavoidable the meter should be tested and adjusted with all such apparatus connected in circuit, under the same conditions which will prevail in practice.*"

The wording of this requirement cannot be regarded as other than unfortunate, as it discourages progress towards the goal of interchangeable meters and transformers, the attainment of which has been a guiding principle for years with many engineers, more especially with those engaged in the construction of high-voltage switchboards. There can be no doubt that the multiplication of instrument transformers on high-voltage switchboards is a bad practice from the all-important point of view of reliability of supply. In the early stages of development of instrument transformers with high voltage work it was common to provide each instrument with its own transformer; the resulting panels were very complicated. Best practice now requires that each panel should have a single current-transformer, which shall be of sufficient capacity to work all the instruments in series. The very many instances where this has been done with success show that this arrangement is a satisfactory one. It is, of course, understood that the transformers must be suitable for their duty. It is very probable that the E.S. Committee have been induced to word their requirement as the result of their experience with poorly designed transformers. In the author's opinion, therefore, it would have been better to have limited the paragraph given above to the requirement that:—

" *The meter should be tested and adjusted with all such apparatus, or the equivalent thereof, connected in circuit under the same conditions which will prevail in practice.*"

This condition is reasonable, especially in view of the fact that as yet no standards of accuracy of current transformers as regards errors of ratio and phase angle have been set up. The words " or the equivalent thereof " are inserted to avoid the necessity of having all the actual instruments on the test bench. It is quite sufficient if equivalent coils are used.

SUGGESTED NEW WORDING OF PARAGRAPH (*h*).

Page 23 of E.S.C. Specification 37. (Appendix I.)

The objections above mentioned would be met if this paragraph were altered to read as follows:—

(*h*) *Additional Apparatus Connected to Current Transformers.* " *The connection to the secondary windings of current transformers, of trip coils, ammeters and similar additional apparatus in series with the meter coils is liable to affect the rate of registration of meters, and for this reason the meter should be tested and adjusted with all such apparatus, or its equivalent, in circuit.*"

USE OF POTENTIAL TRANSFORMERS.

It has been tacitly assumed in the foregoing that the remarks referred to in the E.S.C. Specification No. 37 apply only to current transformers. This assumption is supported by the fact that the paragraph refers to " apparatus in series with the meter coils." This could only have reference to current transformers. The wording of the specification is, however, not clear, and a definite statement of the requirements is very desirable. In the author's opinion it is not necessary to specify that the meters shall be tested connected to their potential transformers. The manufacture of potential transformers has nowadays become so perfect that the errors introduced by them in watt-meters are extremely small; for example, the phase displacement should not exceed about $\frac{1}{4}$ deg., and the ratio error may be reduced to a negligible amount by accurate adjustment. The error (at 0·5 power factor), if not allowed for, of a phase displacement of $\frac{1}{4}$ deg. is only 0·76 per cent. The subject of watt-meters, which are fed from both current and potential transformers, will be dealt with in a later article.

NEW ELECTRICITY WORKS AT WALSALL.

The electricity undertaking at Walsall, until comparatively recently, was one of the few examples of the " Oxford System." In 1910-11, however, a three-phase system was developed, and in 1913 Mr. E. M. Lacey reported in favour of the erection of a new station at Birchills, on the Wyrley and Essington Canal, generation and transmission being at 6,600 volts, three-phase, with rotary convertors at the sub-stations. In 1914 Mr. H. A. Howie was appointed Borough Electrical Engineer, and the proposed scheme has now been brought to a stage of completion.

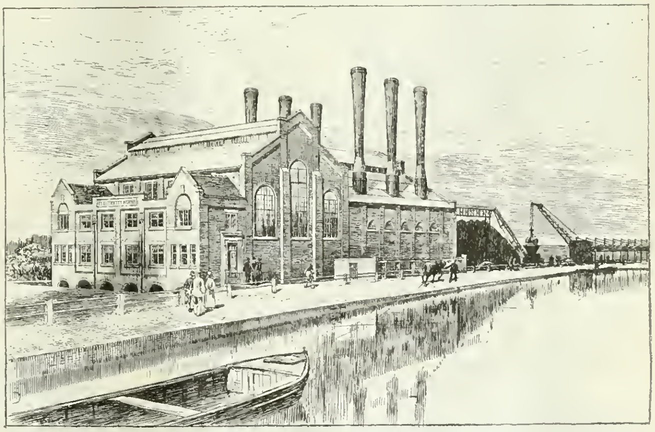

FIG. 1.—VIEW OF BIRCHILLS POWER STATION.

The number of units sold per annum at present approaches 4,000,000, and the average cost per unit, including capital charges, would be about 1·8d. in normal times. The increase in the demand for electricity has been very encouraging and it is confidently anticipated that with a new generating station, having every advantage of position and design for economical production, it will be possible so to arrange the tariff of charges that there will be a rapid increase in the demand for electricity for all purposes.

The buildings of the new power station comprise boiler house, engine house, switch annexe, tank room, and lavatory block. The buildings are constructed in steel and brickwork, the walls being faced externally with red pressed bricks. The general arrangement is seen in Figs. 1, 2 and 4

The coal-handling plant consists of a jib crane by means of which the coal is carried from canal barges to the receiving hopper of a bucket conveyer. This conveyer is so arranged that coal can be transported from the receiving hopper to any part of a large storage yard, and from any part of the storage yard to the overhead boiler house bunkers, or it can be transported direct from the receiving hopper to these bunkers if required. From the overhead bunkers the coal passes through measuring drums with recording counters, and bifurcated chutes to the hoppers of the automatic stokers.

The boiler house is designed for the accommodation of six boiler units, four of which have been erected. Each boiler unit comprises a water-tube boiler with integral superheater, a super-imposed economiser, induced draught plant, a steel chimney of the Venturi type and a chain grate stoker. Fig. 5 shows one of these units, which is now recognised as having very marked advantages over the type in which the economiser is separate from the boiler. The whole of the coal-handling plant, boilers, economisers, mechanical stokers and pipework, were supplied by Messrs. Babcock & Wilcox.

Each boiler unit is designed for a normal evaporation of 26,000 lbs. of water per hour, from a feed temperature of 100°F., entering the economiser, to steam of 185 lbs. per square inch pressure, and a total temperature of 636°F. On high duty each boiler unit will raise 30,000 lbs. of steam per hour. The above duties are based on the use of South Staffordshire unwashed slack of an average calorific value of 11,000 B.Th.U's. per lb. as fired.

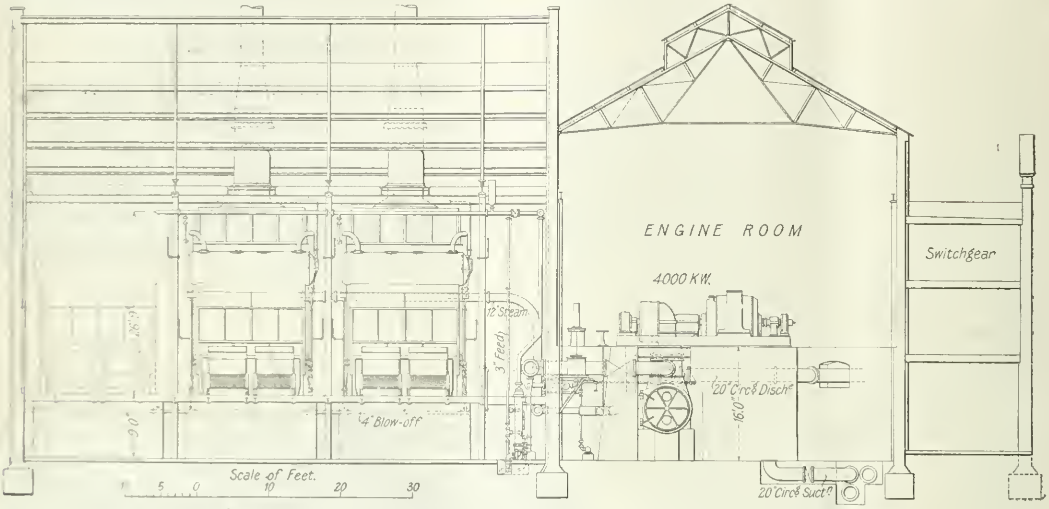

Fig. 2.—Cross-section through Engine Room and Longitudinal Section through Boiler House.

The feed pumps are of the centrifugal type, direct driven by steam turbines, exhausting into a boiler feed heater, and were built by Messrs. G. & J. Weir, Ltd. Each of the two pumps is capable of delivering 8,000 gallons of water per hour against a boiler pressure of 185 lbs. per square inch.

The engine house is designed for the accommodation of three steam turbo-alternators, each of 4,000 kw. capacity. Two units have been ordered, but only one has at present been erected. The turbines are of the compound horizontal, impulse type, the first stage being compounded for velocity, and the subsequent stages for pressure. The condensers are of the contraflow surface type with rotary air-pump ejector, and centrifugal circulating water pump, the pumps being coupled in line and driven by a three-phase motor of 95 B.H.P. The alternators are of the revolving field type and are designed to generate three-phase current, at a terminal pressure of 6,600 volts between phases, with a frequency of 50 cycles per second, when operating at a speed of 3,000 revs. per min.

The full load of the alternators is 5,000 k.v.a., but they are capable also of giving an overload output of 6,250 k.v.a. for a period of two hours. The exciters are of the overhung type, the armatures being mounted directly on the armature shafts. The alternators are cooled by means of air drawn from outside the engine room through a dry filter and duct, by means of fans fitted on the rotors of the alternators.

The turbines and condensers were constructed by Messrs. Belliss & Morcom, at Birmingham, and the alternators by Messrs. Siemens Dynamo Works at Stafford.

The extra-high-tension switchgear is designed for three generator panels and seven outgoing feeders of 1,500 kw. capacity each. The 'bus bars are in duplicate, and the two sets can be coupled by means of a non-automatic interconnecting switch. The Merz-Price system for generator protection is employed. The system is earthed through an earthing transformer directly connected to the 'bus bars. The switchgear was made by Messrs. Reyrolle & Co., and is of their ironclad construction type. A front view showing the control panels is given in Fig. 3.

A new system of extra high tension cables, designed for Callender-Waters earth leakage protection, has been laid down by Messrs. Callender, linking up several sub-stations in various parts of Walsall. At these sub-stations the pressure is reduced to low-tension direct current or alternating current before distribution to the consumers.

The rotary converter plant consisting of two 500-kw. rotaries and three 250-kw. rotaries, have been supplied by Messrs. Siemens Dynamo Works, Stafford. Five 500-kw. static transformers, and the whole of the extra-high-tension and low tension switchgear for nine sub-stations have been supplied by the British Westinghouse Electric & Mfg. Co.

Fig. 3.—General View of Switchboard Gallery.

The static transformers, each of 500 k.v.a. capacity, are used for various purposes. Two, installed in the Birchills power station, convert three-phase current from 6,600 to 375 volts for use in motors driving the station auxiliaries. Two others are used to step up the 3,300-volt supply from the 500 kw. turbo-alternator sets in the old power station to 6,600-volt supply for use on the new extra-high tension distribution system, while a fifth similar transformer is installed to convert from 6,600 to 3,300 volts to feed an existing switchboard and distribution network. All the transformers are of the oil-insulated type designed with ample overload capacity, and to have equal temperature throughout the windings, and a minimum voltage between adjacent turns of the windings. They are contained in cases constructed of sheet steel electrically welded.

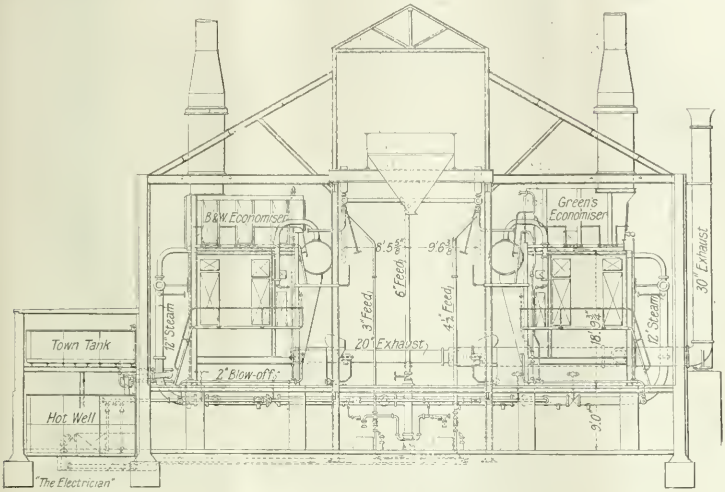

Fig. 4.—Cross-section through Boiler House.

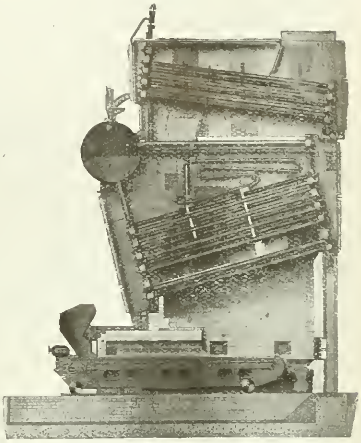

Fig. 5.—Section through Water-tube Boiler, showing Stoker, Superheater and Superposed Economiser.

The extra-high-tension sub-station switchgear is of the sheet-iron cubicle type, a front view of one of the switchboards being given in Fig. 6. A detail view of one panel is given in Fig. 7, which shows sheet-iron doors opened to give complete access to the isolating switches at the top, and a three-pole oil-break switch at the bottom of the panel. It will be noted that the chamber containing the oil-break switch with current transformers mounted above is separated by a horizontal partition from the chamber containing the isolating switches, while this chamber in turn is separated by another barrier from that in which the omnibus bars run across the top of the board. The entire board is made of non-inflammable materials. The panels are fitted with red and green indicating lamps, ampere meters, contacts for voltmeter and synchronising plugs, and suitable relays affording automatic protection to rotaries and feeders, and in the event of a feeder being cut out through excessive overload, preventing interruption of supply to other feeders. The oil-break switches are of the latest design, of large breaking capacity, and embody all the best characteristics of modern switchgear practice.

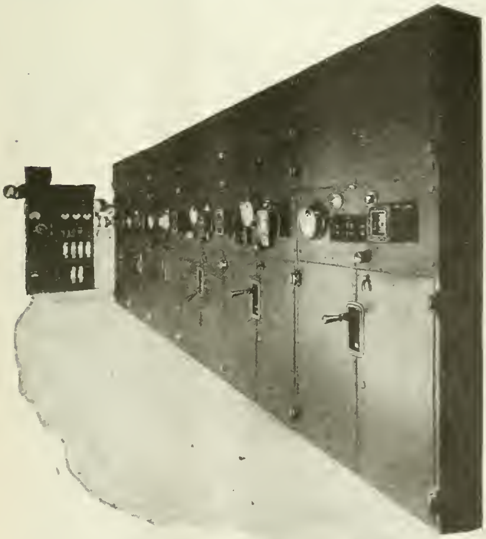

Fig. 6.—General View of Sub-station Switchboard.

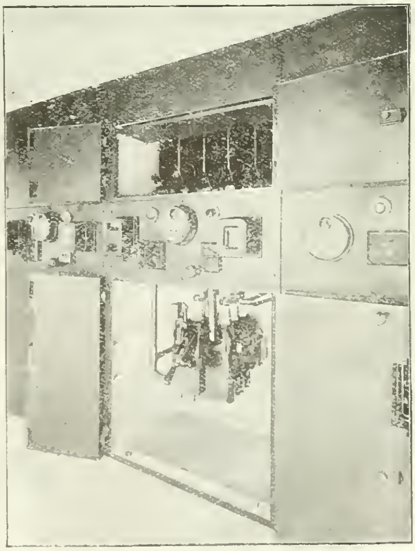

Fig. 7.—View of One Panel of Sub-station Switchboard.

The low-tension direct-current switchboards are of black enamelled slate panels mounted on substantial angle-iron framework, and are equipped with the necessary instruments, fuses, switches and automatic circuit-breakers.

THE HUMAN ELEMENT IN FACTORIES.

At a meeting of the Circle of Scientific, Technical and Trade Journalists, held in the Hall of the Institute of Journalists, last Tuesday week, a Paper on this subject was read by Mr. B. S. Rowntree, Director of the Welfare Department of the Ministry of Munitions.

The Chairman (Mr. L. Gaster), in introducing Mr. Rowntree, remarked that the unprecedented industrial conditions prevailing during the war rendered the welfare movement of special importance. Masses of men, women and children were being transferred from their ordinary vocations to new work, under unfamiliar conditions. Many of the restrictions which formerly acted as a preventive of fatigue had disappeared. Apart from the purely economic standpoint which was of great present importance, it was vital in the interests of future generations that workers should enjoy reasonable conditions as regards food, hours of work, ventilation, lighting, &c. To such matters the welfare movement were paying attention. It was often said that care for the operator *paid* because he could do more work and do it better. But this was not all. He would rather emphasise the fact that attention to the workers' well-being helped to promote a more cordial spirit between master and man, so that the latter ceased to regard himself as a mere tool, and felt that he was doing work of national service.

Mr. Rowntree had a unique experience of these problems, and his pioneering efforts served as an excellent introduction to his work with the Ministry of Munitions. As journalists they could render important services by making these ideas more widely known, and they looked to Mr. Rowntree for suggestions as to how they could best assist the movement.

Mr. Rowntree then proceeded to deliver his Paper on "The Human Element in Factory Work," of which the following is a summary:—

Welfare work may be defined as "the humanising of industrial conditions." There are many employers who fully recognise that responsibility to workers extends beyond the Factory Acts. But others still regard them impersonally as dividend-producing machines, readily replaced if prematurely worn out. Such ideas should not be encouraged.

As an instance of the different spirit that may be brought about by kindly thought on the part of the employer, a case may be mentioned that occurred in America. An employer, whose relations with his men had always been particularly friendly, had got into financial difficulties. One day the men came to him before leaving work, asking for an interview. It turned out that they did not mean to add to his difficulties by airing their own grievances, but for the purpose of placing at his service the savings they had accumulated during past years, as a return for his consideration to them as employés.

There never was a time in our national history when the elimination of waste was more important. To-day there is urgent need for every one of us to do his best and to co-operate for the common welfare.

Not only adequate wages, but reasonable hours of work, and care for the conditions in factories and for the well-being of workers in their leisure hours are in the interests of employer and employé alike.

As a first essential to welfare work the *actual wages received* each week should be enough to support life in comfort. Cases are met with in which employers pay what appears to be a good rate of wages, but actually, owing to delays in issuing work and other causes, the earnings of employés are reduced to an unsatisfactory average figure. It is equally important that the hours of work should not be excessive, and that workers should have leisure and opportunities for rest and recreation. Unless these conditions can be met it is hopeless to expect to build up any lasting system of welfare work in a factory.

The Home Office requirements specify what is the bare minimum in regard to the safety and health of employés. Welfare work goes a step farther in the direction of encouraging conditions which, while not actually prescribed by law, are nevertheless in the interests of employer and employé.

In the old days, when industry was conducted in small factories, the employer knew his workers personally and took an interest in their welfare, but to-day, with enormous factories employing thousands of hands, this intimate contact cannot so well be maintained. Hence it has come about that "welfare departments" have been established in many factories and hundreds of welfare supervisors have been appointed since the war began. The staff of such a department assists in engaging employés and in selecting those suitable for the work in hand, investigates grievances and cases of dismissal, gives advice to employers regarding the provision of hygienic conditions and of canteens, recreation rooms, suitable lodgings, &c. In some cases the efforts of welfare supervisors have revolutionised conditions in factories, bringing about greatly improved relations between the workers and the management and materially assisting output.

Such work is of national value. Workers will never be contented when they are asked constantly to work for longer hours than their physique can support, when they are unable to obtain sufficient and nourishing food, and when they have neither leisure nor opportunity for recreation. There are many factors which materially influence the operators; neglect to provide proper heating and ventilation or adequate and suitable illumination inevitably has a prejudicial effect on the work done. The experience of the Ministry of Munitions has shown that the removal of such defects has had a beneficial influence on quality and output of work, and some striking figures have been published in their recent bulletins on this subject.

Many questions, such as the effect of hours of labour, have been studied very carefully. There can be no doubt that in connection with munition work quite excessive hours were worked in the early stages of the war, and a study of the output, week by week showed that actually more work was done when the hours were reduced. The tendency now is to aim at further reductions, especially in those works where overtime is habitual; on purely economic grounds, there has been a justified and steady diminution during recent months. Tests of fatigue have shown the marked beneficial effect of short pauses for recuperation. It is now suggested that the five-hour shift recommended by the Home Office should contain a mid-way unofficial break of 10 minutes or so, and it is believed that even this comparatively slight pause has a beneficial effect.

One aspect of the work of welfare supervisors which is of special importance in the case of young persons is the personal relation established. The foreman in a works is too busy to pay more than the briefest attention to individual workers, and possibly hardly realises the effect of the sudden transition to unfamiliar conditions in a vast factory on a child fresh from school. The welfare supervisor looks after such cases, ascertaining periodically both from the worker and his immediate superior how they are getting on. In this way a young worker is led to feel that his existence is not entirely forgotten, and that there is someone who has a personal interest in his well-being.

Scientific methods of using labour to the fullest advantage, with a view to securing the maximum output, are not only necessary now, but of vital importance to our industrial future. The nation has never before experienced such a period of industrial pressure, and no one can foresee how serious might be the future consequences to the physique of the country of long-continued severe industrial fatigue. We must learn how to use human effort in the most scientific and humane manner, and the experience now being gained should be of the utmost value in time to come.

Needless to say, good results can only be obtained by steady, persistent effort, and by a steady campaign of education both of employers and employés. We must patiently strive to gain the confidence of the workers and to explain how modern improvements and scientific methods can do much to economise their labour and give quicker and better results. These and similar problems of common interest can only be solved by closer co-operation, frank discussion and more cordial relations between master and man. No method of conducting industry is satisfactory which leads to a waste of human effort, and unless workers are happy and contented and well, they do not and cannot put forth their best efforts.

At the conclusion of Mr. Rowntree's Paper the Chairman read a number of letters from people who had been invited to be present, but were unavoidably absent. Among others, Lord Haldane and the Rt. Hon. Arthur Henderson had written expressing their warm approval of the work of the Welfare Department under Mr. Rowntree's charge, and Sir William Lever, Sir Richard Burbidge and Mr. A. Gordon Selfridge, as employers of labour on a large scale, had all stated their conviction of the importance of care for the welfare of employés and of establishing cordial relations between the management and the staff.

Mr A. J. Mundella, in proposing a vote of thanks, remarked that there was no difficulty in finding welfare work to be done; the real trouble was to find the welfare worker. It was not an easy position to fill, and the Ministry of Munitions had been fortunate in finding Mr. Rowntree to undertake this work.

Mr Gilbert Wood, in seconding the vote of thanks, said that a great deal of education would be necessary in connection with welfare work, both of the employer and the employed. As an instance, he mentioned the case of an employer who decided to improve the ventilation of his factory, and who put in an up-to-date system for this purpose. The employés, however, did not appreciate the new ventilation, and so the ventilators were very soon stuffed up with paper, and thus the final stage was worse than the first. Years ago the employer obtained his experience by passing through his own works. At the present day, however, sons of employers did not pass through the works, and, therefore, did not have the same knowledge of the working conditions.

Mr. A. T. Dale emphasised the importance of the employer mixing with his men and getting to know them individually.

Mr. G. Bellhouse (of the Home Office) thought that a vast amount of education would he necessary if the movement was to succeed. The welfare supervisor also required education before taking on such a position. He thought that education on the part of employés was desirable, because otherwise they were apt to look upon the whole movement with distrust and as a means of short-circuiting the trade unions. Lastly, it was important that public opinion should be formed in favour of the work if any progress was to be made.

Mr. A. P. M. Fleming felt that there were two sides to the question. First, there was the materialistic side, dealing with such matters as fatigue in work. The second was the ethical side, which, if not developed, led to employés accepting any and every condition of work. It was desirable that welfare work, from the point of view of education, should be explained to boys and girls in schools so that they might be brought to appreciate the advantages of proper conditions of work.

Miss L. E. Patterson spoke chiefly of visits she had paid to munition actories, during which sho had been struck with the good influence of the supervisor over the employés and as an intermediary between the employer and the employed.

Miss A. A. Smith asked for an assurance that welfare work was not provided by deductions from the wages of employés.

Mr. S. R. Littlewood drew attention to the great desirability of providing amusement and recreation for employés.

Miss B. O'Reilly remarked that some employers seemed to make the mistake of expecting the supervisors to be at the works during the same hours as the employés. She knew of many women who were excellently fitted for this class of work, but were deterred from accepting it by the fact that they were expected to be at the works at seven o'clock in the morning. If these hours were really necessary, she thought it would be better to have two supervisors at half the salaries and half the hours.

Mr. Rowntree, in reply, emphasised the point that welfare work should not be regarded as charity. It should be looked upon as a duty for which no thanks could be expected, although such work was to the advantage of the employé. Education of the employé was necessary for the results to be appreciated. Welfare work was not in the least an attempt to induce workers to put up with unsatisfactory conditions, or to side-track unions. It was not practicable for the supervisor to be provided by the employés. The supervisor was provided by the employer, and should be regarded simply as one official among others. Any idea of philanthropy should be swept away. It should be realised that employers have responsibilities towards those they employ. He thought that recreation was a very important matter, and this was being taken up by the Ministry of Munitions, not with a view to provide outside entertainments, but with the object of getting workers to provide their own entertainments. In regard to the hours of supervisors, his view was that the hours should be the same as the ordinary office hours, as the work was of an arduous character. If the present movement was to bear fuit to the fullest extent it was most important that a strong public opinion should be formed in favour of it, and for that reason he hoped the Press would give it their ardent support.

PHYSICAL SOCIETY.

At a meeting held on the 10th inst. at the Imperial College of Science, Prof. C. V. Boys, F.R.S., President, in the Chair, a Paper, entitled

"On Diffusion of Liquids,"

was read by Mr. B. W. Clack, M.Sc.

The Paper contains the results of the experiments described by the author in Proc. Phys. Soc. Lond., XXI., p. 374, 1908; XXIV., p. 40, 1911; and XXVII., p. 56, 1914, collected and recalculated in accordance with a theoretical correction recently communicated by Dr. Griffiths (Proc. Phys. Soc., XXVIII., p. 255. 1916).

It is found that in the solutions employed the correction is not considerable, except in the case of the strongest solutions of KCl (2·7 normal), where it amounts to 6 per cent.

The Paper contains the corrected theory of the method, and the value of the coefficient of diffusion is tabulated at different limiting concentrations and at various temperatures; it concludes with a new method of calculating the coefficient at a definite concentration from the experimental results, which appears to be more accurate and free from questionable assumptions than previous calculations of a similar nature.

Prof. G. W. O. Howe asked why the concentration was constant at the bottom of the diffusion tube in the author's apparatus.

Prof. Boys thought this was an important point. He presumed that the upper bulb was sufficiently large that for the purposes of the experiment it could be regarded as an infinite reservoir. A steady state would then be maintained by the circulation through the side tubes, dilute solution rising up one into the reservoir, while more concentrated solution passed down the other.

Dr. R. S. Willows asked why the coefficient of diffusion was greater for strong than for weak solutions in the case of some salts, while the reverse was true for other salts.

Mr. Clack, in reply to Dr. Willows, said he did not know of any reason, but Dr. S. W. J. Smith had told him that that was what would be expected from conductivity data.

A Paper

"On the Regularity in the Distribution of the Satellites of Spectrum Lines, with a Note on the Structure of the Green Line of Mercury, and Terms of Correction in Using a Concave Grating,"

by Prof. H. Nagaoka, was read, in the absence of the author, by Prof. J. W. Nicholson.

The Paper describes a further development of the work done by the author and Mr. Takamine on the distribution of the satellites of the mercury lines. The apparatus employed was a Fabry-Perot interferometer crossed with an echelon or Lummer-Gehrcke plate. An account of the theory governing the interpretation of crossed spectra is given.

It is shown that much of the discord between the results of various observers of these satellites is due to the unsatisfactory nature of the principal line as a datum from which to define their positions, and that if the distances be measured from one of the distinct satellites good agreement is obtained.

If these separations be expressed as differences of wave-number, instead of wave-length, a remarkable symmetry in their distribution becomes apparent. For example, among the satellites of the green line, 5,461, can be found three groups of symmetrical triplets, of which the wave-number differences are in the simple ratios 1 : 3 : 12.

Similar results are obtained for other lines, the principal component of λ4,359 being shown for the first time to consist of a triplet, of which the middle component is relatively weak.

A similarity in the distribution of the satellites exists for all the lines examined, and certain wave-number intervals are common to all.

It is observed that the intervals given by $l\frac{c}{3}$, $m\frac{c}{4}$, and $n\frac{c}{5}$, where $c=0{\cdot}71$, and l, m, and n are whole numbers, are found among the satellites of the eight lines quoted for $l=1$ to 4, $m=1$ to 7, and $n=1$ to 7.

The possible origin of satellites is discussed in the light of the Zeeman and Stark effects, the magnetic or electric fields being electronic in origin, and many of the results are shown to be consistent with Voigt's theory of the vibrations of electrons in an isotropic, quasi-elastic, electric field. The suggested explanations can only be tentative as yet, pending further development of our knowledge of the theory of the Zeeman effect, and the extension of Sir J. J. Thomson's work on positive rays to a larger number of substances.

The second part of the Paper consists of a mathematical investigation of terms of correction in the theory of large-sized concave gratings, which prevent the theoretical resolving power from being realised in practice.

Dr. H. S. Allen thought the Paper contained many interesting and important points. That simple numerical relationships had been shown to hold for the separations of the satellites was likely to prove very helpful to those who were trying to solve the constitution of the atom. He was interested in the discussion of the part which might be played by the magnetic fields of atomic origin in these phenomena. He had himself held this idea for some time.

Dr. R. S. Willows did not quite understand the statement made at the beginning of the Paper that there was, as yet, no observations of the effect of an electric field on the satellites, in view of the experiments of Stark, Lo Surdo and others.

Prof. Nicholson, in reply, said he presumed the statement was intended to refer to the mercury satellites only.

Calculation of Constant in Planck's Radiation Equation.—In a recent "Bulletin" issued by the Bureau of Standards, Mr. J. H. Dellinger discusses the determination of the constant in Planck's radiation equation for the black body. This equation takes the form $J=c_1/\lambda^5 e^{(c_2/\lambda\theta-1)}$, where J is the intensity of radiation, as a function of the wave-length λ, at a constant temperature θ. The constant c_1 merely gives the scale of the ordinates, but c_2 affects the shape of the curve, and should, therefore, be determined with precision. Hitherto c_2 has usually been determined by graphical means. In this Paper a mathematical discussion is presented, showing how equations for determining c_2 can be easily evolved. The method has the advantage that departures from the Planck law are very distinctly indicated.

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A PHASE OF THE SHIPPING PROBLEM, AND ITS SOLUTION.

According to the "Observer" the whole problem of shipping at the present time is to make 55 ships do the work of every 100, the remaining 45 being used for war purposes. With equal truth it may be said that many are of the opinion that the whole problem of the shipper at the present time appears to be that of making one ship earn as much dividend as that which, in pre-war days, was earned by, shall we say, five ships. A perusal of the annual reports of many of the shipping companies leads us to the conclusion that the legislature is at fault ; but, apart from the Excess Profits Tax, as far as we are aware, no steps have been taken to limit the profits of these concerns. Faced with the likelihood of foodstuffs rising to famine prices it surely is the first duty of the State in such cases to limit the profits.

It is not with limitation of profits that we propose to deal in this article. Let not the reader imagine, however, that confiscation of profits falls outside the legitimate business of Parliament. None but the foolish will assert that it is more harsh of the State to confiscate the excess profits made by the subject than it is for the State to compel the subject to engage on an enterprise which to him, may appear to be profitless, and which may, or may not, be congenial to him. Although we are not prepared to deal with either question, we are, nevertheless, strongly of the opinion that all those who, at this time, are privileged to follow peaceful pursuits at home, or to earn big dividends as a result of the war, should pay heavily for the privilege.

It is on a mischievous suggestion in connection with the shipping problem, or, rather, in connection with one phase of the shipping problem that we wish to comment. In a recent interview with a representative of our contemporary, Sir NORMAN HILL, secretary of the Liverpool Steamship Owners' Association and manager of the War Risks Association, made a suggestion which, if acted upon, would make it impossible for this country effectively to compete either with America or Germany for many years to come.

After commenting on matters which are common to peace as well as to war, Sir NORMAN says : "We now come to . . . the time occupied in discharging cargoes. This is all-important, and everything must be done that can be done to shorten it. If you have only 55 ships to do the work of 100, it is obvious that you must use labour very freely to get the cargoes out and get them distributed. You cannot increase the number of your ships, but by using labour freely you can save time, and saving time means more cargoes." We agree with Sir NORMAN that everything must be done that can be done to shorten the time occupied in discharging, and that saving time means more cargoes in a given time, but our powers of perception must be less keen than his, for we confess that we are completely at a loss to understand how using manual labour very freely is going to expedite the discharging and distributing of cargoes. Had we been asked we should have answered emphatically and without hesitation that the free use of manual labour would tend to retard the rapid handling of cargoes. The truth of the matter is that it would be impossible for man to devise a less efficient method than the manual method, and to talk of expediting the handling of materials by using labour freely is to overrate man's capabilities. The manual method was practised by the ancients. It is the slowest, the most expensive and the most dangerous of all the methods known to man, and is largely used in this country. Manual methods are dangerous in so far as they call for the employment of unskilled men in considerable numbers. As long as such men do not organise, and as long as they represent a small percentage of the total population, their presence is of little consequence to the community. When organised, they are in a position to cripple all our industries. The unrest of the transport workers in recent years should of itself be sufficient to make every right-thinking man and woman look forward to the time when the number of men engaged on transport work will be very materially reduced.

Now the only way of reducing the number of transport workers is to use machinery—cranes, conveyors, elevators, runways and the like—and to use it lavishly. In order to secure maximum economy the machinery must be electrically-driven, the electrical energy being purchased in bulk whenever possible, as dock sites are, or should be, far too valuable to be used in part for the purpose of accommodating small and inefficient power stations. An electric motor of 1 horse-power output continuously employed on the mechanical handling of materials will do the work of 30 men. If, therefore, motors of, say, 400 H.P. are used effectively for the purpose of discharging cargo the man-power equivalent is 12,000. Worked at a load-factor of one-half, such motors could discharge 40 tons of cargo per minute, or 16,000 tons per day of 8 hours. Furthermore, when there were no cargoes to discharge it would not be necessary to refuse employment to a considerable body of men. Bearing in mind the existing accommodation at our ports it will be readily seen that when the problem of mechanical handling is tackled in earnest, as it has been tackled in Germany and in America, a vastly increased tonnage can be handled.

There is nothing novel in the idea. Engineers at home were busily engaged in discussing the suitability of electricity as a motive power for cargo-handling appliances some years after the principal ports in Germany were fully equipped with electrically-driven appliances. We venture to say that few of our readers have any idea as to how fully the Germans realise the importance of lavish crane equipment for the rapid loading and discharging of cargo. Elsewhere we give an illustration of one of the quays at Hamburg, and on this quay alone there are more electric cranes than at most of our principal ports. It should be mentioned that the photograph was taken more than 10 years ago, and that the equipment had at that time been in full operation for some years.

The rapid discharging of cargo can only be effected by the close co-operation of the shipper, the dock and railway company, the naval architect and the mechanical and electrical engineer. It is likely that the lavish use of mechanical appliances will necessitate certain radical alterations in the construction of ships. For instance, the decks of modern ore-carrying steamers are removable practically from end to end of the ships, and the holds are free of all obstructions likely to limit the radius of action of the grabs. From eight such boats 70,000 tons of ore have been unloaded in 20 hours at a cost of about 1d. per ton for current. The last figure indicates the extent to which the human element has been eliminated in the mechanical handling of material.

After the recent "James Forrest" Lecture, in which, as our readers will remember, Sir JOHN PURSER GRIFFITH advocated the use of mechanical appliances for the rapid discharging of cargoes, it comes as a shock to us to find that there are people in high places who hold that cargoes should be discharged by using labour "very freely." Had Sir NORMAN HILL's suggestion to be adopted we should find ourselves, when peace was declared, using our labour freely on non-productive work. It needs no argument—and such being the case we shall advance no argument—to prove that a rapid recovery necessitates the employment of a maximum number of hands on productive work. By displaying elementary common sense more than 10 years before war was declared, our enemies will be in a position, after the war, to employ their labour freely on such work, and to our detriment.

THE "GERMAN WAY" OF LOADING AND DISCHARGING CARGO.

BY H. H. BROUGHTON.

Summary.—A brief description is given of a modern crane installation for the loading and discharging of cargo at Hamburg.

Within the last five years it was the common practice to unload grain at an important port in the British Isles by the "bucket-and-shovel" method with the assistance of a hand winch. For all we know to the contrary, grain is so unloaded even to this day at the port in question, and some say that we shall soon be paying a shilling or more for a loaf of bread. During the week we read that boats are being held up at the ports for 28 days owing to congestion. To remedy the evil the proposal has been made to employ manual labour "very freely" at the docks, and this at a time when there is other work work which imperatively demands manual labour waiting to be done. Our leaders tell us that we are spending close upon six millions a day on the war. Of this sum, a considerable percentage is the price we are paying, and which we richly deserve to pay, for our inefficiency. In the last issue of the "Panama Canal Record" there is a note to the effect that at Cristobal 400 tons of coal were loaded into a vessel in 38 minutes, and on another occasion 50 tons of coal were put on board in 3½ minutes.

CRANE INSTALLATION ON ONE OF THE QUAYS AT HAMBURG.

After this country had been at war for more than two years the importance of the mechanical handling of materials was officially recognised. In the hope that someone in authority will benefit by the lesson which it teaches and, having benefited, will see that the country benefits, we propose to give a brief description of the German way of loading and discharging cargo. There are those who in these days believe that everything German is bad. To such people we would say that, good or bad, we have already been compelled to adopt many of them, and that in the future it will be necessary for us to adopt many more of them if we desire to prosper.

Apart from the many heavy cranes in use, no less than 225, 2½- and 3-ton semi-portal cranes have been installed by the

Hamburg Harbour Board at the Oswald, America and Kuhwärder Quays. A striking view of the Kuhwärder Quay is given in the accompanying illustration.

The cranes at the America Quay are capable of lifting a load of 2·5 tons at a fixed radius of 36 ft., the height of lift being 75 ft. The lifting speeds are :—

2½-ton load at	133 ft. per minute.	
1½ ,,	228	,,
½ ,,	320	,,
No-load at	344	,,

The lifting mechanism consists of a 35 H.P. motor, geared through an enclosed single-reduction cut spur gear (8 to 1) to a grooved barrel, and the load is lifted on one part of rope. An electromechanical brake with hand release is fitted to the extended motor spindle. Under full load the slewing speed, measured at the jib-head, is 394 ft. per minute. The mechanism consists of a 5 H.P. motor and double-reduction gearing. A multiple-threaded worm gear is used for the first reduction.

When 20 of the cranes are at work the power house is loaded with an average of about 3·3 kw. per crane ; from this will be seen the effect of the diversity factor in a large electric crane installation. Tests have shown the energy consumption for loading and unloading ships to be as shown in the following table :—

Energy Consumption of Wharf Cranes.

Load, tons.	Watt-hours, unloading.		Watt-hours, loading.	
	Lift, 49·2 ft.	Lift, 26·2 ft.	Lift, 49·2 ft.	Lift, 26·2 ft.
½	70·5	55·0	60·2	47·3
1½	125·9	84·7	94·7	61·2
2½	180·2	123·5	132·3	73·1

The 134 cranes at the Kuhwärder Quay are capable of handling loads up to 3 tons in weight at a radius which is variable from 26 ft. to 36 ft. The lifting speed under full load is 158 ft. per minute, and 197 ft. per minute at half load. A 10 H.P. motor is used for driving the lifting mechanism, and is geared to the barrel through an 8 to 1 cut spur gear. Measured at the jib head the full load slewing speed is 390 ft. per minute, and the mechanism is driven by a 5 H.P. motor.

Shortly after the cranes were erected the energy consumption was carefully measured for the following cycle of operations :—

(*a*) Lifting the load 49·2 ft. to the top position.
(*b*) Slewing under load through 140 deg.
(*c*) Lowering the load to the quay.
(*d*) Lifting the empty hook to the top position.
(*e*) Slewing back through 140 deg.
(*f*) Lowering the empty hook to the initial position.

A summary of the results of the tests is given below :—

Energy Consumption of Wharf Cranes.

Load, tons.	Actual watt hours per cycle.	Specified watt-hours per cycle.
½	68	90
1½	115	114
3	205	230

When the cranes had been in use some time it is said that still lower figures were obtained. If we take the cost of current at 1d. per unit it will be seen that when the cranes are working at their rated load the cost of current amounts to 0·067d. per ton of material loaded.

In concluding, the writer would observe that he has no intention of advertising cranes of enemy manufacture. As everyone who has studied the subject will admit, British built dock cranes embodying many improvements are available, and these are as far ahead of the German dock crane described above as the latter, at the time of its introduction, was ahead of the hydraulic or steam crane. And we urge railway and dock companies to use such cranes *lavishly*.

MR. J. K. STOTHERT'S ADDRESS TO THE SCOTTISH LOCAL SECTION OF THE I.E.E.*

At the opening meeting for the current session held at Glasgow on Nov. 14th, Mr. J. K. Stothert, chairman, delivered an interesting inaugural address on "After-the-War Problems." He said that in the work which had been done in connection with the production of shell and explosives great credit was due to central-station engineers for what they had done to meet the requirements of munition factories. When peace and normal conditions again prevail, electric power installations should be brought into the service of the people of the country without going through the vicissitudes in capitalisation that characterised this development in the past. Technical developments had been mainly in detail, but the obvious necessity to economise fuel was leading to refinements in the steam utilisation plant, and experiments were about to be made with stage re-heating in steam turbines with which the honoured name of Ferranti was associated. The improvements in the application of liquid and gaseous fuel were under consideration. Mechanical firing, large steam generating units and mechanical appliances for conveying the coal from railway truck or ship right into the furnace without manual labour, and conveying the ashes to the dump, mechanically or pneumatically were effecting economies of space and cost of building.

In connection with after-war problems the protection of our industries from competition with enemy and neutral nations did not go to the root of the matter. Trade protection should, however, be treated as free from political bias, as the Army or the Navy. This war was sweeping away pre-war conceptions of things. The old days of indifference and apathy were gone for ever. The first thing to which they had to apply their minds was the subject of education. The cast-iron rules of the Board schools, herding large numbers of children into a schoolroom under the supervision of a single teacher, and trying to mould them all to one standard on a set of rules laid down by Whitehall was not the best way to get the best results out of the future citizens of the Empire. Neither would the system of the English public schools spending so much time in acquiring the dead languages, meet the new situation. The numbers in the classes in the elementary schools would have to be reduced. In the higher grade and public schools of England the methods would have to be more intensive and the State will have to take a hand in the care and education of what was the precious material of adolescents between the ages of 14 and, say, 17.

With regard to the questions of technical education and apprenticeship, at one time the trade unions endeavoured to limit the number of apprentices, while the masters, as a rule, did not give sufficient attention to the education and technical training of the apprentices under their care. The trade unions would come to see that the restriction of the numbers of apprentices would be a fatal policy ; and the masters must see that more care and more training were necessary to make apprentices into skilled workmen.

In one works in the Glasgow district salaried men were employed whose sole duty it was to teach the apprentices, and it had been found that this was beneficial, both to the apprentice and to the employers. Technical training and the apprentice system might have to be taken in charge by a central authority. When and how was technical education to be applied ? Were the youths to work from half-past 6 till half-past 5 and then go to their evening schools, jaded, tired and weary ? Were these youths to work in pairs and thus be allowed so many days a week to work in the shop and the remainder of the time to work at the college ? Were they to work so many years at the bench and so many years at college ? Were they to work in the summer at the bench and the winter at the college ? For some classes of apprentices one system was the better, and for another class another was the better. The Faraday House system of a four or five years' apprenticeship—the first year at the technical college, the next year with an affiliated company, the third year again at college, and the fourth and fifth years in the shops, had worked well.

With reference to research and experiment, no longer must each firm fight entirely for itself ; no longer must they keep their own experiments and research secret for their own individual benefits ; but there must be a freer interchange of views, a freer disclosure of results, or associations in the various trades so that their research could be combined and the results of this research made mutual. Any business which refused to act in this co-operative way would be avoiding a public duty. The I.E.E. was fully alive to this. It had a Research Committee of its own, which was working in conjunction with the Committee of the Privy Council and other bodies.

It has been said that all wealth was the result of labour. It would be truer to say that wealth was the result of well-directed labour.

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* Abstract.

With a million men gone, and two millions crippled, their power of production would be lessened, and they would need all the brains and labour—skilled, semi-skilled or unskilled—available to keep our place in the world, and if we are to compete with neutral nations which have been making hay while we fight, and whose population has not been diminished in the way that has happened with belligerents. How were we going to get over that? They must root from the minds of the workers the fallacious theory that the restriction of output increased the wealth of the nation by creating a scarcity in commodities. They must have every possible labour-saving appliance which would tend to cheapen manufacture. Capital and Labour must work hand in hand with neither avaricious employers nor unreasonable workmen. Some people might think that the problem of a better understanding between employers and employed was almost unsolvable, but when both sides are working with singleness of aim matters could adjust themselves and difficulties disappear. Over 3,000 representatives of the mining industry met in London last month and had unanimously adopted a resolution to do everything in their power to secure an increase in the output of coal. He had heard since preparing his address that an association of the employers and workmen's representatives had been formed to tackle labour problems after the war. The general opinion of the country was that something should be done by which new industries may spring up to employ our population in the manufacture of articles which might as well be made in this country.

Reverting again to the question of education and languages. Business men trading in foreign markets should, either themselves or through their agents, have a knowledge of the language and of the national characteristics and business customs of these countries in which they wished to establish themselves. A great deal of their lagging behind other countries had been the result of Government legislation. They remembered the electric lighting acts of the eighties. Difficulties had been created in high-tension transmisson by the Post Office and Board of Trade rules. They had in Glasgow an excellent system of electric trams; in the second City of the Empire they had not a single electric train. Part of the present Government's programme was to facilitate finance for trade purposes, but unless they went on courageous lines no amount of re-awakened energy, no amount of organisation, no re-doubling of the industry of workers, or increased output would be of much use. He did not think any of these results, however, would be attained until a Ministry of Commerce was established. He knew from agents in foreign countries that the routine necessary to get information from the Foreign Office sometimes took at least two years, while foreigners could get the same information which would enable them to grab the order against ourselves in two days.

This Ministry of Commerce would not poach on the preserves of the Board of Trade and the Foreign Office, but it should take in hand the housing of the workers, and thus encroach upon the duties of the Local Government Board, or at all events, work hand in hand with this meritorious department. The root of much industrial unrest and discontent was planted in the fertile soil of bad housing and miserable environment. Employers of labour who would, in conjunction with the Government and local authorities, look after the housing of their workpeople would attract a better class of workmen. This subject was one of the most important, if not the most important that confronted them in their desire to rear a new Britain.

CORRESPONDENCE.

SHOULD REVIEWS OF BOOKS BE SIGNED?

TO THE EDITORS OF THE ELECTRICIAN.

As the reviewer of Prof. Kapp's book, I am surprised and sorry to see that the few points of adverse criticism which I ventured to make have caused him so much annoyance that he has felt constrained to publish a letter accusing the reviewer of malevolence. He will be surprised to learn that I nearly declined to undertake the review because of associations tending to bias me in favour of the author, and that it was because of these associations that the review was unsigned. You yourself, Sir, have dealt with the subject of signed *versus* unsigned reviews, but I should like to refer to the examples given as a proof of my want of benevolence. I said: "*Although on the whole the symbols used throughout the book appear to be well chosen*, the author could surely have found for cross-section a more suitable symbol than the initial letter of its German equivalent, 'querschnitt.'" Again: "Instead of the usual $\log_{10}r$ and $\log_e r$, the author employs the German symbols lgr and lnr, *which, while certainly preferable from the compositor's point of view* [the italics are new], are bewildering to the English reader, who feels tempted to cancel the l and n with the length and number of turns on the other side of the equation. For example, Prof. Kapp would write $\frac{lnr}{lnr}$ instead of $\frac{lnr}{\log_e r}$." To this the author says: "These symbols are used by Continental scientists. The benevolent critic, if he thought it worth while to allude to so small a matter at all, would have discussed the question whether such symbols are preferable to the *English symbols* or the reverse. *Your reviewer simply alludes to their German origin.*" [The italics are mine.] Whether the choice of symbols is "so small a matter," whether any fuller discussion of the question would be in place in the review, whether Prof. Kapp is speaking accurately when he says that "I simply allude to their German origin," and, finally, whether the sentences quoted are a proof of malevolence, I leave the reader to judge.

Again, the author says: "There is a misprint, a sine having been put where a cosine ought to stand. The benevolent reviewer would have drawn attention to the misprint." I reproduce here the portion of page 177 referred to, together with the necessary corrections:—

$$dF=\frac{I dx \cos\alpha}{b^2}=\frac{I}{b^2}\sin\alpha\, d(a\tan\alpha) \qquad \text{[for sin read cos]}$$

$$\therefore \quad =\frac{I\alpha\cos\alpha\, d\alpha}{b^2\cos^2\alpha} \qquad \text{[for } I\alpha \text{ read } Ia\text{]}$$

$$=\frac{I}{a}\sin\alpha\, d\alpha \qquad \text{[for sin read cos]}$$

$$=-\frac{I}{a}d(\sin\alpha) \qquad \text{[for } - \text{ read } +\text{]}$$

$$\therefore \quad F=\frac{2I}{a}$$

Now, although calling all this a "misprint" might be regarded as a proof of benevolence and tact, it would certainly be no proof of honesty or truthfulness. I called it a muddle.

Nov. 18. THE REVIEWER.

FINAL-GRADE CLASSES IN "ELECTRICAL INSTALLATION WORK."

TO THE EDITORS OF THE ELECTRICIAN.

My address had nothing to do with final-grade classes, which were only alluded to to distinguish them from trade classes.

I disagree with Messrs. Lundberg & Sons about demand and supply. Principals of polytechnics tell me that they are quite ready to provide the classes if the students are forthcoming. The ball is now with the employers.

London, Nov. 14. A. P. TROTTER.

"SUMMATION WATT" CAPACITY OF FIELD RHEOSTATS AND THE LIKE.

TO THE EDITORS OF THE ELECTRICIAN.

I think Mr. Boothman and I are really talking about two different things. I do not deny that his formulæ give accurate results of the summation watts as defined by him in his letter of the 13th inst. Such figures, however, are chiefly of academic interest. I do not think that the summation watts, so found, will be a safe guide as a basis of comparison of rheostats, which is the practical use to which I would put them. For example, Mr. Boothman points out that the greater the resistance in a potentiometer the less are the actual summation watts (based upon his definition). But beyond a certain value the more resistance used the greater becomes the size (*i.e.*, bulk) of the rheostat; therefore, I think it somewhat illogical to say that the *capacity* of the regulator does not materially increase. My point is that, as a guide in designing, Mr. Boothman's method will, if precautions are not taken, lead one astray. As an example, I would point out that Mr. Boothman has recommended for potentiometer regulators to allow 2 to 4 ohms per volt of supply. According to Mr. Boothman's way of looking at it this would be correct, as the higher the ohms the less are the summation watts, as defined by him.

I am of the opinion, however, that this value of rheostat ohms is too high and would result in a needlessly expensive design. In support of this view I can refer to Mr. T. Carter, "Electrical Review," Vol. LXXVI., May 21, 1915, p. 716, who recommends that a potentiometer regulator should have from two to four times the resistance of the field coil. Such a rule results in much lower values of rheostat ohms than recommended by Mr. Boothman and confirms the method of calculation which I originally recommended.

Birmingham, Nov. 20. CHARLES C. GARRARD.

RECENT DEVELOPMENTS IN ELECTRICAL SUPPLY.*

BY A. E. MCKENZIE.

Organisation of Engineering Industries.—Much has been written in the daily press and in the technical journals regarding the reorganisation of British industries. Many committees have been appointed by the Government to consider the case of particular industries. Electrical engineers are awaiting with great interest the recommendations of the committee appointed by the Board of Trade to consider the electrical industry, which is presided over by Sir Charles Parsons. One association which has been recently formed represents alone firms having a aggregate capital of over 150 millions sterling. Many of our largest electrical engineering firms have joined this association, which cannot fail to bring considerable influence to bear in many directions upon the trading conditions of the Empire. We also know that the six leading engineering societies of the German Empire have amalgamated expressly for the purpose of re-capturing their foreign trade. Now, it has been abundantly proved that the engineering firms of this country can supply all our requirements, of equal, if not better, quality than our Continental neighbours could supply, from a turbo-alternator to a lamp.

The 10 important recommendations made by the Institution, through our President, to the Board of Trade Committee, vitally affect the interests of us all, and it is to be hoped that effect will be given to most of them, if not all.

The Linking-up of Power Stations. At the final meeting of this Section last session the Paper by Mr. E. T. Williams on the electricity supplies of this country was discussed. It seemed to be agreed that the interconnecting of most of the existing stations should precede the building of a few large super-stations, from which bulk supplies would be furnished. The linking-up suggestion was not a new one. It was dealt with by Mr. Watson, in his chairman's address in the year 1909, and the conclusions he therein arrived at have since been fully borne out. Several municipalities had already proved the great financial saving that could be effected by interconnecting, especially in the lowering of fuel costs, and the reduction in the quantity of stand-by plant necessary under such schemes.

Probably the circular sent out by the Board of Trade, intimating that it would look with favour upon any linking-up proposals, and practically advocating such schemes wherever commercially possible, has been largely responsible for progress, for without the Board's sanction such schemes could not be carried out.

The linking-up of the supply undertakings in Lancashire and Cheshire was already under the consideration of the municipal and power companies' engineers of these counties before the Board of Trade circular was issued, and credit is due to the engineers responsible for the preparation of the scheme recently described in the electrical press. It is to be hoped that the Government will assist to some extent in the raising of the capital necessary for the carrying out of the work, seeing that the estimated annual saving therefrom is approximately 30 per cent. Two other committees are also at work on this subject.

The question of electricity supply from a national and engineering point of view is being considered by a special committee of our Institution and a joint committee of the Incorporated Municipal Engineers' Association and the Incorporated Association of Electrical Power Companies is going into the more immediate questions of organisation and linking up of existing undertakings, &c.

Without being unduly optimistic, I think we may anticipate the more economical production of electricity in the near future, and the removal of many of those restrictions which have hampered the industry in the past.

The Summer Time Act.—Since our last meeting the Summer Time Act has been passed by Parliament and put into practice. As a result of its operation, the output from many supply stations has been considerably reduced, but there can be no doubt whatever that from the national financial standpoint it has been an unqualified success., and the Act will, I believe be retained upon the Statute book.

Those undertakings devoted chiefly to the supply of current for lighting, and particularly those in the southern counties of England, where the day is comparatively short, as compared to that in the chief cities of Scotland, were most affected. Several of these found it necessary to raise their tariffs considerably without the approval of their consumers. In Manchester the Act has led to marked benefits to domestic users. An examination of four residential districts reveals a saving of some 15 per cent. On the other hand, in certain industrial and shopping districts a similar examination reveals an increase of some 8 per cent., due, doubtless, to war work and revival of retail trading.

So far as it has been possible to institute comparisons at the generating stations in Manchester it is estimated that the reduction in lighting output from the Stuart-street station for the period covered by the Act was equivalent to 1 per cent. of the total output, while the consequent saving in coal was about 600 tons. At the other Manchester Corporation stations the reduction was approximately 1¼ per cent. of the output, with a saving in coal of about 400 tons.

Supplies of Electricity for War Purposes.—The past year has been a strenuous period with all supply undertakings. The output from the various stations situated in all the large manufacturing centres of the country has gone up by leaps and bounds. It is difficult to conceive what would have happened in these centres if these large supplies of electrical power had not been readily available for our manufacturing firms.

It is not surprising that the several electrical undertakings in the Manchester district should be experiencing a period of unprecedented stress. The following few figures relating to the Manchester electrical undertaking are doubtless typical of the experiences of other large undertakings. The total plant capacity installed at the three stations to date is 73,500 kw., and, when the plant now under construction is completed, will be 93,000 kw. Included in the latter is another 15,000-kw. turbo-alternator for Stuart-street station, and a 10,000-kw. ditto for Bloom-street station. These sets will displace reciprocating units of 3,750 kw. and 1,600 kw. respectively.

I remember a well-known central station engineer remarking to me about 12 years ago, when the 3,750-kw. sets were being installed, that it was a mistake to put down such large units, and that additional 1,500-kw. sets would have been far better.

It might interest some present to know that during the year ending March last the present 15,000-kw. set at Stuart-street station generated some 90-million units. The total number of units generated during the year ending September last was 196 millions, of which quite 75 per cent. was supplied to firms engaged on war work. This was an increase of 27 millions, or 16 per cent. over the quantity generated during the previous year. This increase, however, will be greatly exceeded during the current year, as the increase of power demands has already exceeded all previous records.

Undoubtedly the city is even yet only supplying a small fraction of the demand which will eventually be made upon the system for lighting, heating, cooking and power. Some proof of this is found in the fact that the number of gas and electricity consumers in Manchester are 191,000 and 16,000 respectively.

Further, one can see from the roof of the Stuart-street station in the immediate vicinity no less than 386 large chimneys rising from works or mills. If one takes a mean of 300 H.P. for each of these, which I think most engineers will agree is a reasonable estimate, a total of 115,800 H.P. yet to be connected in this area alone is arrived at, which covers a very small part of the total area supplied.

It can safely be predicted that the annual output from the Manchester stations will within the next five years reach 300-million kilowatt hours.

Electro-Chemical Demands.—One direct outcome of the war is the evident desire of the Government to render this country less dependent on foreign countries for supplies of certain materials, and in no case is this more marked than regards certain chemical productions.

Many of the electro-chemical plants can be adapted to take a restricted-hour supply during the winter months of the year, thus furnishing an ideal load for central stations. The demand of one such consumer in Manchester will far exceed that of any other on the system, not excluding the entire tramway demand. This supply will be given by the Corporation without the latter having incurred any capital outlay on plant to supply same, because over the peak of the winter load—viz., from 3.30 p.m. to 5.30 p.m.—and at any other times of severe atmospheric conditions, the consumer has arranged to reduce his load to zero if required. Otherwise the demand will be continuous night and day.

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* Abstract of Chairman's Address to the Manchester Local Section of the Institution of Electrical Engineers, November 14, 1916.

There are several other large consumers on the system taking a restricted-hour supply as above, but the specific one mentioned is by far the largest. Such desirable consumers are, of course, rightly entitled to the lowest possible rate per unit.

Fuel.—Great difficulty has been experienced by both gas and electricity supply undertakings during the past year in obtaining their necessary supplies of fuel, even where it could be proved, as in Manchester, that practically the whole output was for war work.

The fuel that is procurable to day is inferior to that obtained before the war from the same pits, because of the greater percentage of the dirt content. A large proportion of the total fuel now offered was until recent years unsaleable. During the late coal strike more than one large electricity undertaking was only enabled to keep running by burning fuel which had been thrown on the rubbish tip in the preceding years.

The present high prices for fuel have caused colliery managers to recognise more fully the very great waste that undoubtedly has taken place at many pits. As much as from 10 to 15 per cent. of the total output from some mines has in the past been left in the mines, as being too small to warrant raising to the surface. Government control should in future obviate this wastage of our great national asset.

The high prices now obtaining for all classes of fuel undoubtedly call for the more efficient management of our boiler-houses. The man in charge should be an engineer of exceptional ability, and he should be well paid, for his salary forms a very small fraction of the saving he can effect. To him should fall the duties of seeing that combustion is obtained as perfectly as circumstances will allow; also that correct gas, water and steam temperatures are maintained.

The indispensability of the analytical chemist in electricity undertakings of any magnitude is not yet sufficiently recognised. Only by regular testing can one ensure getting fuel of anything approaching constant quality from most collieries, and the knowledge that such tests are made is usually sufficient to make contractors careful in sending supplies to works where this practice is followed. The chemists should be responsible for the correct treatment of the feed water, and for seeing that scale and corrosion in the boilers are prevented, and the like.

Power Stations of the Future.—The large station of the future will, I believe, have a proportion of boilers gas-fired, the proportion being based upon the load factor in such manner that the extra capital incurred by the installation of by-product recovery plants will be remunerative, and the by-products of the bulk of the fuel used recovered.

Gas firing is not, cannot be, a means of direct saving of fuel. The two-stage process of conversion of "coal to gas and gas to steam" must necessarily involve heat inefficiencies exceeding those in the direct conversion of "coal to steam." Skilled analysis and extensive experience tend to show, however, that with improved forms of producers the aggregate value of by-products recoverable from coal by conversion to gas equal or exceed the original coal value, and when extra capital and labour charges are taken into account the procedure leads to a substantial rebate on fuel costs.

There were isolated cases on record in the days when slack could be bought at 6s. or 7s. per ton, where large boiler installations were fired throughout the year substantially for nothing; and as the value of the various by-products fluctuates largely in sympathy with coal values one might expect a net saving by the system of between 4s. and 7s. per ton of coal consumed.

There are, broadly speaking, two fundamental types of gas recovery plants:—

(*a*) *Low-temperature Distillation.*—In which coal is converted to coke or smokeless fuel yielding gas, spirits such as benzol, toluol and the like, heavier oils, tar, and a comparatively small amount of sulphate of ammonia.

(*b*) *Producer.*—In which coal is burned to ash with yield of abundant gas, a comparatively poor tar, the residual value of which about pays the cost of collecting, but high yield of sulphate of ammonia. A combination of the two systems offers attractions, but much will depend upon location and future relative value of by-products.

Gas firing has not yet had its fair chance, in that practically every trial has been conducted with Lancashire or water-tube boilers converted. These boilers specifically and admirably designed round fire grates, for high efficiency with direct firing, are far from ideal for gas combustion. Efficiencies up to 94 per cent. have been demonstrated possible with a certain type of boiler. Figures such as these cannot, however, be anticipated in practice on a large scale.

Obvious advantages incidental to gas firing will be the utilisation of poorer grades of coal, and clean, comfortably controlled, smokeless boiler-houses, involving low maintenance charges.

More than usual interest attaches to this subject by reason of the published experiments on a sufficiently large scale that are to be made at the Yorkshire Power Co.'s station at Barugh, near Barnsley, and at the Southwick power station of the Brighton Corporation. In each case the electricity undertaking is to purchase gas in bulk from a company operating the low-temperature distillation process. It will, therefore, be seen that the financial risks, such as they may be, are carried by the company supplying the gas. Provided the guarantees of the latter are fulfilled it would appear from the particulars published that the Brighton Corporation has made an exceptionally good bargain. In any case the results will furnish an interesting comparison with what can reasonably be achieved with a scheme working on producer lines.

Apart from the question of gas-firing *v.* coal-firing, considerable attention of late has been given to the design of new boiler houses and the utilisation of larger units. In this connection there is a marked contrast between British and American practice.

Much could be said on both sides, but inasmuch as the war has compelled a revision of our ideas generally, on the correct sizes of generating units to be employed, it seems not improbable to expect that British engineers will aim at increasing the size of individual boiler units in the future, whilst decreasing the number to be installed. The proposed use of large gas-engine-driven generators is now clearly a thing of the past. Their manufacture was never taken up very seriously by many engineers in this country. Turbine plants undoubtedly hold the field, and in the near future one may confidently anticipate seeing units of 20,000 kw. to 25,000 kw. being installed in some of our large British stations.

Electrification of Railways.—During the last year or two most of the large railways have converted portions of their suburban traffic from steam to electric traction, and there is no doubt that many similar conversions will be tried before electric traction is generally adopted for the main-line traffic. There are those who consider, perhaps, that legislation should be passed to standardise one of the existing systems. Without doubt, standardisation in this particular direction is ultimately desirable, but at the present stage would seem to be a great mistake. If each system is developed and given a fair trial, the best will soon demonstrate its superiority over the others. Then let the Government legislate to enforce the adoption of this particular system in the future, in order to ensure through running on all railways.

Rate Relief.—The war has served to bring into prominence again the vexed question of rate relief from the trading departments of municipalities. In these days of a 5s. income tax, and with the possibility of an increase even on this figure, surely the time has come for a drastic revision of the methods followed by many municipalities of exacting large sums of money by way of rate relief from the trading departments.

Most engineers are agreed that the nearer electricity supplies are furnished to cost price the better for the community at large.

As an alternative to a system of rate relief that may be laid down by any municipality (and which runs counter to the above proposition regarding cheap supplies) it would not be unreasonable for the ratepayers at large—who would receive no direct benefit under a no-rate relief scheme—to stipulate that the supply undertaking should in addition to providing for debt redemption, at the same time make some provision over an extended period of years for a renewal of the assets of the undertaking when worn out, so as to avoid recourse to borrowing.

1916 REPORT OF THE COMMITTEE ON NOMENCLATURE AND STANDARDS OF THE ILLUMINATING ENGINEERING SOCIETY—DEFINITIONS.

The following definitions are recommended by the Committee on Nomenclature and Standards of the Illuminating Engineering Society of America:—

1. *Luminous Flux* is radiant power evaluated according to its visibility—*i.e.*, its capacity to produce the sensation of light.

2. *The visibility*, K_λ of radiation, of a particular wave-length is the ratio of the luminous flux to the radiant power producing it.

3. *The mean value of the visibility*, K_m, over any range of wave-lengths, or for the whole visible spectrum of any source, is the ratio of the total luminous flux (in lumens) to the total radiant power (in ergs per second, but more commonly in watts).

4. *The luminous intensity*, I, of a point source of light in the solid angular density of the luminous flux emitted by the source in the direction considered; or it is the flux per unit solid angle from that source.

Defining equation

$$I = dF/d\omega$$

or if the intensity is uniform

$$I = F/\omega,$$

where ω is the solid angle.

5. Strictly speaking no point source exists, but any source of dimensions which are negligibly small by comparison with the distance at which it is observed may be treated as a point source.

6. *Illumination* on a surface is the luminous flux-density on that surface, or the flux per unit of intercepting area.

Defining equation

$$E = dF/dS,$$

or when uniform

$$E = F/S,$$

where S is the area of the intercepting surface.

7. *Candle*—the unit of luminous intensity maintained by the national laboratories of France, Great Britain and the United States.*

8. *Candle-power*—luminous intensity expressed in candles.

9. *Lumen*—the unit of luminous flux, equal to the flux emitted in a unit solid angle (steradian) by a point source of 1 c.p.†

10. *Lux*—a unit of illumination equal to 1 lumen per square metre. The cgs. unit of illumination is 1 lumen per square centimetre. For this unit Blondel has proposed the name "phot"; 1 millilumen per square centimetre (milliphot) is a practical derivative of the cgs. system; 1 foot-candle is 1 lumen per square foot and is equal to 1·0764 milliphots.

The milliphot is recommended for scientific records.

11. *Exposure.*—The product of an illumination by the time, Blondel has proposed the name "phot-second" for the unit of exposure in the cgs. system. The microphot second (0·000001 phot-second) is a convenient unit for photographic plate exposure.

12. *Specific luminous radiation, E'*—the luminous flux-density emitted by a surface, or the flux emitted per unit of emissive area. It is expressed in lumens per square centimetre.

Defining equation for surfaces obeying Lambert's cosine law of emission

$$E' = \pi b_0.$$

13. *Brightness, b,* of an element of a luminous surface from a given position, may be expressed in terms of the luminous intensity per unit area of the surface projected on a plane perpendicular to the line of sight, and including only a surface of dimensions negligibly small in comparison with the distance at which it is observed. It is measured in candles per square centimetre of the projected area.

Defining equation

$$b = dI/dS \cos\theta,$$

where θ is the angle between the normal to the surface and the line of sight.

14. *Normal brightness, b_0,* of an element of a surface (sometimes called specific luminous intensity) is the brightness taken in a direction normal to the surface.‡

Defining equation

$$b_0 = dI/dS,$$

or when uniform

$$b_0 = I/S.$$

15. *Brightness* may also be expressed in terms of the specific luminous radiation of an ideal surface of perfect diffusing qualities—*i.e.*, one obeying Lambert's cosine law.

16. *Lambert*—the cgs. unit of brightness, the brightness of a perfectly diffusing surface radiating or reflecting 1 lumen per square centimetre. This is equivalent to the brightness of a perfectly diffusing surface having a coefficient of reflection equal to unity and an illumination of one phot. For most purposes the millilambert (0·001 lambert) is the preferable practical unit.

A perfectly diffusing surface emitting 1 lumen per square foot will have a brightness of 1·076 millilamberts.

Brightness expressed in candles per square centimetre may be reduced to lamberts by multiplying by $\pi = 3·14$.

Brightness expressed in candles per square inch may be reduced to foot-candle brightness by multiplying by the factor $144\pi = 452$.

Brightness expressed in candles per square inch may be reduced to lamberts by multiplying by $\pi/6·45 = 0·4868$.

In practice no surface obeys exactly Lambert's cosine law of emission; hence the brightness of a surface in lamberts is, in general, not numerically equal to its specific luminous radiation in lumens per square centimetre.

Defining equation

$$L = dF/dS$$

or when uniform

$$L = F/S.$$

17. *Coefficient of reflection*—the ratio of the total luminous flux reflected by a surface to the total luminous flux incident upon it. It is a simple ratio. The reflection from a surface may be regular, diffuse or mixed. In perfect regular reflection all of the flux is reflected from the surface at an angle of reflection equal to the angle of incidence. In perfect diffuse reflection the flux is reflected from the surface in all directions in accordance with Lambert's cosine law. In most practical cases there is a superposition of regular and diffuse reflection.

18. *Coefficient of regular reflection* is the ratio of the luminous flux reflected regularly to the total incident flux.

19. *Coefficient of diffuse reflection* is the ratio of the luminous flux reflected diffusely to the total incident flux.

Defining equation: Let m be the coefficient of reflection (regular or diffuse). Then for any given portion of the surface

$$m = E'/E.$$

20. *Lamp*—a generic term for an artificial source of light.

21. *Primary luminous standard*—a recognised standard luminous source reproducible from specifications.

22. *Representative luminous standard*—a standard of luminous intensity adopted as the authoritative custodian of the accepted value of the unit.

23. *Reference standard*—a standard calibrated in terms of the unit from either a primary or representative standard and used for the calibration of working standards.

24. *Working standard*—Any standardised luminous source for daily use in photometry.

25. *Comparison lamp*—a lamp of constant but not necessarily known candle-power against which a working standard and test lamps are successively compared in a photometer.

26. *Test lamp*, in a photometer—a lamp to be tested.

27. *Performance curve*—a curve representing the behaviour of a lamp in any particular (candle-power, consumption, &c.) at different periods during its life.

28. *Characteristic curve*—a curve expressing a relation between two variable properties of a luminous source, as candle-power and volts, candle-power and rate of fuel consumption, &c.

29. *Horizontal distribution curve*—a polar curve representing the luminous intensity of a lamp or lighting unit in a plane perpendicular to the axis of the unit, and with the unit at the origin.

30. *Vertical distribution curve*—a polar curve representing the luminous intensity of a lamp or lighting unit in a plane passing through the axis of the unit and with the unit at the origin. Unless otherwise specified, a vertical distribution curve is assumed to be an average vertical distribution curve, such as may in many cases be obtained by rotating the unit about its axis and measuring the average intensities at the different elevations. It is recommended that in vertical distribution curves, angles of elevation shall be counted positively from the nadir as zero to the zenith as 180 deg. In the case of incandescent lamps it is assumed that the vertical distribution curve is taken with the tip downward.

31. *Mean horizontal candle-power* of a lamp—the average candle-power in the horizontal plane passing through the luminous centre of the lamp.

It is here assumed that the lamp (or other light source) is mounted in the usual manner, or, as in the case of an incandescent lamp, with its axis of symmetry vertical.

32. *Mean spherical candle-power* of a lamp—the average candle-power of a lamp in all directions in space. It is equal to the total luminous flux of the lamp in lumens divided by 4π.

33. *Mean hemispherical candle-power* of a lamp (upper or lower)—the average candle-power of a lamp in the hemisphere considered. It is equal to the total luminous flux emitted by the lamp in that hemisphere divided by 2π.

34. *Mean zonal candle-power* of a lamp—the average candle-power of a lamp over the given zone. It is equal to the total luminous flux emitted by the lamp in that zone divided by the solid angle of the zone.

35. *Spherical reduction factor* of a lamp—the ratio of the mean spherical to the mean horizontal candle-power of the lamp.*

36. *Photometric tests* in which the results are stated in candle-power should be made at such a distance from the source of light that the latter may be regarded as practically a point. Where tests are made in the measurement of lamps with reflectors or other accessories at distances such that the inverse square law does not apply, the results should always be given as "apparent candle-power" at the distance employed, which distance should always be specifically stated.

The output of all illuminants should be expressed in lumens.

37. *Illuminants should be rated* upon a lumen basis instead of a candle-power basis.

38. *The specific output of electric lamps* should be stated in terms of lumens per watt, and the specific output of illuminants depending upon combustion should be stated in lumens per British thermal unit per hour. The use of the term "efficiency" in this connection should be discouraged.

When auxiliary devices are necessarily employed in circuit with a lamp, the input should be taken to include both that in the lamp and that in the auxiliary devices. For example, the watts lost in the ballast resistance of an arc lamp are properly chargeable to the lamp.

39. *The specific consumption* of an electric lamp is its watt consumption per lumen. "Watts per candle" is a term used commercially in connection with electric incandescent lamps, and denotes watts per mean horizontal candle.

40. *Life tests*—Electric incandescent lamps of a given type may be assumed to operate under comparable conditions only when their lumens per watt consumed are the same. Life test results, in order to be compared, must be either conducted under or reduced to comparable conditions of operation.

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* This unit, which is used also by many other countries, is frequently referred to as the international candle.

† A uniform source of one candle emits 4π lumens.

‡ In practice, the brightness b of a luminous surface or element thereof is observed, and not the normal brightness b_0. For surfaces for which the cosine law of emission holds, the quantities b and b_0 are equal.

* In the case of a uniform point source, this factor would be unity, and for a straight cylindrical filament obeying the cosine law it would be $\pi/4$.

41. *In comparing different luminous sources*, not only should their candle-power be compared but also their relative form, brightness, distribution of illumination and character of light.

42. *Lamp Accessories.—A reflector* is an appliance the chief use of which is to re-direct the luminous flux of a lamp in a desired direction or directions.

43. *A shade* is an appliance the chief use of which is to diminish or to interrupt the flux of a lamp in certain directions where such flux is not desirable. The function of a shade is commonly combined with that of a reflector.

44. *A globe* is an enclosing appliance of clear or diffusing material the chief use of which is either to protect the lamp or to diffuse its light.

45. *Photometric hints and abbreviations.*

Photometric quantity.	Name of unit.	Symbols and defining equations.	Abbreviation for name of unit.
1. Luminous flux	Lumen	F. Ψ	l
2. Luminous intensity	Candle	$I=\frac{dF}{d\omega}$, $\Gamma=\frac{d\Psi}{d\omega}$	c.p.
3. Illumination	Phot, foot-candle, lux	$E=\frac{dF}{dS}=\frac{I}{r^2}\cos\theta$ β	ph. fc.
4. Exposure	Phot-second micro-phot-second	Et	phs. μphs.
5. Brightness	Apparent candle per sq. cm. Apparent candle per sq. in.	$b=dI/dS\cos\theta$	...
	Lambert	$L=dF/dS$	...
6. Normal brightness	Candles per sq. cm. Candles per sq. in.	$b_0=dI/dS$	
7. Specific luminous radiation	Lumens per sq. cm. Lumens per sq. in.	$E'=\pi b_0$, β'	...
8. Coefficient of reflection	...	$m=E'/E$	...
9. Mean spherical candle-power		scp.	
10. Mean lower hemispherical candle-power		lcp.	
11. Mean upper hemispherical candle-power		ucp.	
12. Mean zonal candle-power	...	zcp.	
13. Mean horizontal candle-power		mhch.	

14. 1 lumen is emitted by 0·07958 spherical candle-power.
15. 1 spherical candle-power emits 12·57 lumens.
16. 1 lux = 1 lumen incident per square meter = 0·0001 phot = 0·1 milliphot.
17. 1 phot = 1 lumen incident per square centimetre = 10,000 lux = 1,000 milliphots = 1,000,000 microphots.
18. 1 milliphot = 0·001 phot = 0·929 foot-candle.
19. 1 foot-candle = 1 lumen incident per square foot = 1·076 milliphots = 10·76 lux.
20. 1 lambert = 1 lumen emitted per square centimetre of a perfectly diffusing surface.
21. 1 millilambert = 0·001 lambert.
22. 1 lumen emitted per square foot* = 1·076 millilamberts.
23. 1 millilambert = 0·929 lumen emitted per square foot.*
24. 1 lambert = 0·3183 candle per square centimetre = 2·054 candles per square inch.
25. 1 candle per square centimetre = 3·1416 lamberts.
26. 1 candle per square inch = 0·4868 lambert = 486·8 millilamberts.

46. *Symbols.*—In view of the fact that the symbols heretofore proposed by this Committee conflict in some cases with symbols adopted for electric units by the International Electrotechnical Commission, it is proposed that where the possibility of any confusion exists in the use of electrical and photometrical symbols, an alternative system of symbols for photometrical quantities should be employed. These should be derived exclusively from the Greek alphabet; for instance—

Luminous intensity	Γ
Luminous flux	ψ
Illumination	β

OVERSEAS TRADE OF THE GENERAL ELECTRIC CO.

Various suggestions have been made for a constructive policy to enable British manufacturers to take the fullest advantage of the overseas trade, which is confidently expected to develop after the war. Many of the proposals involve a drastic reorganisation of pre-war methods as followed by the general run of British industrial concerns. They demand not only co-ordination in manufacture, but a wide extension of the means taken to secure business and carry out orders in the world's markets. In connection with this subject it is interesting to realise that the organisation put into action by the General Electric Co. (Ltd.) before the war is precisely of the character towards which war-awakened enterprise in other countries is now tending. The war will not bring about any material change in this organisation; all that will be necessary is that the machinery already at work should "carry on" upon the broader basis which trade growth after the war will demand.

The dominating feature in electrcal overseas trade is the activity of large electrical manufacturing companies which canvass actively for business in even the remotest corners. The pace is set, so to speak, by the Amercan and German electrical combinations, which have enjoyed protected home markets and other advantages not yet granted to British firms. Competition under such conditions has not been an easy matter, but it has not been found impossible. Recognising that it was essential to conduct operations on a scale comparable with that of the chief rivals abroad, the G.E.C. set itself many years ago to build up overseas companies capable of supplying the electrical demands of all the chief markets. These companies, through their connection with the co-ordinated manufacturing concerns of the G.E.C. in Great Britain, were able to quote for complete electrical installations. They were, moreover, provided with staffs capable of erecting the installations and putting them into operation. This organisation has reached so high a stage of development that the overseas companies have not only laid down complete power plants, but have actually placed stock orders for electric supply equipments, including power houses, switchboards, transformers, distribution cables, lamps, motors and all accessories. In a word, manufacturing and business-getting facilities have been correlated in a steady and vigorous growth. While the world-wide selling organisation directly benefits the general electrical engineering, the cable, telephone, instrument, carbon, lamp and other factories of the parent company, it also brings a great deal of grist to British manufacturers allied with the electrical industry. Orders for turbines and other steam-driven engines, for gas, oil and other internal combustion engines, for producer-gas installations, for boilers, condensers, pumps, economisers and numerous other accessories are involved in contracts for complete electric power equipments. Thus, the G.E.C. organisation acts as a feeder for the manufacturers of other non-electrical items, and has been the means of bringing orders to British firms from parts of the world where they were not represented. It may be of interest briefly to give some idea of the G.E.C. overseas organisation and of the kind of plant it supplies.

South Africa is covered by the British General Electric Co. (Ltd.), whose headquarters are at Johannesburg, with branches at Cape Town, Durban, Bulawayo and other places. There is a 1,000-kw. "Witton" generator at the power house of Durban Corporation, and is driven through gearing by a Parsons turbine. This is a typical example of plant sent abroad by the G.E.C. One of the special lines of activity of the South African company consists of complete town lighting schemes—Ermelo, Pietersberg and Bethel provide a few examples out of many. Undertaking to supply the whole of a power plant and distribution system, the South African company is able to deal with schemes in a manner far more satisfactory than if the plant and apparatus were ordered piecemeal. Much other important work in South Africa has been undertaken by this company, including, for instance, a pumping plant for the Rand Water Board.

In *Australia*, the British General Electric Co. (Ltd) is actively engaged in the electrical trade of the Commonwealth. Its headquarters are in Sydney; its branches are at Brisbane, Melbourne, Wellington (N.Z.) and other places. As a typical instance of "Witton" plant supplied to Australia, it may be mentioned that two 275-k.v.a. alternators have been supplied to Adelaide cement works. These sets are driven by Premier gas engines, and are interesting as the only gas-driven alternators to run in parallel in Australia, and their operation has been entirely satisfactory. Important work has been undertaken for the municipalities in Australia. Some years ago a motor generator was supplied to the Melbourne Corporation, and for this set a repeat order was given after many years of working. In addition, considerable work has been done in the smaller towns.

India is covered by the General Electric Co. (India) (Ltd.), with headquarters at Calcutta, and a branch at Madras. This company has secured many important Government contracts. Most electric motors make money for their users, but those installed in the Calcutta Mint make it rather more quickly than some others. The power plant at the Mint comprises three 270-kw. "Witton" continuous-current generators driven by Belliss engines, with a complete installation of "Witton" motors.

In regard to China, one of the most important of the G.E.C. overseas companies is the General Electric Co. of China (Ltd.) which is engaged in the heavy competition for the Chinese electrical trade. The headquarters are at Shanghai, with branches at Hong Kong and Hankow. A considerable number of complete electrical equipments for Chinese towns—for instance, Fatshan, Soochow, Ningpo and Yangchow—have been undertaken by this company. At Ningpo G.E.C. generators are driven by Belliss engines.

In South America, the Argentine is covered by the Anglo-Argentine General Electric Co. (Ltd.), of Buenos Aires and Chili, and other territories by Messrs. Huth & Co., of Valparaiso and other towns. Amongst the important plants installed by the G.E.C. may be mentioned the complete equipment of the power house of the large Chilian Naval Dockyard at Talcahuano, and the installation at the Concepcion flour mills, whilst in Brazil, G.E.C. machines are working in the Manaos power house.

For the Barcelona tramways a complete rotary converter installation has been supplied. France is covered by the General Electric de France, and Belgium by the G.E.C. of Belgium.

From the foregoing some idea will be gained of the overseas activities of the G.E.C. When, after the war, the home works are able to devote themselves to the huge volume of export trade, it is certain that the G.E.C. overseas selling organisation will be able to handle the trade and to divert it into British channels.

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* Perfect diffusion assumed.

LEGAL INTELLIGENCE.

W. T. Henley's Telegraph Works Co. (Ltd.) v. British & Foreign Agencies Co.

On Tuesday Mr. Justice McCardie and a common jury heard this action, in which plaintiff company claimed damages for the non-delivery of 3½ tons of copper wire. Defendants pleaded that there was no completed contract, but only negotiations.

Mr. J. B. Matthews, K.C., and Mr. Tyrrell were for plaintiffs; Mr. Ralph Bankes, K.C., and Mr. Douglas Hogg for defendants.

Mr. MATTHEWS said the defence was that there was no actual contract in writing, and that that being so there never was any contract at all. The question was really rather one of law than of fact, and turned to a great extent on the correspondence between the parties. W. T. Henley's Telegraph Works Co., who were manufacturers of submarine cables, used very large quantities of copper wire. Plaintiffs had known the partners in defendant firm (Messrs. Dennis & Pollock) for quite a number of years in connection with the copper trade. Being a young firm, defendants were anxious to do business with such a company as plaintiffs' and approached them with that object in view. From time to time they had invited plaintiffs to give them orders, and three or four contracts had been satisfactorily carried out. The present contract was entered into in December, 1915, when plaintiffs gave defendants an order for 3½ tons of ·028 plain copper at $12\frac{13}{16}$d. a pound, to be shipped from New York at the end of January, c.i.f. in London. Defendants were unable to give delivery of the goods, and eventually asked to be released from the contract.

Evidence was given to show that the price of electrolytic wire bars in January was £108, in February £136. 10s., and throughout March £136.

After legal argument, the jury found in favour of plaintiffs, for whom his lordship gave judgment for £147 and costs.

Lowe v. Weld.

Last week the Court of Appeal (Lords Justices Swinfen Eady and Bankes and Mr. Justice A. T. Lawrence) heard the appeal of defendant (Mr. C. J. Weld Blundell) from the verdict and judgment entered at the trial before Mr. Justice Ridley and a special jury.

Capt. W. H. Lowe, electrical engineer, brought the action against defendant to recover damages for alleged libel. The facts were given in THE ELECTRICIAN for March 10 last. The jury awarded £1,000 damages to plaintiff for whom judgment was entered. Defendant appealed upon the ground that the damages were excessive.

Mr. Mitchell Innes, K.C., and Mr. Theobald Mathew appeared in support of the appeal; and Mr. Lewis Thomas, K.C., and Mr. Cotes-Preedy for the respondent.

During the arguments Lord Justice Swinfen Eady suggested what sum the Court thought was a reasonable one to be paid by defendant and accepted by plaintiff, and in the result the appeal was ordered to stand over for 14 days to enable the parties to consider the proposal with the view to a settlement.

Electric Lamp Patent Case.—*Correction.* In the report given in our last issue (p. 227) of the action brought by the B.T.H. Co. against [illegible] A. Electrical Co. for infringement of patent, the efficiency of the lamp which was the subject matter of the patent, was given as 5 watts. Of course this should have been 0·5 watt.

PARLIAMENTARY INTELLIGENCE.

THE MARCONI-TELEFUNKEN AGREEMENT.

In the House of Commons last week, Mr. R. GWYNNE asked whether, under the agreement of 1913, the Marconi and Telefunken wireless telegraphy systems were technically and commercially combined, and whether any steps had been taken to prevent that combination proving a [illegible] under [illegible] conditions.

[illegible] the two systems had always been [illegible] with each other, and the agreement did [illegible] in any way, and did not involve a [illegible] of the two companies. The agreement ceased [illegible] and special measures were taken to [illegible] communication with the enemy.

[illegible] which may be of extreme importance [illegible] upon the managing director of a [illegible] the facts for themselves?

[illegible] carefully considered, and I am not [illegible] to ask the company to give information [illegible] regarding the arrangement between the two companies. I [illegible] that the facts are as I have stated.

[illegible] a German firm, and [illegible] arrangements between the [illegible] Company and a German company?

[illegible] the Marconi Company are prepared [illegible] that their arrangements were [illegible] before the war [illegible] advantage, but I have no power to ask the Marconi Company to make public the arrangement they had made prior to the war.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

13,951 COMPAGNIE DE SIGNAUX ELECTRIQUES POUR CHEMINS DE FER. Signalling on railways by detonators. (27/6/13.)

16,340 MARKS. (Siemens & Halske.) System of connections for telephone installations in which the work of the operators is supervised from special observation places.

1915 SPECIFICATIONS.

103 LA COUR, JR. Dynamo-electric machines for transforming alternating currents into continuous currents or vice versa, and applicable also as double current generators. (2/1/14.)

14,482 B.T.-H. CO. (G.E. Co.) Protective devices for electric distribution systems.

14,493 AKT. GES. BROWN, BOVERI ET CIE. Time limit electric circuit-breakers. (30/11/14.)

A circuit-breaker with time limit device for electric currents, in which the armature of the electromagnet is connected to an opposing spring through a time element controlled device, so that when the overload current acts the armature is attracted against the spring, but is disconnected therefrom when the time element has elapsed, and the armature then operates sharply with a large force to open the main switch.

14,503 HARRY W. COX & CO. & TEN BRUGGENKATE. Interrupters for inductive electric circuits.

An interrupter for inductive circuits comprising in combination means for projecting a jet or column of mercury, a mechanical device operating periodically to interrupt or cut the mercury jet or column, and a magnetic device operating to blow out or extinguish the arcing spark occurring at the moment of interruption.

14,633, 14,643 HEYS. (Neuland Patents, Ltd.) Dynamo-electric machines.

14,729 LONG. Arrangement of circuits for the transmission of æther waves—*e.g.*, those used in wireless telegraphy.

Relates to an arrangement of circuits in wireless telegraphy which consists in the employment of an oscillating circuit of low damping electromagnetically coupled to the existing and radiating circuits for the purpose of obtaining a single wave of very low damping in the aerial circuit under certain conditions of coupling.

14,851 B.T.-H. CO. & RALPH. Magneto-electric machines.

15,633 B.T.-H. CO. (G.E. Co.) Protective devices for electric circuits.

16,640 ELECTROMOTORS (LTD.), LONGBOTTOM & GREENHALGH. Dynamo-electric machinery.

17,160 STATTER & ST. JOHN. Accessories for use with telephones.

1916 SPECIFICATIONS.

1,116 VACUUM BRAKE CO., DOVER, H. J., & WALKER, W. P. Fluid pressure controlled collectors for electricity. (101,737.)

4,306 DIXON, A. F. Electric signalling systems and apparatus, particularly applicable to automatic multiplex printing telegraphy. (22/4/15.) (100,306.)

5,750 UNITED STATES METALS REFINING CO. Electrolytic refining or extracting process. (20/4/15.) (100,318.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 9, 1916.

14,312 CRAVEN. Telephone switchboard plug.
14,322 HAMILTON. Cable-hauling sheaves.
14,325 BEARD & ELECTRICAL IMPROVEMENTS. Protecting devices for multiphase alternating-current apparatus.
14,345 CHITTY. Electric-machines.
14,348 COWPER-COLES. Electrodeposition of lead.
14,351 COWPER-COLES. Coating metallic sheets, &c., with lead.
14,355 SUBMARINE WIRELESS CO. Sound-operated circuit controller. (19/5/16, U.S.)
14,358 YOUNG. Signalling apparatus.

October 10, 1916.

14,363 CARNDUFF. Ships' telegraphs.
14,367 MACTAGGART & SCOTT. Telemotor apparatus.
14,371 WELLER. Preparation of material applicable for varnish, insulation, &c.
14,383 BOYCE & BRUSH ELECTRIC ENGINEERING CO. Collection of electric currents from revolving apparatus.
14,416 GILES. Electric condensers. (13/10/15, Switzerland.)
14,417 & 14,423 DURNFORD & SUBMERSIBLE & J. L. MOTORS. Electric motors.
14,422 DURNFORD & SUBMERSIBLE & J. L. MOTORS. Pumps and electric motors.

October 11, 1916.

14,425 LANCASTER. Route indicator for tramcars, &c.
14,439 SAVILLE. Electrodes.
14,466 MOFFATT. Electric furnaces.
14,467 STUART. Electrolytic deposition of copper from acid solutions.

October 12, 1916.

14,509 BERRY & BRITISH ELECTRIC TRANSFORMER CO. Ellwood electric connections.
14,518 B.T.-H. CO. (G.E. Co., U.S.) Electric ship propulsion.
14,521 & 14,522 SYKES INTERLOCKING SIGNAL CO. Electric commutators.
14,524 HAUSSEN. Electrically sterilising foods. (12/10/15, Norway.)
14,542 WADE. (Orlandi & Meucci.) Burglar alarms.
14,546 WESTERN ELECTRIC CO. Duplex circuits. (13/10/15, U.S.)

October 13, 1916.

14,566 MARSHALL. Magnetic controlling devices.

October 14, 1916.

14,631 CAPAC[illegible]. Electric treatment of organic and inorganic substances.
14,643 ALLGEMEINE ELEK.-GES. Electric incandescent lamps filled with argon. (11/11/15, Germany.)
14,6[illegible] FLETCHER & HALLIMOND. Electric magnetic separator.

October 16, 1916.

14,6[illegible]8 WHITAKER. Electric cables and electric protection schemes.
14,660 BLANCH & FAVERO. Sparking plugs.
14,663 T[illegible]. Sparking plugs.
14,666 SIMPSON. Telephones.
14,670 BOOTH. Telegraph alarm.
14,6[illegible] MUELLER & UNIVERSAL OXYGEN CO. Electrolysing apparatus.
14,699 FERRANTI. Electric welding.
14,7[illegible]3 CA[illegible]. Combined electric lamp-holder and movable jointed bracket.

October 17, 1916.

14,717 BULLOCK. Therapeutic electric chair.
14,7[illegible] TAYLOR. Improving voltage regulation in alternating-current sub-stations, &c.
14,7[illegible] ACKE. Variable magnetically [illegible] reaction coil electric circuit.
14,745 CLARKE & FAIRHOLME. Apparatus for electrocuting animals.
14,767 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Vacuum type inverted converters. ([illegible]/11/15, U.S.)
14,768 OLDHAM. Separators for electric batteries.
14,[illegible]6 VANDERVELL. Dynamo-electric machines.
14,[illegible] HENDERSON. Gyro[illegible].

October 18, 1916.

14,[illegible]1 MORRIS. Bayonet cap with lamp-holder.
14,[illegible]7 IRELAND. Sparking plugs.
14,[illegible] NAYLOR & TYLER. Electrodes.
14,[illegible] [illegible]. [illegible] & electric lamps.
14,[illegible]1 B.T.-H. CO. (G.E. Co., U.S.) Vacuum pumps.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

Experiment in Co-operation.

The firm of Turner Bros. (Ltd.), of Rochdale and Trafford Park, are making an interesting experiment in order to prove to their workpeople the importance of co-operation and the advantage of making themselves more efficient and inducing them to make suggestions as to how machinery and methods might be improved.

Both of these ideas have been put into practice at Trafford Park, where there are nearly 500 employés, and at Rochdale, where they number four times as many. At Trafford Park, efficiency classes, which are held in working hours, are being attended by all sections of the working community, with (it is stated) gratifying results. According to Mr. R. J. Wilson, the manager, the firm has been "simply inundated" with suggestions of improvements. For each suggestion which is deemed to have merit a reward of 10s. is offered, and if it should prove practicable enough to be put into force the reward is doubled. At the end of the year a prize of £10 is to be added for the suggestion which proves to have been the best, £7 for the second best and £5 for the third.

In order to improve further the relations between the firm and the workpeople, facilities are given for periodical social gatherings, dances and concerts, a works choir has been formed, and nearly all of the boys of 14 to 18 years of age have been enrolled in the troop of Boy Scouts.

The inauguration of the experiment is due to Mr. Samuel Turner, jun., one of the joint authors of "Eclipse or Empire."

* * * *

Empire Industries.

The Trade and Industry Committee of the Royal Colonial Institute recently submitted the following resolution to the Governments of the Dominions and Colonial Governments having power to legislate, as well as to chambers of commerce, &c., in all parts of the Empire:—

That with a view to encouraging the establishment of new industries in the British Empire and giving a measure of confidence and security to capital to be embarked therein, as well as assisting the expansion of existing industries, the Governments of the Empire be urged to make it obligatory on all Government departments, municipalities, railways, dock and harbour boards, gas, water, and electric light corporations, and all such bodies spending public moneys, or enjoying charters from Government or other public authorities, to purchase Empire-made goods, and to place all contracts with British firms, exceptions to be made, by special permission of proper authority, only in cases where such a course is considered to be at variance with public interest.

In forwarding the resolution it was pointed out that if it were made compulsory in each part of the Empire that Government departments and municipal and other public bodies should place contracts only with British firms, it would prove a very strong factor in stimulating the establishment of new and the growth of existing industries, as well as consolidating inter-Empire trade. Sympathetic replies have been received from the Governments of the Dominion of Canada and the Provinces of New Brunswick, Manitoba, Nova Scotia, Saskatchewan and Ontario; from South and Western Australia, Newfoundland, Hong Kong, Straits Settlements, Ceylon, Jamaica, British Guiana, Trinidad, Barbadoes, the Leeward and Windward Islands, Bermuda, British Honduras, Gambia, Seychelles, and the Nyasaland Protectorate, and from a number of chambers of commerce.

Chambers of Commerce and Alien Members.

Many Chambers of Commerce have altered their articles of association in order to remove alien members and to preclude the possibility of their election at any future time Last week a special meeting of the Manchester Chamber of Commerce was held to consider the subject.

After discussion a resolution was passed—that after Sept. 30, 1916, no German, Austrian, Bulgarian, or Turk who had not before Aug. 1, 1904, become a naturalised British subject, and no firm, corporation, company, association or society, or representative of a firm, corporation, company, association or society in which a German, Austrian Bulgarian or Turk who had not before Aug. 1, 1904, become a naturalised British subject was a partner or director, or in the case of an unincorporated association or society was a member, and no corporation or company in which one-fifth or more of the issued stock or share capital or of the debenture or loan capital was held by or for the benefit of any German, Austrian, Bulgarian or Turk who had nor before Aug. 1, 1904, become a naturalised British subject should be eligible for or admissible to membership of the Chamber

* * * *

Engineering Workers and Industrial Control.

What is referred to as a "rank and file" conference, promoted by the Metal, Engineering and Shipbuilding Amalgamation Committee, was held at Leeds last week.

The gathering was stated to be the outcome of a conference held in August last in London, at which a resolution was passed calling upon the executive committees of all unions of engineering workers to fuse all the sectional organisations into one industrial union, embracing every worker in the industry, regardless of craft, grade or sex.

In opening the conference on Saturday, the chairman, Mr. Dan Roll (Amalgamated Society of Engineers), said that merely to secure amalgamation of the sectional unions for getting larger benefits or increase of wages or a shortening of hours was not sufficient. The chief object of amalgamation must be to secure the control of the industry.

Mr. W. F. WATSON, secretary of the Committee, observed that owing to the war their activities had for some time been in abeyance, but by September, 1915, the repression of the legislation which had been projected by the Government had had an effect on the rank and file of the unions, which were beginning to look around for a method of strengthening their position in the industrial field. Over 2,000 had subscribed to the amalgamation as associate members since January last; 6,000 votes had so far been given for amalgamation, and by the end of the year they would have 200,000 to 250,000. The great feeling that was behind the movement was that they were out definitely for the control of the industry, and, having achieved that, they proposed to run it in the interests of the whole of the people, and not in the interests of "the international gang of sneak-thief financiers."

The following resolution was carried with one dissentient: "That realising that as at present organised the trade union movement is entirely inadequate, this conference of the rank and file demands that the executives of all unions (catering for engineering and shipbuilding workers) immediately get together and formulate a practicable scheme of amalgamation that shall fuse all sectional unions into one industrial union, having as its object the organisation of all workers in the industry regardless of craft or sex; and, as its ultimate aim, the control of industry for the complete abolition of the wages system."

An amendment to delete the words "regardless of craft or sex" was defeated by a large majority. The conference expressed the opinion that action should be taken on the initiative of the Amalgamated Society of Engineers within three months.

* * * *

Registration of Electricians in U.S.A.

According to the "Electrical World," there were on Dec. 31 last 1,187 electricians registered in the department of gas and electricity of Chicago, an increase of 196 over 1914.

The registration of electricians is stated to be giving excellent satisfaction, as the supervision which this registration affords the department ensures a more rigid compliance with the rules than was heretofore maintained. The enforcement of the ordinance requiring registration has protected the public against inferior work by irresponsible contractors.

* * * *

Japanese Trade with Australia.

In order to meet the requirements of the greatly increased trade between Japan and New Zealand the Nippon Yusen Kaisha have inaugurated a service of steamships between the two countries.

The first vessel left Yokohama for Wellington on Aug. 24, and it called at Melbourne and other Australian ports. Besides toys, the vessel carried general Japanese merchandise, including glassware, porcelain, electrical fittings, enamelled wares, &c. Messrs. Mitsui & Co. (the Mitsui Busan Kaisha) also intend to operate a monthly service of cargo steamers between Japan and Sydney and Melbourne.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Nov. 11, 1916, *to* Nov. 17, 1916

IMPORTS.

FOLKESTONE.—*France:* Elec. apparatus, 17 c.s.; elec. carbons, 40 c.s.; unenumerated 17 cases.

LONDON.—*U.S.A.:* Elec. motor, 1 c.s.; electrodes, 42 c.s.; unenumerated, £1,601—1,014 c.s. *Holland:* Elec. glow lamps, £6,215—64 c.s.; elec. bulbs, 236 pkgs.; elec. lamps, 898 pkgs.; elec. batteries, 50 pkgs.; unenumerated, £71—998 pkgs. *Japan:* Unenumerated, £1,067—1,868 pkgs.; *Switzerland:* Unenumerated, £1,664. *France:* Elec. wire, 16 pkgs.; unenumerated, £582 c.s. *Canada:* Wire and cable, £30; unenumerated, £95. *Denmark:* Unenumerated, £578. *Sweden:* Unenumerated, £601. *Italy:* Unenumerated, £470.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £787. *Melbourne:* Wire and cable, £74; elec. machinery, £989; elec. meters, £411; unenumerated, £967. *Sydney:* Elec. machinery, £620; elec. lamps, 2,450 n.o.; unenumerated, £3,078. *Wellington:* Elec. lamps, 584 n.o.; wire and cable, £70; elec. machinery, £356; unenumerated, £996. *Lyttelton:* Wire and cable, £137; unenumerated, £13. *Adelaide:* Unenumerated, £3,273 *Christchurch:* Telegraph material, £93; unenumerated, £525. *Brisbane:* Wire and cable, £57; unenumerated, £761. *Dunedin:* Wire and cable, £212; elec. lamps, 3,100 n.o. unenumerated, £881. *Invercargill:* Wire and cable, £52; unenumerated, £14. *Oamaru:* Elec. machinery, £240.

AFRICA.—*Durban:* Wire and cable, £1,861; elec. machinery, £551; elec. lamps, 17,888 n.o.; unenumerated, £2,364. *Cape Town:* Wire and cable, £538; elec. machinery £921; elec. lamps, 2,500 n.o.; unenumerated, £1,954. *Port Elizabeth:* Unenumerated, £536. *Delagoa Bay:* Elec. machinery, £1,440; *Laurenco Marques:* £105. *Beira:* Wire and cable, £50; unenumerated, £912. *Chinde:* Unenumerated, £210. *Ascension:* Telegraph material, £69. *Mombasa:* Wire and cable, £7; unenumerated, £35.

MALTA.—Unenumerated, £40.

EGYPT.—*Alexandria:* Unenumerated, £27. *Port Sudan:* Unenumerated, £14.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. lamps, 500 n.o.; wire and cable, £202; unenumerated, £1,017. *Calcutta:* Elec. machinery, £541; elec. lamps, 7,400 n.o.; unenumerated, £2,102. *Madras:* Unenumerated £67. *Ceylon:* Unenumerated, £359. *Singapore:* Elec. machinery, £214; unenumerated, £40, *Bangkok:* Unenumerated £57. *Penang:* Elec. machinery, £30; unenumerated, £20.

CHINA.—*Shanghai:* Unenumerated, £562. *Saigon:* Unenumerated, £60.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £207; telegraph material £16; unenumerated, £135. *Valparaiso:* Wire and cable, £142; telegraph material £49; unenumerated £95. *Rio de Janeiro:* Unenumerated, £42. *Montevideo:* Unenumerated, £41. *Santos:* Elec. machinery, £205. *Antofagasta:* Elec. lamps, £54. *Chile Rosario:* Wire and cable, £18; unenumerated, £62.

HOLLAND.—*Amsterdam:* Wire and cable, £1,150. *Rotterdam:* Unenumerated, £47.

FRANCE.—*Dieppe:* Wire and cable, £210; elec. machinery, £216; unenumerated, £18. *Paris:* Unenumerated £121. *Rouen:* Unenumerated, £858. *Marseilles:* Elec. machinery £170. *Bordeaux:* Unenumerated, £452.

NORWAY.—*Christiania:* Wire and cable, £634; unenumerated, £39.

PORTUGAL.—*Oporto:* Telegraph material, £100.

NORWAY.—*Bergen:* Unenumerated, £136.

RUSSIA.—*Vladivostok:* Elec. machinery, £597. *Petrograd:* Elec. machinery £495; unenumerated £374.

CANADA.—*Quebec:* Unenumerated £40.

U.S.A.—*Boston:* Unenumerated £10.

FOREIGN GOODS (duty paid and free).

Durban: Elec. lamps, 1,569; unenumerated, £48. *Cape Town:* Elec. lamps, 4,900; unenumerated, £19. *Port Elizabeth:* Unenumerated, £36. *Bankok:* Unenumerated £20. *Beira:* Unenumerated £62. *Boston:* Unenumerated, £23. *Calcutta:* Elec. machinery £370. *Napier:* Unenumerated, £13. *Paris:* Unenumerated, £712. *[illegible]hampton:* Unenumerated £40.

IN TRANSIT.

Adelaide: Elec. lamps, £408. *Sydney:* Elec. lamps, £1,039.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Shares for Sale by Tender.—The Public Trustee invites tenders for the purchase of the whole (or any part) of 26,001 £1 preference and 7,400 £1 ordinary shares of the Sterling Telephone & Electric Co. (Ltd.), vested in him as Custodian by an order of the Board of Trade dated Aug. 1, 1916. Tenders are to be delivered to the Public Trustee (Mr. C. J. Stewart), Kingsway, London, W.C., by noon on Friday, Dec. 8. Forms of tender from the Public Trustee or from Messrs. W. B. Peat & Co., 11, Ironmonger-lane, London, E.C. Particulars of the issued capital, profits, location of offices and works, &c., are given in an advertisement.

The partnership between Sidney T. Jolley, E. Tickett and L. Tickett, accumulator manufacturers, Woodham's yard, Bournemouth Park road, Southend on Sea, has been dissolved, so far as concerns Mr. [illegible]

Plant for Sale.—Messrs. Barlow & Young, 25, Catherine-street, Westminster, S.W., have for sale some a.c. motors, with pulleys, belting, &c.—*See an advertisement.*

Messrs. Marshall, Sons & Co. (Ltd.), 79, Farringdon-road, London, E.C., advertise for sale a Willans high speed enclosed engine direct coupled to [illegible] dynamo, 230 v., 500 amperes, 350 r.p.m.

ELECTRICITY SUPPLY.

EXTENSIONS.

Dundee.—The Scottish Office has sanctioned further expenditure of £27,080 on the extension of the electricity supply works, but on condition that a contribution of £[illegible] is made towards the cost of the contemplated extensions out of revenue, and also that provision is made for the reduction of the loans raised under the sanction by setting aside annually to a sinking fund not less than 4 per cent. of the amount borrowed.

Hull.—The acting electrical engineer (Mr. J. F. Magoris) has reported that it is necessary to proceed with the erection of the water-cooling plant authorised in February, 1915 (but subsequently postponed as the result of representation from H.M. Treasury), so as to have the plant in commission during the summer of next year.

Since the above date the output of the electricity undertaking has increased by over 30 per cent.

The Electricity Committee has now applied for the sanction of the L.G. Board to the borrowing of the necessary capital.

Lowestoft.—It is proposed to lay a cable for supplying electrical energy to new premises of Messrs. Brooke & Co. outside the borough boundary, at a cost of £200.

Wednesbury.—The Council has received sanction to the borrowing of £6,690 for extensions of the electricity works.

GENERAL.

Alleged Preferential Charging.—Hackney (London) Electricity Committee report that a writ has been issued by the Gas Light & Coke Co. against the Borough Council asking for :—

(1) A declaration that Council are acting in breach of the provisions of the Electric Lighting Act, 1882, in supplying electricity for lighting purposes to persons who also take electricity for power at a lower rate than they supply to persons who take current for lighting only; (2) An injunction to restrain defendants from making any such differentiation in the rates charged by them for the supply of electricity in breach of the provisions of the said Act. The Committee have caused an appearance to be entered on behalf of the Council, who will defend the action.

Glasgow.—At the meeting of the Corporation last week Mr. Wheatley asked the convener of the Electricity Committee whether the men in military uniform engaged on street work in connection with the department were being paid the same rate of wages and given the same conditions of labour as the men usually employed on that work, or were they merely being paid at soldiers' rates and working under military discipline.

In reply, Mr. HANNAY said the military working party doing labouring work for the street mains section of the electricity department were paid the same rate of wages for such work and had the same hours and working conditions as ordinary squad labourers. Payment was made to the Paymaster of the Scottish Command, who, after making deductions for food and billeting, paid the balance to the men.

A further question as to whether the sanction of the Committee and the Corporation had been obtained to the placing of the industrial work of the Corporation under the control of the military authorities, was ruled out of order as no notice had been given.

Hackney (London).—Application is to be made to the L.C.C. for a loan of £6,500 in respect of the expenditure to be incurred in linking up the electricity undertaking with that of the North Metropolitan Electric Supply Co.

Kingstown.—The Urban Council have agreed to pay £100 to the consulting electrical engineer (Mr. J. B. Tierney) for the preparation of plans, &c., for the electricity supply scheme.

Middlesbrough.—The Mayor (Councillor J. Calvert) has been re-elected chairman of the Gas and Electricity Committee.

The borough electrical engineer (Mr. Scotson) reports that the effect of "daylight" saving has been to reduce by 7½ per cent. the number of units used for lighting, but, in spite of this reduction, there has been an increase of £450 in the revenue for the past six months, compared with the same period of 1915.

Poplar (London).—The Borough Council will support the proposals of the National Electric Power Supply Joint Committee with reference to the inter connection of Electric Supply Stations.

St. Pancras.—Acting on the advice of the chief electrical engineer (Mr. G. W. Paynes), the Electricity Committee has decided that no new consumers shall be connected or additions to existing installations made, except when required for war purposes, owing to the difficulty in obtaining materials and to the shortage of the staff and generating plant, particularly boiler power. All applications will be carefully considered by the Committee.

Sheffield.—At a special meeting of the City Council on Friday last a proposal to buy the local gas works was rejected.

Stretford.—Owing to the Urban Council being unable to supply electric current to the exhibition buildings at Old Trafford, Manchester, the Automobile Show announced for Dec. 1 to Dec. 9, has been postponed.

Tottenham.—The General Purposes Committee has notified the North Metropolitan Electric Power Supply Co. to cease lighting all the arc lamps, and to provide, fix and light 50 c.p. incandescent lamps at 17 points as agreed by the Council.

Walthamstow.—The electrical engineer (Mr. G. R. Spurr) has reported the result of his negotiations with regard to supplying Messrs. Peter Hooker (Ltd.) with from 750 H.P. to 1,000 H.P., and application is to be made by the Council for a loan of £13,140 under the Coventry terms and conditions and a grant of £8,063.

TRACTION NOTES.

Bradford.—The tramcar service is to be curtailed in the evening, and on all routes the service will in future cease half an hour earlier.

The general manager of the Corporation Tramways (Mr. C. J. Spencer) has had an interview with Lord Derby on the general question of men under 30 years of age in the tramway service, and it was agreed that certain exchanges should be made.

It appeared that there were in the Army a number of former corporation employees who had failed from the military point of view, but who were all right for tramway service; and it was proposed that these men should come back and so release Class A men, who were at present employed on the tramways. A scheme of substitution is being arranged.

Brighton.—The Council have agreed to the proposal of Messrs. Tilling (Ltd.) to acquire the whole of the omnibus services in Brighton and Hove.

Negotiations had been in progress for some months to secure single control. In agreeing to the transfer of the licences, the Corporation reserve their full rights under the Act sanctioning railless traction and the leasing of motor omnibuses, which may be brought into operation after the war.

Electric Traction in the U.S.A.—It is announced that the Chicago, Milwaukee and St. Paul Railway Co. has increased its electrically-operated mileage in Montana by 110 miles, the new section extending from Deer Lodge to Alberton, and bringing the total length of electrified line to 336 miles. The last section (between Alberton and Avery, Idaho) will probably be opened for traffic about the commencement of next year. When completed the total length of the electric system will be 440 miles, extending from Harlowton, Montana, to Avery, Idaho.

L. & S.W. Railway.—The electrification of the line to Claygate has now been completed, and a half-hourly service of electric trains was started on Monday.

Newcastle-on-Tyne.—The manager of the Corporation tramways (Mr. E. Hatton) has been requested by the motormen to stop the tramway service at 10.30 each evening.

The request has been made by the men owing to the excessive strain upon the men who drive the cars through many hours of darkness, and who have also to resume work early in the mornings under similar conditions of restricted or non-existent street lighting.

Plymouth.—The Tramways Committee has decided to buy land to facilitate the working of the trams at the Pennycomequick corner, and also in Pound street to double a length of line at the entrance to Coburg street.

The effect of through running and the penny fare has been to increase the number of passengers and the receipts. The success of the scheme has been phenomenal, and it is expected to continue. Eight new tramcars are on order.

Rossendale Tramways Arbitration.—Mr. J. M. McElroy, general manager of the Manchester Tramways, sat at Bacup on Monday as Board of Trade arbitrator to determine the difference between Rawtenstall and Bacup Corporations as to the proposal of Rawtenstall to alter and increase the tramway stages and fares on the electric tramway system between Rawtenstall and Bacup.

Rawtenstall Corporation proposed to increase the number of stages between Bacup and Waterfoot, so that the fares would be 1½d. from Bacup to Stacksteads and 2½d. from Bacup to Waterfoot, instead of 1d. and 2d. respectively. The contention of Rawtenstall was that Bacup passengers were getting more than their due proportion out of the present stages, as they got an undue advantage over passengers using the length between Waterfoot and Rawtenstall. Bacup Corporation contended that the whole of the increases proposed were in Bacup borough, and held that the existing fares of 1d. to Stacksteads and 2d. to Waterfoot, which had been originally fixed, should not be altered.

Various representatives of both corporations gave evidence and the arbitrator reserved his decision.

Sunderland.—The tramway employés have been awarded increased wages as from Oct. 1 last.

In lieu of the present war wages, a war wage of 6s. per week will be paid to all adult conductors (male and female), motormen, cleaners, trackmen and handymen, and high and low shed men, and a war wage of 3s. 6d. per week to all point boys and shed lads.

Tramway Stoppages.—Birmingham is not the only place where difficulty is experienced in maintaining a full supply of electrical energy for the tramway service.

At Walsall on Monday there was a suspension of the tramway service for between two and three hours. Owing to a failure in the supply of current the service on all sections was brought to a standstill about 9.30 a.m., and was not resumed until shortly after noon. The manager of the electricity supply department (Mr. Howie) explained that, it being a very dark morning, there was a very big overload on the plant at the power station, and as it was found steam pressure was being lost it became imperative to curtail the supply of current. The only thing to do was to cut off the tramways, as the department felt it was imperative not to take any measures which would have interfered with the supply to factories. Owing to existing conditions, the department is short of boiler power at the new station. On Monday one of the boilers had to be cleaned out, and another boiler could not be got under steam until dinner-time.

There was also a slight dislocation of the Corporation tram service in Wolverhampton on Monday, due to a temporary breakdown at the electricity station. The defect was soon put right, and the ordinary service was resumed.

Walthamstow.—The Clerk is to communicate with the Commissioner of Police pointing out the increasing scarcity of men suitable for employment as motor men on the tramways, and urging that women should be licensed as drivers.

Women Tramcar Drivers in Paris.—The Prefect has authorised the tramways company to employ female drivers. They will commence their duties in January next.

TELEGRAPH AND TELEPHONE NOTES.

Hull.—The Telephone Committee have awarded bonuses of 4s. a week to males over 18 whose wages do not exceed 40s. a week, and of 3s. to those whose wages exceed 40s., but do not exceed 60s. a week. Females and males under 18 are to receive half these amounts.

Press Telegram Rates.—The Postmaster-General announces that owing to the restriction on the introduction of paper into the United Kingdom, and to the present state of disorganisation and disturbance due to the war, he proposes to postpone the operation of the new press telegraph rates until Jan. 1, 1918.

The new rates (which would have come into force in January next) would have reduced from 75 to 60 the number of words that can be sent for 1s. during the daytime, and from 100 to 80 the number of words at night. The scale for multiple-address telegrams was also to have been raised.

Telephony in Argentina.—The United River Plate Telephone Co. has been authorised by the Argentine National Government to establish a branch office at Fisherton (Rosario).

A petition for a concession for the exploitation of an automatic telephone service, presented by Mr. Alex. Schwinmer to the Municipality of Buenos Ayres, has been referred by the Intendency to the Municipal Commission. The accompanying message (from the Executive Department) states that the establishment of the new service proposed ought to be beneficial, as it is undoubted "that the proposed system represents great improvements over those already in use." It is recommended that a clause giving the right either to the Municipality or to the National Government to expropriate the service should be added to the concession. It is also stated that a similar concession is asked for by Señor Ricardo Jurado, and the Executive say they "have no objection to according the concession to both or either of the applicants."

EMPIRE NOTES.

Australasia.—A deputation introduced by Mr. Davies, President of the Legislative Council of Victoria, recently waited upon the Premier of Victoria (Sir Alex. Peacock) to protest against the Government's scheme for the future control of the tramway systems of Melbourne and suburbs.

Mr. Davies said the municipalities had paid the price for cable tramways; they owned the tramways of Melbourne, and should appoint the new board. With regard to the proposal that railways should take a proportion of the profits of the tramway system, the municipalities were already giving a great deal to the Government. There was no justification for creating a separate board to control the tram system. Sir David Hennessy, Lord Mayor of Melbourne, stated that the tramways were faced with great difficulties; interest was high and the employees were making demands which would take £173,000 extra per annum if granted in full. All materials had risen in price. The Councils should have the right to nominate their own men to carry on the tramways. There was clear evidence that the tramway system was providing facilities which the railways were unable to supply.

After other speakers had expressed their views, Sir Alex. Peacock said as a matter of fact the battle the Government was fighting was for municipal ownership as against nationalisation. The Opposition and a large section of Parliament were in favour of nationalising the tramways. As to the method of management he would bring the views of the deputation before the Cabinet, but could not hold out any hopes that they would vary the bill.

Canada.—It is believed in official quarters that the waterpower resources of the Winnipeg River will eventually equal, if not actually surpass those of Niagara. The city of Winnipeg and the province of Manitoba have, therefore, with the potential powers of the Winnipeg River, an assurance and a guarantee of continued industrial, commercial and municipal growth.

The Hydro-Electric Commission has decided to double the capacity of the Toronto sub-station, to instal new switchgear, &c., at Port Dundas power house, to duplicate the Dundas–Toronto transmission line, and to increase the equipment at Niagara Falls. The capital cost is estimated at £200,000.

FOREIGN NOTES.

Italy.—It is stated in an American consular report that every hardware dealer in Venice and probably in all towns in the Veneto, handles electric and gas fixtures. Venice would hardly serve as a centre for Italian import trade, as the Veneto is generally supplied by wholesale dealers in Milan or Genoa.

Venice, however, was formerly visited at regular intervals by German and Austrian commercial travellers who, in order to obtain control over the market, quoted prices in Italian lire, including duty and carriage. Both electricity and gas are used for illumination in Venice and the principal towns in the district, though in smaller centres electricity is the only illuminant. The price of gas has greatly increased in some cities. In others gas lighting has ceased entirely or been diminished. An attempt is being made by the gas company that serves Venice to double the price of gas, and there is an increased use of electricity for lighting, power, heating and cooking. The use of the electric light was on the increase in the country towns even before the war, on account of the abundance of water power. There is a familiarity with English in commercial circles, but it will be found to advantage if correspondence is conducted in Italian. Italian firms usually require 90 to 120 days' credit.

New Trans-European Electric Railway.—M. Herriot, the Mayor of Lyons, is at the head of a movement in France for the construction of a great Trans-European railroad which would directly link up the Atlantic coast of France with Italy and South Russia.

Before the war the only communication overland between the Atlantic seaboard and Russia was through German territory. In order to obtain a sort of "right of way" which would make Russia, France and Italy independent of the German lines, it is proposed to promote the establishment of a Trans-Continental line which would closely follow the 45th parallel degree from Bordeaux, moving slightly northwards to Lyons thence to Turin, Milan and Venice. From Venice it would follow the Adriatic coast to Trieste, Fiume and Agram to the banks of the Danube, passing through Serbia and Rumania into South Russia, where its terminus would be at Odessa. The line would be 2,500 kilometres in length, and would closely cling to the southern slope of the great mountain ranges of Europe. The numerous water-falls and the character of the country would admit of the line being electrified throughout its entire length. There are said to be no material or engineering difficulties that could not be overcome. Many existing lines could be utilised, but would require widening and the laying down of an additional set of metals. It would link up Switzerland directly with the French Atlantic seaboard and greatly facilitate trade between Italy and the West of France. For this reason the Italian Government is said to favour the scheme, and correspondence has taken place on the subject between the French and the Italian Governments. M. Herriot thinks that the capital for such a line should be jointly guaranteed by France, Italy and Russia.

MISCELLANEOUS NOTES.

Building Construction.—Messrs. Spiers, Limited, 13, Blythswood Square, Glasgow, specialists in timber framed buildings, whose system of construction has been employed in connection with the erection of [illegible] [illegible] and Stores throughout Scotland, have been [illegible] [illegible] for the re-building of Dixmude and other towns in Belgium which have been devastated by the war.

We understand that the choice of the "Spiresque" type of building construction in Belgium is the outcome of a Light Buildings Exhibition recently held in Paris.

County of London Company's Advertising Design.—The design for an electric [illegible] [illegible] got out by the County of London Electric Supply Co., and reproduced a short time ago in these columns, has quickly achieved a wide popularity.

We learn that a large number of supply undertakings throughout the country have purchased copies of the poster and by arrangement with the County of London Electric Supply Co. Messrs. Bolling & Co. have used the design on the cover of their [illegible] [illegible], of which about 100,000 have been issued.

Electric Signalling with Bare Wires.—The West of Scotland Branch of the Association of Mining Electrical Engineers are organising a display of all the various types of electric bells that comply with Mr. Redmayne's report on this subject. The exhibit will be held on Jan. 20, 1917. Manufacturers desirous of exhibiting can obtain further particulars from the secretary, Mr. D. Landale Frew, 45, Hope-street, Glasgow.

Entertainment of Wounded Soldiers.—A party of 300 wounded soldiers were entertained by the employees of Siemens Dalston Lamp Works on Saturday, the 18th inst.

The Charrington Hall, St. Pancras, was kindly lent for the occasion by Mr. Hopkins, and every possible arrangement made to ensure the comfort and amusement of the guests. Nine motor 'buses were provided by Mr. A. Pegley to convey the men from the various hospitals to the Hall. The entertainment, which consisted of a concert, tea, and dancing, commenced at 2 p.m., the ladies of the Wotan Lamp Works having an opportunity of proving that they take a keen interest in social affairs; and we understand that each wounded "Tommy" had the attentions of a lady. A good proportion of the talent for the concert was drawn from the Dalston Works staff, but several professional friends readily gave their assistance. All the items were highly appreciated by the audience, and tea was served at 4 p.m., after which the hall was cleared for dancing. At about 6.45 the soldiers were conveyed back to their respective hospitals; incidentally, 200 of the party were from the King George's Hospital. It is hoped that this function, which was undertaken at the initiative of the workpeople themselves, will be one of a series of similar entertainments. The arrangements were in the hands of a committee, of which Mr. D. Woollon was secretary and Mr. F. Price treasurer.

Exports to Liberia.—The "London Gazette" of Nov. 10 contain corrections to names and addresses of persons and firms in Liberia in the list published Sept. 22 last as those to whom goods may be consigned from the United Kingdom, and the "London Gazette" of Nov. 21, contains a further list of persons and firms in Liberia to whom goods may be consigned.

Increased Charges for Electrical Energy.—Increases in charges are being made at the following places:—

Stepney Electricity Committee is increasing its charges, except in cases where there are special contracts by an additional 13⅓ per cent., making a total of 33⅓ over pre-war rates.

Bognor Gas Light & Coal Co. proposes to increase its charge for electrical energy from 6d. to 7d. per unit and to make a minimum charge for 20 units per quarter.

Epsom Council will charge from Dec. 1, 7d. per unit for lighting and, 3½d. for power and heating, with the option of sliding scale rates for large consumers, the minimum being 3½d. plus 25 per cent. for lighting and 1½d. for power.

Walthamstow Lighting Committee is increasing the rates for public and private lighting by 5 per cent. and for power and heating by 10 per cent.

Miners' Lamps Approved.—On Nov. 16 the Home Secretary issued an Order approving the following safety lamps for use in all mines to which the Coal Mines Act, 1911, applies:—

Kingsway miners' electric safety lamp, Davis-Edison accumulator miners' electric safety lamp, Cambrian officials' lamp No. 7, Pearson officials' pocket lamp.

The order also makes certain amendments in the specification of certain other safety lamps, approved in previous Orders.

Prohibition and Restriction of Exports.—On Nov. 17 His Majesty in Council approved of the following alterations in the Proclamation of May 10, 1916, in regard to the prohibition and restriction of exports:—

That the following be deleted:—(*b*) Emery, corundum and crystolin and manufactures thereof. (*b*) Mica, mica splittings, micanite and mica cloth.

That the following be added:—(*c*) Electrical apparatus and plant for the generation, distribution and utilisation of electric power, not otherwise prohibited. (*b*) Emery and corundum and manufactures thereof, carborundum, alundum, crystolin and all other artificial abrasives and manufactures thereof. Insulating materials the following:—(*c*) Compounds intended for the purpose of electrical insulation. (*c*) Oxides of lead. (*c*) Zinc, barium pigments made from zinc salts and barium sulphate. (*b*) Mica, mica splittings, mica powder, micanite, articles made therefrom, and insulating materials containing them. (*c*) Varnishes not otherwise prohibited.

Rifle Club Match.—A match between the "Ediswan" and "G.E.C." Rifle Clubs was "shot by post" on Saturday last under rather diverse conditions.

"Ediswan" shot on their outdoor range at Ponder's End, and we all remember what last Saturday's weather was like, which included in its menu snow, rain and a biting wind. The "G.E.C." were more fortunate in being able to shoot in their indoor range at Witton, no doubt heated by electric radiators. Being sportsmen, both teams had great faith in themselves; but it came as a great surprise to the "Ediswan" men to learn that they had won the match under such "trench like" conditions. The "Ediswan" team were represented at Witton by Mr. W. H. Fletcher, of their Birmingham branch, and the "G.E.C." team sent a very popular man to represent them in the person of Lieut. Ward. The scores were as follows: "Ediswan," 1,280—average, 80·00; "G.E.C.," 1,191—average 74·43. Team captains were: "Ediswan," A. J. Corbett; "G.E.C.," A. D. Mackay.

TENDERS INVITED.

Turbo-Alternator and Condensing Plant.

Durban Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-alternator and Condensing Plant. Specification (No. S.238) from Borough Electrical Engineer.

Electric Cable and Wire.

The Commissioners of H.M. Works, &c., invite tenders for the supply of Electric Cable and Wire during a period of one year from Jan. 1, 1917. Forms of tender, conditions of contract, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W., and tenders, to the Secretary, H.M. Office of Works, Storey's-gate, London, S.W., by 11 a.m. of 27th inst.

Motors, &c.

Cape Town (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

Motor-Generator, &c.

Dunedin (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

Telephone and Telegraph Material, Stores. &c.

Tenders are invited up to Dec. 22 for the supply to the Australian Commonwealth Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492

Sligo, Leitrim & Northern Counties' Railway Co. require tenders by Dec. 1 for 12 months' supply of Electric Telegraph Material, Wire, &c. Forms of tender, from the Secretary, Enniskillen.

Electrical Fittings, &c.

Messrs. Walter Scott (Ltd.), Trimdon Grange Colliery, co. Durham, require tenders by Dec. 3 for six months' supply of Electrical Fittings, Iron, Steel, Castings, &c. Forms of tender from the Storekeeper.

Diesel Engines, Dynamos, &c.

The Department of Sanitary Works, Buenos Ayres, requires tenders by Dec. 11 for the supply of three units each, consisting of a Crude Oil Diesel type Motor with Dynamo and Switchboards and Accessories.

Meters, Carbon Brushes and Cut-outs.

Johannesburg (Transvaal) Corporation require tenders by noon Dec. 9 for supply of 1,427 House Service Electricity meters, 7 Switchboard meters and 100 Time Switches (specification 104). Forms of tender from the Municipal Offices.

Tramcar Materials, &c.

Johannesburg Corporation require tenders by noon Jan. 3 for Iron Axles and Bushes (contract 163). Specifications, &c., from the Municipal Offices (Room 53).

Transformers.

Dunedin (N.Z.) City Council require tenders by 5 p.m. Nov. 29 for the supply and delivery of 21 Single-phase Transformers ranging from 1½ k.v.a. to 40 k.v.a., with Accessories and Spares (British manufacture only). Specification may be seen at the office of the City Electrical Engineer, Market-street, Dunedin, N.Z.

Electric Crane and Coal Transporter Plant.

The N.S.W. Railway and Tramway Department require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Tenders are invited for the supply, delivery and erection in Melbourne, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Ppty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders by noon Dec. 11.

TENDERS RECEIVED AND ACCEPTED

Walthamstow.—The following tenders have been accepted, subject to the usual sanctions :—

Babcock & Wilcox, water-tube boiler, £4,850 ; economiser, £929 ; steel chimney, £1,650 ; pipe work, £890 ; hotwell tank, £170 ; feed pump, £345 ; induced draught tank, £950 ; Bruce Peebles & Co., 1,000kw. motor converter, £3,250 ; British Thomson-Houston Co., e.h.t. switchgear, £233 ; General Electric Co., l.t. switchgear, £355.

Government Contracts.—The following tenders were accepted by the British Government Departments during October :—

War Office.—W. Maxwell & Co. and Peel-Conner Telephone Works, electric bells ; Park Royal Engineering Works and Parmiter, Hope & Sugden, distributing boards ; British Insulated & Helsby Cables, Craig Park Elec. Cable Co., W. T. Glover & Co., Hooper's Telegraph & India Rubber Works, St. Helen's Cable & Rubber Co., and Siemens Bros. & Co., elec. cable and wire ; London Elec. Wire Co. & Smith's, telephone cords ; Cable Accessories Co., Edison Swan Elec. Co., General Accessories Co., General Elec. Co., C. H. Parsons (Ltd.), Peyton & Peyton, Sun Electrical Co., and C. J. Thursfield & Co., elec. light fittings ; Austin Motor Co., Fyffe, Wilson & Co. and Keighley Gas & Oil Engine Co., generating sets ; Electric Construction Co. and Siemens Bros. & Co., motors and switchboard, &c. ; Ancoats Vale Rubber Co. and Siemens Bros. & Co., insulating tape, &c. ; Johnson & Phillips, volt-ammeters ; F. Smith & Co., copper wire.

India Office.—Pritchetts & Gold, accumulators ; J. Stone & Co., spare parts.

H. M. Office of Works.—British Thomson-Houston Co. and Pope's Electric Lamp Co., incandescent lamps (until Aug. 31, 1917).

Post Office.—Creed & Co., telegraph apparatus ; Siemens Bros. & Co., telephone apparatus ; British Insulated & Helsby Cables, Enfield Electric Cable Mfg. Co., W. Geipel & Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., C. Macintosh & Co., St. Helens Cable & Rubber Co. and Union Cable Co., telegraph cable ; Peel-Conner Telephone Works, telephone cable ; Siemens Bros. & Co., dry cells ; London Electric Wire Co. & Smiths, telephone cords ; British Insulated & Helsby Cables and Western Electric Co., cable drums ; Taylor, Tunnicliff & Co., insulators ; Bayliss, Jones & Bayliss, Bullers (Ltd.) and Guest, Keen & Nettlefolds, insulator spindles ; British Insulated & Helsby Cables, insulated bronze wire ; T. Bolton & Sons, and British Insulated & Helsby Cables, copper wire ; Dorman, Long & Co., Rylands Bros., Shropshire Iron Co., F. Smith & Co., and Whitecross Co., g.i. wire ; Eyre Smelting Co. and Siemens Bros. & Co., battery zincs.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Montevideo Telephone Co. (Ltd.)

The 28th annual general meeting of the shareholders was held on Monday, Mr. Chas. Lock presiding.

The SECRETARY (Mr. Robert H. Rivers) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said : Gentlemen, the first item in the balance-sheet is the large amount of £180,000 odd representing the cost price of our telephone system and of the various additions which have been made to it during its existence, less the amounts written off from time to time by way of depreciation. The tendency of that item is to keep down because the amount we write off by way of depreciation is a bit larger than the annual capital outlay. The next item, stores at Montevideo and in transit (£5,829), is rather less than in the preceding year. It represents materials and appliances which are required for use in connection with the system. They are quite modern and up to date, and each item is perfectly valuable to the company at the price at which it stands in the books. The item of sundry debtors stands at £9,073 1s. 5d. ; every penny of that amount represents subscribers' subscriptions. Investments at cost stand at £72,000 ; there is a very big jump there compared with the amount shown last year, when the item stood at £49,289. That means that we have been at pains during the year to take advantage of the offers of war loans, Exchequer bonds, &c., and have invested all the free money we had in that way. I think you will regard that as a most excellent asset in the balance-sheet. Real estate in Montevideo is a few hundreds up; that means that we bought a small property in the course of the past financial year—for the purposes of our undertaking, of course. Bills receivable (£9,500) are slightly less, and cash (£12,470) is slightly more. They practically both represent cash, and if you add them together you get nearly £22,000 of bills receivable and cash this year, while last year the amount was £21,798. On the other side we have our capital account, which remains the same. Sundry creditors amount to £8,864. 7s. 1d., as against £8,815 in the previous year—practically the same. The reserve fund is actually the same. The reserve for renewal of plant, &c., is £54,449, a matter of some £14,000 up compared with last year. That is arrived at by taking the amount we reserved last year (£9,000) and one or two other odds and ends, which appear in the Montevideo books, make up that figure. The next two items—reserve for income tax and excess profits duty and profit and loss account—I will deal with a little later. If one has the interest to tot up the various items in the balance-sheet one would find that, deducting what one might call the fixed investment of £180,000, the purchase price of the system, we have liquid and realisable assets to the tune of £131,330. The only off-set to that would be the sundry creditors, on the other side, the reserve for income tax (£3,000), and such amount of the profit and loss account as was required to be distributed for dividends when this account was passed. Those items amount together to £16,000, and therefore your actual liquid and realisable assets, perfectly free and quite apart from the system, amount to at least £115,000. The profit and loss account shows a small increase in the subscriptions—£72,685 as against £69,117 for the previous year—an increase which you would probably have expected from the paragraph in the report which states that there has been a moderate increase in the number of subscribers during the year. For the year preceding the one we are now discussing you will remember that there was a small decrease in the number of the subscribers, but at the last general meeting I think I forecasted that there had been an improvement in business conditions in Montevideo, that we were already experiencing a return of some of our old subscribers, and that we might look forward to a better year in that respect than the previous one had been. I am glad to say that that prognostication has been correct, as we have had something over 500 new subscribers during the year. There is a small increase in the interest on securities. While we are in the happy position of being able to say that there has been a small increase in the number of subscribers, and consequently in the receipts, we are also in the happy position of being able to say that those receipts have been obtained at somewhat less cost than the smaller amount in the previous year, our working expenses in Montevideo being practically under £42,000, compared with £42,550 in the previous year. I consider that that is very satisfactory, and it reflects great credit on the management in Montevideo for their close and economical working. Part of that happy circumstance arises, no doubt, from the fact that we have been signally free from storms during the year. Those of you who come here year after year know that from time to time we have to meet some heavy expenditure because we have the misfortune to meet the heavy storms which are sometimes prevalent there. This year, however, we have been very free in that respect. London office expenses are about the same—a little more—than they were last year. The item of balance of income tax (£2,416) compares with a smaller amount last year; but it is a matter of common knowledge that income tax has considerably increased in the interval. So much has it increased—it being now 5s. in the pound, as you know—that, on the suggestion of our auditors—a very businesslike suggestion, I think—we are reserving the sum of £3,000 against income tax for the four months from April 5th to July 31, 1916, the end of our financial year, partly as a reserve for tax and partly as a reserve against excess profits duty. The result is that we show a net balance of £25,985, compared with £25,766 for the previous year. That being so, we, after due consideration as to the best means of dealing with the balance, came to the conclusion that our usual conservative course was the only one we could possibly adhere to on this occasion, and we therefore suggest that £8,000 be written off to depreciation account, and that an addition be made to the reserve for the renewal of plant of another £9,000. That reserve for renewal of plant will be a great stand-by to us, no doubt, in the not far distant future. Should we be so fortunate as to get our concession for the underground plant we should want a good deal of money with which to start operations, and I venture to think that a reserve for renewal of plant of £54,449, added to by this £9,000, will make a very respectable nest egg with which to initiate our operations. Having made these reserves we are in the position of being able to recommend the payment of a dividend on the preference shares of 5 per cent. for the year, and on the ordinary shares of 6 per cent. for the year. Interim dividends of 2½ per cent. and 3 per cent. respectively have been already paid, and the resolution I shall submit to you presently will authorise, I hope, the payment of final dividends of corresponding amounts. That practically deals with the result of the past year's operations, but there are one or two points one would like to dwell on for a few moments, and the chief of them is the question of the concession for the underground plant. Last year you will remember I told you that a new President had been elected during the year 1915, and with the new President a new Cabinet, of course, goes into office. It is always necessary that these august officials should have the opportunity of studying the situation, so as to pick up the thread of affairs left by their predecessors, and, therefore, we did not anticipate that much progress would be made that year with the underground concession. In 1915 they had the opportunity of making themselves acquainted with affairs, and during the year which we are now dealing with we should have expected that some discussion would have taken place on the matter. That has been the case. The Minister of Industries has met our local representatives from time to time, and considerable *pourparlers* have resulted. We are not yet in sight of any grant of the concession, nor can I, of course, say that we shall have it granted, but it seems to me that the atmosphere is rather more favourable than it has been for some time past. On the other hand, in this state of war, you can quite understand that we are in no great hurry to incur a heavy obligation for putting down a large amount of plant. At the same time, as we have been so ready for many years to accept a grant of this concession, when it comes, we, of course, stand ready to do so; but, in view of the very heavy cost of materials, such as copper wire and cable, we, of course, rather hope that the grant will be delayed for some little time, and that the term provided for in the concession for getting approval of the plans and for commencing operations, and the time allowed us for raising capital will be looked to, and granted in rather a more liberal spirit than that in which they were conceived in the draft concession we have been considering for so long. In other words, while we are quite ready to take the concession when we can get it, we hope that the expenditure may be deferred as long as possible. That is not only in the interests of the Company, but also in the interests of the Government, because one of the terms of the concession—and a very important term—is that the Uruguayan Government should have the right to expropriate the undertaking at their convenience and discretion on terms which, of course, we consider satisfactory; but, of course, the more we have to pay for the plant, labour, and so on in installing the system, the greater will be the cost to them when they come to expropriate the undertaking. It is therefore in the interests of the company and the Government that this expenditure should be deferred as long as possible. Before I sit down I should like to say, on behalf of my colleagues and myself, that we very much appreciate the close attention and able administration given to the company's affairs by the local board and the manager in Montevideo; and I should also like to say in Sir John Gavey's presence how much we appreciate the very admirable advice he has tendered to us from time to time during the year—advice which is not only inspired by vast experience in the telephone world, but also, I am sure, by very great devotion to the interests of the company. With these few remarks, I now move that the reports and accounts be received and adopted, and that the final dividends for the year ended July 31, 1916, of 2½ per cent. on the preference shares and of 3 per cent. on the ordinary shares be declared and paid.

Mr. J. G. LE MARCHANT seconded the motion, which was unanimously adopted after a brief discussion.

The CHAIRMAN, having answered one or two questions, moved the re-election of Lord St. Davids as a director of the company. Mr. LE MARCHANT seconded, and the motion was carried unanimously. Mr. Albert Anns was then elected a director; and Messrs. Gérard Van de Linde & Son were re-elected auditors for the ensuing year. A donation of 50 guineas was voted to the British Red Cross Society, and a vote of thanks to the Chairman terminated the proceedings.

Edison Swan Electric Co. (Ltd.)

The thirty-third annual general meeting of this company was held on Wednesday, Mr. C. J. FORD (Chairman) presiding.

The SECRETARY (Mr. R. H. Parker) having read the notice convening the meeting and the auditors' certificate,

The CHAIRMAN said: Gentlemen, in proposing the adoption of the directors' report and accounts for the year ended June 30, 1916, I presume you will take the same as having been read. You will see that the figures run into much larger amounts than last year, and I believe it is correct for me to say that the turnover has never been on such an extensive scale since the company started business. Sundry creditors and credit balances have increased from £80,000 to £125,000; stocks show an increase of from £211,000 to £272,000, and amounts due from sundry debtors from £89,000 to £103,000. We have expended a sum of about £16,000 on buildings, plant and machinery, and after providing for depreciation at the usual rates, the net increase under these headings amounts to £7,293. The net profit on trading account has been increased from £55,000 to £65,000, whilst, so far as general expenses are concerned, these show a reduction of £2,700. The profit earned for the period has been increased from £14,000 to £24,000, which I trust you will consider, under all the circumstances, satisfactory. The engineering side of the works has been almost wholly employed upon Government work at moderately remunerative prices. The lamp side of the works has been fully employed so far as restricted labour conditions have permitted, and the sale of lamps has been largely increased. It was pointed out to you last year that the prices of lamps have remained the same as they were previous to the war, and had it not been for the increased cost of labour and raw materials which may be safely put at between 30 and 40 per cent., the company have done very well indeed in this department, and the profits would have shown a still further improvement.

It is only necessary for you to study the balance sheet a little, in order to become aware of the fact that the company is urgently in need of further capital. I have referred to this question in my previous annual remarks, but as the trade increases this shortage of capital naturally becomes more acute, and the time has now arrived when the board feels that the most serious effort must be made to provide further funds. For this reason, as set out in the report, it is much to be regretted that it has been impossible for your directors to recommend the payment of a dividend, as, although there is a profit of £24,000, you will see that we have had to employ £16,000 of this in additional plant and machinery to cope with the increased business. If, on the other hand, we had further adequate working capital, it would no doubt be possible to distribute a proper portion to the shareholders in the shape of dividends. For this reason we recommend the transference of £25,000 to reserve, bringing this up to £40,000, and carrying forward £4,025. The board have been, as I have stated, very seriously considering this question of further capital, and have taken an opportunity of consulting some of the largest share and debenture stockholders with reference thereto. You are, of course, aware that there is a sum of £2 per share uncalled upon 99,000 ordinary shares, and the usual course for a company with this amount of uncalled capital would be to call up the necessary amount required. This, however, is denied to us, as the amount in question is, as you are also aware, pledged to the debenture stockholders as part of their security and cannot be called up without their consent. Undoubtedly this uncalled liability has a very prejudicial effect upon the price of the shares, as otherwise there is, to my mind, no reason whatever why, with the improved prospects of the company and its profit-earning capabilities, they should not stand at a higher price, and this reflects itself in great measure undoubtedly upon the price in the market of the debenture stocks. The board are in a difficult position, standing, as they do, between the debenture stockholders and the shareholders, who have divergent interests, and any scheme for the raising of further capital has to be framed to meet the views of both parties, which is not easy. However, amongst many suggestions, a scheme has been discussed with leading representatives of both these interests, and I am pleased to be able to inform you that there is now a fair chance of arriving at a solution of the difficulty, and although I cannot pledge myself that it will finally assume the exact form which I am about to refer to, I trust that we shall be able to achieve something on the following lines : That £100,000 7 per cent. preference shares be issued, participating in further profits up to a further 3 per cent. after the ordinary shareholders have received a dividend, the rate of which has not yet been decided upon. The board feel that in any scheme for the provision of further capital, strenuous endeavours should be made to deal with the liability upon the ordinary shares, and it has been proposed that this shall be met in the following way : We to offer to our existing shareholders the right to subscribe for £1 of preference shares in respect of each ordinary share held by them, and if they accept this offer the debenture stockholders will be asked simultaneously to agree to the cancellation of the £2 liability in respect of such shares held by those parties who avail themselves of this option ; shareholders who do not so avail themselves of this option will be left as they are to-day, with the liability. In effect, it amounts to this, that for the payment of £1 per share, for which a shareholder will receive a participating preference share, he will wipe out the other £1 of liability, and it is thought that a large number of shareholders will avail themselves of this opportunity. As a recompense to the debenture stockholders for this concession, it is suggested that the two classes of debenture stocks shall be amalgamated into one class, and that the interest thereon be fixed all round at 5 per cent. per annum ; to-day the first debenture stock, amounting to £307,000, bears interest at 4 per cent., and the second debenture stock, amounting to £67,000, at 5 per cent. This will throw an additional burden by way of interest upon the company amounting to £3,000 per annum, but under the circumstances, I think it is entirely warranted. Further, it is suggested that after the payment of the preference dividend up to 7 per cent., a percentage of the available profits remaining shall go to a sinking fund for redemption of debenture stock, and the balance will be available for dividend on the ordinary shares.

In the opinion of the board, apart from the profits which the proposed new capital should earn, the additional money will enable the company to enter into far more advantageous contracts for the purchase of raw materials and other goods than has been possible for some time past, which naturally will go to increase the profits. These are the general lines of the scheme which we have been considering, and I am hopeful that we shall be able to carry it, and if the consent of the debenture stockholders can be obtained, I think you will agree that it is obviously in the interests of you, as shareholders, to support it. We have come to this position in the affairs of the company, that unless means can be found to enable us to go forward we must inevitably go backward, and I am hopeful that after the cessation of hostilities restrictions will be put upon the free import into this country of electrical goods at the ruinous cut prices which have hitherto prevailed, that with adequate working capital we shall be able to do a largely increased profitable business, particularly on the export side. To-day we could, had we the money, largely increase the sales in Australia, South Africa and India. We have during the past two years greatly extended our operations in these countries, and are building up a good business there, and it is in these that we are looking to the employment of part of the additional capital we are endeavouring to obtain. There is one other point to which I desire to refer, and that is with regard to the denomination of the present £5 shares. A £5 share to-day is somewhat unwieldy, and it has been suggested to the board by members of the Stock Exchange that if they were split into shares of £1 each they would be far more marketable and with this I entirely agree, and we are proposing to deal with this matter. Of course, the partly paid £5 shares, that is, any shares upon which the liability is not cancelled in the manner I have before referred to, should our scheme go through, will be 12s. paid with a liability of 8s. thereon. I propose the adoption of the report and accounts.

Mr. E. B. **ELLICE-CLARK** seconded the resolution.

Mr. **RAYMENT** said, as a shareholder who had frequently criticised the policy of the old Board, he expressed his hearty congratulations to the Chairman and the Board on the material improvement in the Company's position. They were fortunate in having Mr. Ford at the head of the Company. The material improvement in the way in which the accounts were prepared and the excellent way in which Mr. Ford took them into his confidence inspired the shareholders with absolute confidence that the Board were doing everything possible to place the Company on a sound financial basis and to regain the old reputation of the Edison Swan Company. While he fully appreciated the wonderful improvement which the accounts showed this year, with a profit of nearly £25,000, he could not help feeling keenly disappointed that it was necessary to again allocate all the profit to reserve, which, he understood, was to be applied to extensions, new machinery and other improvements. He did not question the wisdom and necessity of that course, but since 1906 £90,000 of profits had been dealt with in that way. That profit, he took it, in ordinary circumstances was the profit of the shareholders. If they consented year after year to its being applied for extending premises and business, and thereby improving very materially the already ample security provided for the debenture holders, he thought that in some way the shareholders should receive some benefit from the successful trading of the Company ; that some portion of the profits might be earmarked as being the sole property of the shareholders. The Chairman had referred to a scheme which would be satisfactory to the shareholders and should also be satisfactory to the debenture holders, and such a reorganising of the capital would probably make his (Mr. Rayment's) suggestion unnecessary, but it occurred to him that it might perhaps be used as a lever to induce doubtful debenture holders to agree to the scheme.

The **CHAIRMAN** said he thought the scheme he had outlined rather discounted Mr. Rayment's remarks. The scheme was proposed in order that their profits might be divided amongst the shareholders. If Mr. Rayment could show how, on the balance-sheet to-day, any of the profits could be paid in the shape of dividends the Board would be delighted to consider the matter. At June 30 they had cash at bankers and in hand £15,000 odd. On July 1 they had the whole of their debenture interest due. Where the money could come from to pay a dividend he could not conceive. There was no intention of making a call. It would require the consent of the debenture holders and the money would have to be handed to them. The scheme was drawn up to put the Company on a sound financial basis and to enable a fair portion of the profits to be declared in the shape of dividends. He did not see how it was possible to earmark profits for the shareholders, for the debenture holders had a charge on the whole of the assets. With regard to the reserve of £90,000. When he became Chairman there was a so-called reserve of £40,000, but that had been created by showing a profit in the past which really never existed, certain assets included in the balance-sheet did not exist, and the whole of that reserve was written off. They must only look at the reserve fund that had been created since, which stood at £40,000.

The motion was put and carried. The **CHAIRMAN** then proposed the re-election of Mr. Ellice-Clark and Major Quilter as directors. Mr. C. E. **HUNTER** seconded and the motion was also carried.

The **CHAIRMAN** then announced that the auditors (Messrs. Welton, Jones & Co.) had informed the Board that they could not offer themselves for re-election, their staff having been greatly depleted by clerks being called up by the military authorities. They had had to give up a large portion of their work. The Board suggested the appointment of Messrs. Broads, Paterson & Co.

On the motion of Mr. **RAYMENT**, seconded by Mr. J. **GLYNN**, Messrs. Broads, Paterson & Co. were appointed auditors at a fee of 250 guineas.

The **CHAIRMAN** stated, in reply to a question, that it was not a question of fees. When Mr. Bond, of Messrs. Welton, Jones & Co., first approached them, he (the Chairman) asked him whether it was a question of fees and his reply was absolutely in the negative. If Messrs. Welton, Jones & Co. had asked for an increase the Board would have recommended the shareholders to give it to them. He proposed that Messrs. Welton, Jones & Co. be thanked for their services.

Mr. **BOND** confirmed the Chairman's statement and acknowledged the Chairman's expression of thanks for his firm's services.

A vote of thanks to the Chairman, directors and staff was then passed, and the meeting terminated.

AMAZON TELEGRAPH CO. (LTD.)—The gross revenue for the year ended June 30 amounts to £61,587, and the working expenses were £31,707. After providing £13,255 for debenture interest and £9,578 for sinking fund, the directors recommend payment of a dividend of 3 per cent. (less tax) on the share capital, leaving £6,806 to be carried forward. The directors refer with regret to the death of Mr. Geo. Keith, who had been a director since 1897, and chairman and managing director of the company since 1902. Mr. Frederic Edward Nosworthy, who joined the company's staff in Brazil in 1897, and was appointed general manager in 1904, has been elected to a seat on the board and appointed managing director, in place of the late Mr. Keith.

PROVINCIAL TRAMWAYS CO.—For the year ended Sept. 30 the net revenue received from the local companies was £52,288, against £48,789 in 1914-15. After setting aside £12,000 to reserve and depreciation and adding £1,000 to reserve for third-party insurance, the balance is £27,375. The directors recommend a dividend of 10d. (and a bonus of 6d.) per share on the ordinary, making, with 8d. per share paid in June last, 2s. per share, being at rate of 10 per cent. for the year. This will absorb £8,304 and leave £19,072 to be carried forward, subject to excess profits tax.

NEW COMPANIES, &c.

ACCURATACT (MAGNETOS (LTD.) (145,287). Reg. Nov. 13, capital £5,000 in £1 shares, to carry on the business of manufacturers of and dealers in patent contact breakers and magnetos, electrical engineers and manufacturers, founders, machinists, &c., and to adopt an agreement with A. P. Hann and H. D. Grant. Private company. First directors are A. P. Hann and H. D. Grant (both permanent). Reg. office : Suffolk House, Laurence Pountney Hill, E.C.

GIUSTI PATENTS AND ENGINEERING CO. (LTD.) (145.128) Reg. Oct. 20, capital £1,500 in £1 shares (500 "A" and 1,000 "B"), to carry on the business of mechanical and electrical engineers, manufacturer of motor cars, &c., and to adopt an agreement between T. Giusti, of Leghorn, and J. Coppo, of London (for the company). Private company.

CITY NOTES.

MEMORANDA (Nov. 22).—**Bank rate** 6 **per cent. (since July 13, 1916). Consols** $55\frac{11}{16}$. Consols Pay Day, Dec. 1. **Stocks and Shares Ticket Days**, Nov. 29 and Dec. 13. Pay Days, Nov. 30 and Dec. 14. Price of Silver, $34\frac{13}{16}$d.

BRITISH EVER-READY CO. (LTD.)—The directors have declared a dividend at the rate of 10 per cent. per annum on the preference and ordinary shares for the half-year ended Sept. 30.

CAPE ELECTRIC TRAMWAYS (LTD.)—The board have declared a dividend of 3¾ per cent., less tax.

CASTNER-KELLNER ALKALI CO. (LTD.)—The directors have declared a dividend of 13 per cent. for the six months ended Sept. 30, making with the interim dividend 22 per cent. for the past year.

ELECTRIC CONSTRUCTION CO. (LTD.)—The directors have declared an interim dividend at rate of 7 per cent. per annum on the preference shares for the half-year to Sept. 30 (less tax), payable on the 30th inst.

GLOBE TELEGRAPH & TRUST CO.—Quarterly interim dividends of 3s. per share on the preference and 2s. per share on the ordinary shares have been declared.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The directors are offering to the shareholders 43,916 shares of £1 each at £1 15s. per share.

WELSBACH LIGHT CO. (LTD.)—Meetings of the shareholders and of the holders of the 4½ per cent. debenture stock have been convened for considering arrangements for an exchange of interests between the company and Austrian and German companies, thus freeing the company of all control by or interest in German or Austrian companies.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 22 the following as the present basis prices of—

New Metals.	Per lb.		Per ton
Solid Drawn Brass Tubes	17¾d.	English Lead	Nominal.
Solid Drawn Copper Tubes	21½d.	Antimony	Nominal.
Brazed Copper Tubes	21¼d.	Old Metals.	Per ton
Brazed Brass Tubes	19¾d.	Clean Copper Scrap	£120 10 0
Brass Wire	16¼d.	Clean Brass Scrap	69 0 0
Copper Wire	20¾d.	Braziery Copper Scrap	100 0 0
Rolled Brass	16¼d.	Old Lead	27 0 0
Brass Sheets	16¼d.	Old Zinc	40 0 0
	Per ton.	Hollow Pewter	130 0 0
Copper Sheets	£168 0 0	Black Pewter	90 0 0
Spelter	57 5 0	Gun Metal	88 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Nov. 21, the following approximate prices of Scrap Metals:—

	Per ton.		Per ton.
Aluminium Cuttings	£110 0 0	Old Lead	£4 under English lead price
Clean Mixed Brass	73 0 0	Old Zinc	40 0 0
Clean Copper	125 0 0	Hollow Pewter	135 0 0
Braziery Copper	95 0 0	Shaped Black Pewter	95 0 0
Gun Metal	100 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £54. Commercial Tinman's Solder, £105. Blowpipe Solder, £115.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 21.

Shrs.	Last Dividend	Name.	Price, Tues., Nov. 21	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
1[illegible]	6%	B[illegible] & P[illegible] E.L. Ord.	6¼	7 1 2	Mar., Sept.
1	4½%	Do. 4½% Cum. P[illegible]	7¼	5 16 2	Feb. Aug.
1	6%	Do. 6% [illegible] Pref.	9¼	6 1 6	Feb. Aug.
[illegible]	10%	B[illegible] & K[illegible] Ord.	6[illegible]	7 6 9	Mar. Sept.
[illegible]	7%	Do. 7% P[illegible]	[illegible]	5 9 10	Mar. Aug.
St.	4%	C[illegible] Deb. St.	80½	4 19 5	..
St.	4%	[illegible] West End & City Debs.	7[illegible]	5 0 8	Jan. July
[illegible]	[illegible]	Do. 4½ [illegible]	3½	6 18 6	..
[illegible]	[illegible]	Do. [illegible]	[illegible]	7 [illegible] 1[illegible]	Aug. Feb.
[illegible]	4½	Do. [illegible]	3½	6 19 [illegible]	[illegible], Dec.
[illegible]	4	[illegible] L[illegible] O[illegible]	3½	6 8 7	Mar. Sept.
St.	4½	Do. [illegible] D[illegible]	87	6 3 5	Jan. July
[illegible]	[illegible]	[illegible] L[illegible] Lt. Ord.	11½	6 1[illegible] [illegible]	Feb. Aug.
1	[illegible]	[illegible]	[illegible]	[illegible] 3 1	Mar. July
[illegible]	[illegible]	[illegible] D[illegible]	97½	4 17 6	Jun. Dec.
St.	4	Do. 4½ D[illegible]	7[illegible]	[illegible] 13 [illegible]	Jun. Dec.
1	7	[illegible]	10	[illegible] 14 [illegible]	Mar. Sept.
[illegible]	[illegible]	[illegible]	9	[illegible]	Feb. Aug.
[illegible]	4½	[illegible]	[illegible]	[illegible] 11	Jan. July
[illegible]	4½	[illegible]	11½	[illegible] 6 6	May, Nov.
St.	4½	[illegible]	[illegible]	6 [illegible]	July
[illegible]	[illegible]	[illegible]	[illegible]	6 1 [illegible]	Feb. Aug.
St.	4%	Do. [illegible]	7[illegible]	5 6 4	Jan. July
[illegible]	6%	[illegible]	4½	[illegible] 18 [illegible]	..
St.	4%	[illegible]	80	[illegible]	Jan. July
[illegible]	3%	[illegible]	[illegible]	[illegible]	Mar. Aug.
St.	4½	Do. [illegible]	[illegible]	[illegible]	Jan. July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 1 0	Jan. July
[illegible]	[illegible]	[illegible]	[illegible]	6 0 6	Mar. Sept.
St.	[illegible]	[illegible]	[illegible]	[illegible] 14 11	Mar. Sept.
1	6%	[illegible]	[illegible]	6 3 10	Apl. Oct.
[illegible]	6%	[illegible]	[illegible]	[illegible] 19 7	Mar. Sept.

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price Tues., Nov. 21	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6 7/16	6 2 4	Feb, Aug
5	7%	Do. do. Pref.	5 15/32	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	67¼	6 12 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1¼	6 8 0	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	6	5 16 8	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways and Tramways.			
St	5%	British Elec. Traction 5% Debs.	82½	6 1 3	Apl, Oct
St	6%	Do. 6% Cum. Pref.	77	7 15 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	65	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70¾	5 13 8	..
St.	4½%	Do. 4½% Pref.	82¼	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	74¼	5 7 6	Jan, July
St.	4%	City & S. London Deb.	67	5 19 1	May, Nov
St.	5%	Do. Pref. 1896	70¼	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2 5/16	5 14 4	Jan, July
St.	4%	Do. 4% Pref.	61	6 11 2	Mar, Sept
St.	4%	Do. 4% Debs.	71½	5 11 10	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24⅛	4 2 11	Feb, Aug
St.	3½%	Do. 3½% Pref.	59	5 18 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	57	6 2 10	Feb, Aug
St.	3½%	Do. 3½% A Debs.	61	5 14 9	Jan, July
St.	3½%	Do. 3½% Debs.	64½	5 9 5	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16⅜	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	69⅞	6 7 3	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105¼	5 13 6	Jan, July
St.	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 17 7	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2 15/16	5 2 2	Apl, Oct
1	6%	Do. 6% Pref.	1 7/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1½	4 13 4	Mar
100	5%	Do. Prior Lien Debs.	89¼	5 11 9	Jan, July
1	6%	Do. 6% Pref.	15/16	6 8 0	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	11⅝	7 10 6	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 5/32	5 16 4	Jan. July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	15/16	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2 13/32	6 4 8	April
100	6%	Do. 6% Prior Lien Debs.	99¼	6 0 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12 13/16	7 16 1	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A. £3 pd.	1/32	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1 3/32	6 17 2	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	14 11/16	7 4 9	July
10	6%	Do. 6% Pref.	9 13/32	5 18 2	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16	6 5 0	Feb, Aug
5	5%	Do. 4½% Cum. Pref.	4 7/16	5 7 6	..
St.	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	13	7 13 10	Feb, Aug
10	5%	Do. Pref.	7⅞	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38	6 6 7	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	1 13/32	6 11 2	May, Aug
1	5%	Do. 5% Pref.	⅞	5 14 3	May, Aug
St	4%	Do. 1st Debs.	77¼	5 3 3	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¾	4 10 2	June, Dec
St	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95	6 6 4	Fb,My,Aug,N
St	1½%*	Do. Def. Ord.	23¼	7 1 6	Fb,My,Aug,N
[illegible]	4%	Commercial Cable 4% Debs.	70¾	5 13 1	Ja. Ap, Jly,O
10	5%	Cuba Submarine Ord.	8½	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6 3/16	6 9 6	Ja,Ap,Jly,O
St.	8%	Eastern Tel. Co. Ord.	141¼	5 12 6	Ja,My,Jly,O
St.	3½%	Do. 3½% Pref.	63½	5 10 3	Ja.My,Jly,O
St.	4%	Do. 4% Deb.	74¼	5 7 9	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	13 13/16	5 15 10	Ja,Ap,Jly,O
10	22%	Gt. Northern Tel. Co. With Coup. 11	37¾	5 16 7	Ja, My, Jly
25	13%	Indo-European	51¼	6 6 10	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2[illegible]	3 8 10	April
1	7%	Do. 7% Pref.	2½	2 16 0	July
10	[illegible]	West India & Panama Ord.	1[illegible]	3 4 9	May, Nov
10	6%	Do. 1st Pref.	7⅞	7 12 5	May, Nov
10	[illegible]	Western Telegh. Co.	14[illegible]	5 11 4	Mr, Jly,O,Dec
St	4%	Do. 4% Deb. St.	72¼	5 10 9	June, Dec
..	4½%	Western Union 50-yr. Bds.	99⅛	4 10 10	May, Nov
		Telephones.			
[illegible]	[illegible]	Monte Video Teleph. Ord.	[illegible]	7 7 8	Nov
1	[illegible]	Oriental Telephone Ord.	2[illegible]	4 6 6	Apl, Oct*
St.	4%	Do. Db. St.	78¾	5 1 7	Jan, July
St.	4½%	Teleph. Co. of Egypt Db. St.	83	5 8 5	Jan, July
[illegible]	[illegible]	United River Plate Ord	[illegible]	5 16 3	Apl, Oct
[illegible]	[illegible]	Do. 5% Cum. Pref.	4[illegible]	5 13 6	Jan, July
St	4½%	Do. Deb. Stk.	8[illegible]	5 11 10	Jan, July
		Financial and Investment.			
1	[illegible]	Globe Teleg. & Trust	12[illegible]	4 15 9	Sp.Dc.Mr.Jn
[illegible]	6%	Do. 6% Pf.	10[illegible]	5 17 9	Sp.Dc,Mr,Jn
1[illegible]	[illegible]	Mackay Companies' Common	85½	5 17 6	Ja.Apl,Jly,O
[illegible]	4%	Do. $100 Pref.	70	5 14 3	Ja Apl,Jly,O
1[illegible]	6%	Submarine Cable Trust Certs.	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
[illegible]	3/0	Adelaide Elec. Supply 6% Pref.	4[illegible]	6 1 6	Mar, Sept
[illegible]	5%	Do. 5% Deb.	94½	5 5 10	Jun, Dec
[illegible]	6%	Bombay E.S. & T. 6% Pref.	10½	5 15 8	..
St	4½%	Do. 4½% Debs.	83	5 8 5	Jan, July
5	9%	Calcutta E.S. Corp. Ord.	6[illegible]	6 19 9	May, Nov.
5	5%	Do. 5% Pref.	4[illegible]	5 16 0	Mar, Sep

* Plus 3/6 bonus. † Ex dividend or interest.

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NOTES.

German Electrical Machinery.

ELSEWHERE is given, under the above heading, an account of some correspondence between Messrs. ARNHOLD, KARBERG & Co. and the Shanghai Town Council, relative to the breakdown of a turbo-alternator of A.E.G. manufacture. A perusal of the correspondence leads to the conclusion that some of the parties concerned are unreliable witnesses. It is remarkable that high insulation resistance should be given by someone, presumably an electrical engineer, as evidence that the insulation of a high-voltage stator is proof against breakdown. Although a novice in electrical matters might draw wrong conclusions from an insulation resistance of 40 megohms, it is inconceivable that the accredited agent of a large manufacturing enterprise should have the temerity to bring this forward as proof that the machine could not break down on account of faulty insulation. Bluff of this kind carries no weight with electrical engineers, nor will it in a court of law. No qualified electrical engineer would attach much importance to a low-voltage insulation resistance test on a high-voltage machine. From the correspondence it appears that the stator coils were found to be loose in the slots, and we are inclined to think that this is a likely explanation of the cause of the breakdown. Engineers at home have had considerable experience of breakdowns due to air pockets in the slots and to imperfect contact between insulated conductor and slot lining and between slot lining and slot. The unanimity of opinion, as revealed by the correspondence, amongst users of A.E.G. machinery is very striking, and if things are as bad as they are made out to be, German prestige in this direction will be lowered.

Rectifying Contacts.

A GREAT deal of work has been done on the subject of rectifying contacts such as are used in wireless telegraphy. The method generally followed has been to use relatively high voltages, which are applied over considerable intervals of time, whereas under actual operating conditions the applied voltages are very small, and the frequency of the phenomenon is comparatively high. Unfortunately, such investigations are beyond the capabilities of the oscillograph, and, therefore, other methods must be adopted. We are glad to see that Mr. D. OWEN, by adopting some ingenious devices, has been able to investigate these contact phenomena while applying the voltage during very small intervals. We give an abstract of the Paper in another column. From this it is satisfactory to note that the characteristic curves obtained for the variation of the contact resistance by applying the testing voltage for one hundredth of a second is materially the same as that which would be found at the expiry of a period of the order of a millionth of a second. It appears that the time element is not so important as might have been anticipated; indeed, the author reaches the conclusion that the sensibility of a wireless receiving circuit does not differ very materially from that deduced from a slow period characteristic. With regard to the ultimate explanation of the contact phenomena, physicists are generally in favour of a thermal basis. Mr. OWEN supports this view, but he complicates it by making it dependent upon the contact resistance residing in a stratum of molecular thickness at the interface of the two elements of contact. We sometimes doubt whether the explanation is so simple as has been suggested, for it is a well-known fact that the efficiency of the contact often varies enormously by altering the position of the point of contact. The theories that have so far been put forward seem to indicate that the effect should be merely dependent upon ordinary physical conditions of the surface contacts concerned, but it is questionable whether these conditions vary so greatly as would be implied by practical experience.

◆

Engineers and War Work.

ON another page is given a brief account of a recent conference between members of the Government and representatives of the Amalgamated Society of Engineers. Judging by the headlines in the daily press, it would appear that there are many who now believe that the engineers have been mobilised. As a result of the conference it is possible that many members of the Government fondly imagine they have succeeded in mobilising the engineers. We state emphatically that no serious attempt has yet been made to utilise the trained engineering talent of the country. What has been done is to enter into a rational working agreement with as fine a body of men as can be found in the country—namely, the engineering *artisans*. But the latter are not qualified to advise on engineering problems connected with the war. As surely as the

War Department has had to call in a civilian engineer to attend to all questions dealing with the roads, as surely will it be found necessary, sooner or later, to call in men to advise them on other branches of engineering, if their desire is to bring the war to a speedy conclusion. The point we wish members of the Government and War Office officials to understand is that there is as much difference between the engineer and the engineering artisan as there is between the officer and the private.

* * *

Civil Service Examinations.—For the purpose of recommending to the Treasury a revised scheme of examination for Class I. of the Home Civil Service, after consulting the Indian, Foreign and Colonial Offices as to their particular requirements, the following Committee has been appointed :—

Mr. Stanley Leathes, C.B. (chairman), Sir Alfred Ewing, K.C.B., F.R.S., Sir Henry A. Miers, D.Sc., F.R.S., Mr. H. A. L. Fisher, M.A., and Prof. W. G. Adams, M.A. The Secretary is Mr. D. B. Mair, M.A., Civil Service Commission, Burlington-gardens, W.

The new scheme must be "advantageous to the higher education of this country," and the Committee must take into account "the various other purposes" which the present system has served hitherto.

Mobilising the Engineering Artisans.—Those members of military age of the Amalgamated Society of Engineers who are not already engaged on war work are to be enrolled either as War Munition Volunteers or in the Artificers' Corps of the Army as a condition of exemption from general service. This arrangement, which was announced by the Minister of Munitions, was agreed to at a conference between Mr. Montagu, Lord Derby, Mr. A. Chamberlain, and the Labour Adviser to the Government on the one side, and representatives of the Amalgamated Society on the other. The agreement is as follows :—

The undertaking given by the Prime Minister on Sept. 28, 1916, that "skilled men (by which I mean men who from natural ability or training or a combination of both have special aptitude for particular and indispensable kinds of national work here at home) ought not to be recruited for general service," will be strictly observed subject to the conditions attached to it by the Prime Minister at the time.

In order to give immediate effect to this pledge it is proposed that :—

1. All members of the society, as one of the trade unions of the skilled engineering trades, at any time ceasing to be fully engaged, shall enrol as War Munition Volunteers, and thus place their services at the disposal of the country, in accordance with arrangements now in existence under the War Munitions Volunteer scheme.

2. Skilled men referred to in this agreement are men who were either journeymen, or apprentices prior to August 15, 1915.

3. All skilled men on war work, or who have enrolled as War Munition Volunteers, shall be provided with a card of exemption from military service. No man who produces such a card to the local recruiting officer shall be removed from his work without specific authority from the War Office, which will not be given without reference to the Minister of Munitions and the executive of the man's union.

4. The provision of skilled mechanics for the Army will in future be made by the Ministry of Munitions.

The trade unions will do their utmost to provide the Ministry of Munitions with skilled men, who will undertake to serve at the choice of the Ministry either in the Artificers' Corps in the Army or as War Munitions Volunteers in civil life.

5. The society will furnish particulars of skilled men now serving in non-mechanical corps, and the Army Council will continue to transfer such skilled men to mechanical units.

OBITUARY.

Sir Hiram Maxim.—[illegible] record the death of Sir Hiram [illegible] Maxim, [illegible] on Friday last at his residence at Streatham, London.

Sir Hiram [illegible] Maine (U.S.A.), on Feb. 5, 1840 [illegible] descent. He was appren[illegible] developed a taste for scientific and mechanical [illegible] at machine work at [illegible] mechanic and draughtsman. [illegible] philosophical instrument [illegible] to the Novelty Ironworks [illegible] he began his career as an [illegible] boilers, steam and gas [illegible]. In 18[illegible], he commenced his electrical [illegible] brought out a printing telegraph which lent itself to the transmission of messages in the Chinese language. With Mr. Schuyler he carried out electric lighting experiments, and in order to prove that oxygen was the sole destructive agent he made a lamp from which he expelled the air, introducing gasoline vapour in its place, when he found that the carbon, instead of wearing away, gained in weight and volume, while assuming a grey metallic colour. He then experimented with platinum for producing light and invented an incandescent lamp with a filament of that metal, at the same time turning his attention to the divisibility and also the regulation of electric currents. In 1878 he brought out his carbon incandescent lamp which he claimed to be the first incandescent lamp ever invented. Afterwards he devised several systems of arc lighting which produced an intense light in the focus of parabolic reflectors, the suspended lamps being fed by a single current, and afterwards an arc lamp regulator. At this stage he is said to have obtained over 100 patents, many of which related to the details of electric lamps. He returned to the carbon incandescent lamp which he had abandoned after having secured it by patent, and in 1880 he devised a machine for the demagnetisation of watches. In order to keep down the floods of Mexico he proposed to utilise the waterfalls as a means of driving dynamos' transmitting the force by electric currents. With Messrs. Schuyler & Williamson he founded the United States Electric Lighting Co., to take over and work the Maxim electric lighting patents. This company was awarded a gold medal at the Philadelphia Electrical Exhibition, and in 1881 Sir Hiram Maxim received the decoration of the Légion d'Honneur from the French Government for his electrical exhibit at the Exposition of that year in Paris. The third period of his career as an inventor began in 1881-82, when he made working drawings of his automatic gun in which the force of the recoil is utilised for performing all the functions necessary for loading and firing the machines. In 1883 the first example of this celebrated implement was constructed, and about this period he also patented his electrical training gear for large guns. In 1888 he patented maximite, a smokeless powder. The gun in the first instance was worked by the Maxim Gun Co., amalgamated with the Nordenfeldt Guns & Ammunition Co. in 1888, and in its turn the combined concern was taken over as from October, 1896, by Messrs. Vickers, who, in 1897, changed their title to Vickers, Sons & Maxim. In 1911, when Maxim ceased to be one of their "special" directors, they became Vickers (Limited). Maxim also took a keen interest in aviation, and in 1889 he began his attempt to make a flying machine, initiating it with a series of experiments on the efficiency of propellers in air. For motive power he relied on steam, and he showed extraordinary ingenuity in constructing machinery sufficiently light for the purpose. The two compound steam engines he employed weighed together 600 lb. and developed 362 H.P., while the water-tube boiler, fired with naphtha or petrol, weighed 1,000 lb., so that the total weight of the machinery per horse-power was less than 4½ lb. The aeroplane itself, with its framework of thin steel tubing, was also made as light as possible. The trials were carried out at Bexley in 1894. Later Maxim constructed a captive flying machine, passengers being carried through the air in boats attached to a central rotating standard. The avowed object of the device was to bring in money for further aeronautical experiments, but the financial results did not come up to expectations. The honour of knighthood was conferred upon him in 1901, and he was the recipient of orders and decorations from monarchs and rulers all over the world.

Sir Geo. White.—We also regret to record the death of Sir Geo. White, Bart., head of the firm of Geo. White & Co., stockbrokers, of Bristol. Deceased was chairman of the Bristol Tramways & Carriage and the Imperial Tramways Companies. In conjunction with the late Sir J. Clifton Robinson he was interested in many pioneer electric tramways, including the London United, the Dublin, the Middlesbrough, Thornaby and Stockton tramways, &c. These lines were among the earliest to be converted to electric traction. He is also said to have established the first factory in England for making aeroplanes. He was a convinced believer in the future of aviation, even at the earliest stages of its development, and he did not hesitate to back his opinion by putting a fortune into the British & Colonial Aeroplane Co.'s works.

Bennett Fitch.—We also regret to announce the death, which occurred at Ealing on Monday, of Mr. Bennett Fitch, M.I.C.E. Mr. Fitch was a director of the St. James' & Pall Mall Electric Light Co. and the Central Electric Supply Co.

Killed in Action.—The following deaths in action or of wounds are reported :—

Sec. Lieut. Thos. F. Whinster (R.E.), 35 years of age, who was killed on Nov. 19, was a native of Glasgow and was head of the testing department of the Victoria Falls Electric Power Co.'s Germiston station, near Johannesburg (Transvaal), until he entered the army a year ago.

Sec. Lieut. R. N. Lodge (Lancs Fusiliers), previously reported missing, but now known to have been killed, was in the General Electric Co.'s service before the war.

Lieut. Edgar Hampson (Lancs. Fusiliers), previously reported missing and now officially reported killed, was a student at the Salford Royal Technical Institute prior to joining the army.

Other deaths in action are those of Lieut. T. J. Webster, formerly on the clerical staff of Willesden Council's electricity department; Sergt. W. C. Stevens and Private Ernest Hall, formerly employed by Messrs. Dick, Kerr & Co., at Preston; Private Walter Jackson, who was employed at the National Electric Supply Co.'s works at Preston prior to the war; and Private H. E. Horrocks, a former Bolton tramway official.

PERSONAL.

Sir William Slingo has been elected by the Council of the Institution of Electrical Engineers to fill the position on the Council caused by the resignation of Capt. R. J. Wallis-Jones, due to military duties.

Military Honours.—The following rewards for bravery have been given :—

Temp. Lieut. F. A. Robinson, who was in the electrical department of the India Rubber Co., Silvertown, has been awarded the Military Cross for having, as a "Tank" officer, displayed great gallantry.

After tremendous fighting his tank became "ditched," and he and his crew dug for 14 hours under heavy fire until they eventually got the monster out and returned with it to the assembling point. Lieut. Robinson had previously done fine work of the same character at the taking of High Wood. On that occasion his tank was hit by a direct shell and damaged, but he got his men out safely and immediately went into the trenches and worked a machine gun. Lieut. Robinson joined the Navy in the November following the outbreak of war, entering the R.N.A.S. In 1915 he got his commission in the Machine Gun Corps, and having received the necessary training he went out with the first of the tanks to the front. Lieut. Robinson is the son of Commander Robinson, R.N.R. (retired), of the submarine department of the India Rubber Co., Silvertown.

Pte. Fredk. J. Edwards (Middlesex Regt.), who was formerly in the employ of the Western Electric Co., is amongst the recipients of the Victoria Cross. He displayed most conspicuous bravery and resource. His part of the line was held up by machine-gun fire, and all officers had become casualties. There was confusion and indication of retirement. Private Edwards on his own initiative dashed out alone towards the gun, which he knocked out with bombs. This gallant act made further advance possible.

APPOINTMENTS VACANT.

Applications are invited for the position of shift engineer, to take charge of the running of boiler-house at Summer-lane generating station, Birmingham. Salary £150, plus £10 extra per annum during the war. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Wednesday, Dec. 13. *See an advertisement.*

Applications are invited for the full time appointment of demonstrator in the department of electrical engineering and applied physics at the Northampton Polytechnic. Particulars and forms of application from the Principal, Dr. R. Mullineux Walmsley, St. John-street, Clerkenwell, London, E.C. *See advertisement.*

An experimentalist is required for the development department of an electrical engineering company. Full technical training necessary. *See advertisement.*

An experienced electrical engineer is required to take charge of electrical plant and sawmills. *See advertisement.*

A works manager is required, with experience in organisation of works and manufacture of drawn wire lamps. *See an advertisement.*

An electrical and mechanical engineer is wanted (temporarily) by the University of Bristol. Applications to the Registrar. *See advertisement.*

Applications are invited for the position of chief engineering assistant in the Leeds electricity department at a salary of £350 per annum. Applications to the manager, Mr. C. Nelson Hefford, 1, Whitehall-road, Leeds, by 10 a.m. of Saturday, Dec. 9.

Reigate Corporation require a shift engineer at their generating station. Applications to the Borough Electrical Engineer by Dec. 12.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—A general monthly meeting of the members will be held on Monday, the 4th inst., at 5 p.m.

Electric Vehicle Committee.—A meeting of the Electric Vehicle Committee was held in London on the 10th ult., Mr. E. S. Shrapnell-Smith, the vice-chairman, presiding in the absence of Mr. R. A. Chattock.

Mr. J. A. Priestley, having been elected by the Institute of Cleansing Superintendents as their representative upon the Committee, took his seat for the first time.

Mr. Arthur Harrison, the borough engineer of Southwark, attended the meeting by invitation in order to discuss with the members matters concerning the utilisation of electric vehicles for municipal purposes. In the course of an interesting discussion, Mr. Harrison explained the reasons why he had reported recently against the use of electric vehicles for certain work for which he proposed using motor traction. He made it perfectly clear that he was not unfavourable to the principle of the electric vehicle, and that the reason why he had reported against it was really owing to there being no design of electric vehicle on the market which complied with an essential requirement for the particular work—viz., that the loading rail of the body should not be higher than 4 ft. 6 in. above road level. As far as Mr. Harrison was aware, there was no design of electric vehicle at the present time on the market which complied with this requirement. Mr. Harrison expressed the hope that designers would in the near future be able to produce a vehicle specially adapted for the particular purpose he has in view—*i.e.*, the quick and easy removal of street sweepings from the depots or stands in the streets where they are collected and the collection of house refuse.

In connection with the provision of charging facilities on the route London to Birmingham, correspondence was read from the electric supply department of the city of Coventry setting forth that they were unable to give any facilities for charging, and from the manager of the Northampton Electric Light & Power Co. promising to afford every possible facility for charging vehicles, and stating that when the amount of business warrants it they will consider putting down a proper charging plant. They have decided to adopt the E.V.C. standard tariff. The secretary reported that inquiry sheets as to charging facilities had been sent round to electric supply undertakings in connection with the list to be published shortly in the C.M.U.A. Handbook.

It was decided to invite the Institute of Automobile Engineers and the British Rubber Tyre Manufacturers' Association to nominate a representative upon the Committee. It was also decided that the official designation of the Committe in future should be The Electric Vehicle Committee of Great Britain, formed under the auspices of the Incorporated Municipal Electrical Association.

It was decided to recommend to the accumulator section of the B.E.A.M.A. that, in the case of lead plate batteries on electric vehicles, the upper and lower limits of Sp.G. should be clearly marked on the battery. It is suggested that this should be either in the form of a large plate with raised letters and figures attached to the battery box, or, as an alternative, that the figures should be moulded on the ebonite covers of he cells.

ARRANGEMENTS FOR THE WEEK.

MONDAY, Dec. 4th.

Institution of Post Office Electrical Engineers.

6 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Western Electric Co.'s Automatic Telephone System," by Mr. B. O. Anson.

Royal Society of Arts.

5 p.m. At John-street, Adelphi, W.C. Howard Lecture on "Coal and its Economic Utilisation," by Prof. J. S. S. Brame. (Lecture II.)

TUESDAY, Dec. 5th.

Rontgen Society.

8.15 p.m. Ordinary meeting to be held at the Institution of Electrical Engineers, Victoria Embankment, W.C.

Engineers' Club.

7.30 p.m. At Albert-square, Manchester. Debate on "The Decimal System," opened by Mr. E. C. Barton.

WEDNESDAY, Dec. 6th.

Birmingham Local Section, Institution of Electrical Engineers.

7 p.m. At Birmingham University, Edmund-street, Birmingham. Paper on "The Parallel Operation of Electric Power Stations," by Mr. J. S. Peck.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, W.C. Paper on "The Coal-Tar Colour Industry," by Mr. C. M. Whittaker, B.Sc.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week.

Officer for the Week.—Platoon Commander H. de P. Birkett.

Next for Duty.—Platoon Commander Parker.

Monday, Dec. 4.—Technical for Platoon No. 9, at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.25 to 8. Lecture on Telephones, 7.30.

Tuesday, Dec. 5.—School of Arms, 6 to 7. Lecture, 7.15, "The Service of Protection," Company Commander Hynam.

Wednesday, Dec. 6.—Instructional Class, 6.15. Platoon Drill, Platoon No. 2.

Thursday, Dec. 7. Platoon Drill, Platoon No. 7. Ambulance Class by M.O., 6.

Friday, Dec. 8.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill, 6.25 to 8.25. Lecture on Telephones, 7.30.

Saturday, Dec. 9. Inspection by General Sir Desmond O'Callaghan, at 3, in Hyde Park. Parade in uniform at Headquarters at 2.15 sharp. A full muster is of great importance.

Sunday, Dec. 10. Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday ration to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice and Table at Headquarters.

Corps Supper. A Corps Supper will be held at the Queen's Hotel, Leicester-square, on Dec. 8, at 7. A few tickets can still be had of the Company Sergeant-Major.

Notice.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

TEMPERATURE RISE OF INSULATED LEAD-COVERED CABLES.*

BY RICHARD C. POWELL.

Summary.—The thermal conductivity of a cable is expressed in terms of the volume thermal conductivity of the insulation, the surface thermal conductivity of the lead sheath, and the dimensions of the cable. The values of the thermal conductivities as given by various observers, including the author, are compared. Sometimes the lead sheath of a cable carries considerable stray current. A formula is given for calculating the increased temperature due to such current.

I. INTRODUCTION.

The limitation of the current-carrying capacity of electrical conductors due to heating effects has been a subject for investigation since 1849, when Joh. Müller,† starting with Newton's Law of Cooling, arrived at the result that, for bare wires of the same material, the rise of temperature varies as the 1·5 power of the current. We now know this to be incorrect, as the exponent is nearer 1·25. The subject was taken up by Forbes ‡ in 1882, and a good resumé of the subject up to 1905 is given by Teichmüller in his "Die Erwarmung der Elektrischen Leitungen"

Since European practice is to employ armoured cables buried in the earth, few European data can be applied by American engineers desiring information on lead-covered cables for a drawn system. In 1905 Fisher published the results of some extensive tests at Niagara, and on the basis of these tests he prepared, in 1906, a table of current ratings, which has been extensively used by engineers. This table is to be considered as furnishing a good safe rule, applicable under somewhat unfavourable conduit conditions. Atkinson in 1913 gave the results of some tests in a more detailed form better suited to the use of engineers.

Previous to the above mentioned table by Fisher, cables were usually rated according to some rule allowing a certain number of amperes per unit area, and Fisher's work was a very great advance. In order to expedite matters for a subject such as cable ratings, where there is an almost endless variety of conductor sizes, insulation thickness, types of make up, &c., and at the same time make it possible to compare properly the work of various investigators, the problem must be reduced to its simplest physical terms; that is, the complexity must be reduced by considering only the independent physical constants. Once these have been established, any engineer having the dimensions of a cable and sufficient data upon the surrounding temperature may obtain a dependable rating cable.

In searching through the available literature the writer has found only a few Papers that conform to the above requirements, and which may, therefore, be a basis for proper comparison. These are :—

Mie, "Uber die Wärmeleitung in einem verseilten Kabel," "Elekt. Zeit.," 1905.

Melsom and Booth, "The Heating of Cables with Current," "Jour.," Inst. Elec. Engrs., Vol. XLVII., 1911.

Atkinson and Fisher, "Current Rating of Electric Cables," "Trans." Am. Inst. Elec. Engrs., 1913.

Dushman, "The Rating of Cables Carrying Current," "Trans." Am. Inst. Elec. Engrs., 1913.

The purpose of the present Paper is to discuss more particularly the carrying capacity of paper insulated cables, although much of what follows is applicable to cables insulated with other materials.

II. RATING OF CABLES.

The rating of an insulated cable is determined by :—

A. Continuous rating:

1. The maximum temperature at which the insulation may be operated without undue deterioration.
2. The thermal conductivity of the cable.
3. The thermal condition and properties of the surrounding medium, usually the air in a conduit system.

B. Overload or intermittent rating, in addition to 1, 2 and 3 under A.

1. The thermal capacity of the cable and surrounding medium, that is, the ability of the cable to store a portion of the heat released in the conductor, and thereby, for short periods of time, to put less demand upon the cable as a dissipator of heat.

It is demonstrated in works on heat that the thermal conductivity of an infinite hollow cylinder in watts per centimetre of length per degree centigrade is

$$k_1=\frac{2\pi\lambda}{ln\frac{d_1}{d}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which λ=specific thermal conductivity of the material in watts per degree centigrade per centimetre, ln=Naperian logarithm, d_1=outer diameter of cylinder, d=inner diameter of cylinder.

For a cable, d_1 and d are, of course, the inner diameter of the lead sheath and the diameter of the conductor respectively. In applying equation (1) to thermal measurements of cables it is necessarily assumed that the conductor and the sheath are in very close contact with the insulation, and that there is no appreciable temperature drop from the conductor to insulation or from insulation to sheath. This assumption may not be correct ; hence it is always advisable to obtain values for λ from measurements on actual cables instead of from the insulation taped up on cylinders, &c. It may be said, however, that equation (1) when applied to cable measurements gives consistent values.

The surface thermal conductivity of the lead sheath to air is, in watts per centimetre of length per degree centigrade,

$$k_2=\pi d_3 h, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where h=specific surface thermal conductivity for lead to air in watts per degree centigrade per centimetre², d_3=outer diameter of the sheath in centimetres.

The thermal conductivity of the cable, that is, the watts per centimetre per degree centigrade difference in temperature of the conductor and the air surrounding the lead sheath, is

$$k=\frac{k_1 k_2}{k_1+k_2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This expression gives the electrical conductivity of two conductors in series. The analogous thermal conductors in series are the insulation and the lead sheath.

It is only necessary to agree upon values for λ and h in order to establish ratings for all one conductor cables. Various observers have obtained somewhat widely differing values for these :—

Values for λ and h.

Observer.	λ	h
	For saturated paper.	For lead sheaths.
Melson and Booth	0·00102 to 0·00134	0·00088 to 0·00155
Atkinson and Fisher	0·00100 to 0·00115	0·00083 to 0·0096
Powell	0·00081 to 0·00114	0·00090 to 0·0011
Dushman	...	0·00081 to 0·0011
*Symons and Walker ...	0·00142 to 0·0017	...

In view of the varying conditions of the cables tested, the above values appear to be in reasonable agreement. Atkinson and Fisher state that they tested new cables with bright lead sheaths, and Dushman presumably made his tests upon new cables. The writer's values are from tests on old cables taken from service as well as on new cables, and it is to be especially noted that the variation in λ is greater than that given by any other observer, excepting Melson and Booth, and the writer is unable to state anything regarding the age of the cables tested by them.

In the writer's opinion the degree of saturation and hence the age (since there is more or less continual drying action in service) has an important bearing upon the carrying capacity of paper insulated cables.

Thermal Conductivities in Watts per Foot per Degree Centigrade of New and Old Paper insulated Cables.

Size cir. mils.	Thickness of insulation.	Observer.	
		Atkinson and Fisher A.I.E.E., 1913.	Powell.
500,000	4/32	0·21	...
500,000	5/32	...	0·19
1,000,000	4/32	0·275	0·26
1,000,000 (new)	4/32	...	0·308
1,150,000	4/32	0·31	0·318

Although the thermal conductivity of the paper decreases with service, that of the lead increases, and the two effects just about balance, so that an old cable has nearly as good carrying capacity as a new one.

The values due to Atkinson and Fisher are for new cables, and are those calculated from the table given in the discussion of their previously mentioned Paper, and increased by 12 per cent. to agree with their test values. Except as noted, the writer's values are for old cables.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

† Glühen von Metalldrähten durch den galvanischen Strom. Bericht über die neuesten Fortschritte der Physik. Band I.

‡ "On the Thickness of Wire Required to Carry Different Electric Currents without Overheating," THE ELECTRICIAN, 1882.

* "The Heat Paths in Electrical Machinery," "Jour." Inst. Elec. Engrs., Vol. XLVIII. These values were obtained by wrapping the Paper on a copper cylinder which was then placed in an oil bath.

Values of λ and h to be Used in Determining Carrying Capacity.—The above-mentioned table recommended by Atkinson and Fisher is based upon $\lambda = 0{\cdot}00100$ and $h = 0{\cdot}000833$.

It is believed that the value of λ is too high for cables after several years' service, and *h* is too low even for new cables after being exposed to the air for a few months. The writer, therefore, proposes ratings for paper cables based upon $\lambda = 0{\cdot}00085$ and $h = 0{\cdot}001$. First class cables, particularly, in a short time after installation, will usually show 15 to 20 per cent. greater carrying capacity than that calculated from these values and most old cables of the same quality 10 per cent. greater. However, allowance must be made for paper and saturation which may not be of the best, for inaccuracies of measurements on cables in a conduit system, and some uncertainty as regards heating due to sheath currents.

If *t* is the thickness of insulation in inches and $\lambda = 0{\cdot}00085$, equation 1) becomes—

$$k_1 = \frac{2\pi \times 0{\cdot}00085}{ln\left(1+\dfrac{2t}{d}\right)} \times 30{\cdot}5$$

$$= \frac{0{\cdot}1625}{ln\left(1+\dfrac{2t}{d}\right)} \text{ watts per foot per degree Centigrade.} \quad . \quad (4)$$

Similarly, equation (2) becomes, if d_3 is in inches—

$$k_2 = \pi d_3 \times 0{\cdot}001 \times 6{\cdot}45 \times 12$$

$$= 0{\cdot}244 d_3 \text{ watts per foot per degree Centigrade.} \quad . \quad (5)$$

These two equations enable *k*, the thermal conductivity of the cable, to be determined.

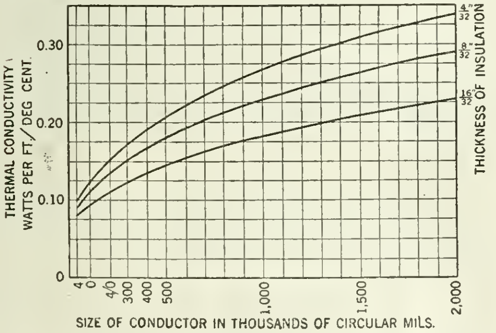

FIG. 1.—THERMAL CONDUCTIVITIES OF ONE-CONDUCTOR PAPER-INSULATED LEAD-COVERED CABLES.

The three curves in Fig. 1 give the thermal conductivities of one-conductor paper cables for various sizes of conductors and three thicknesses of insulation—viz., 4/32 in., 8/32 in., and 16/32 in. Values for any intermediate thickness of insulation may be readily interpolated.

As a maximum safe temperature for saturated paper 85°C., the value allowed in the Rules of the Institute may be accepted with every assurance that it is conservative, and does not represent the maximum temperature that this material will stand without deterioration. The Institute Rules call for a reduction from 85°C. of 1 deg. for each 1,000 volts of operating voltage.

The maximum current carrying capacity, or the rating of a cable is given by—

$$W_\theta = I^2 r_\theta = k(\theta - \theta_d). \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

in which I = the current in amperes, W_θ = watts lost per foot at temperature θ, r_θ = resistance per foot at temperature θ, θ = maximum allowable temperature for the conductor, θ_d = temperature of air in duct.

It is sometimes assumed that the thermal conductivity of paper has a positive temperature coefficient comparable in value to the negative temperature coefficient of copper, so that the increase in loss due to the latter may be neglected. As a result of some tests on this point, however, the writer concludes that the above assumption is incorrect. The error in neglecting the temperature coefficient of copper is not on the safe side. In the following tables ⅛ in. lead has been assumed. Although the smaller cables invariably have thinner lead, the difference from ⅛ in. is not sufficient to cause appreciable error.

III. TABLES OF CARRYING CAPACITY, IN AMPERES, OF ONE-CONDUCTOR PAPER-INSULATED LEAD-COVERED CABLES.

Table I.—*Insulation, 4/32 in. Working Pressure, 750 volts. Maximum Temperature, 85°C.*

Size.	Temperature of air in duct, degrees Centigrade.				
	30	40	50	60	70
4	133	120	106	90	70
3	154	139	122	104	80
2	181	164	144	122	95
1	200	182	160	136	105
0	240	220	192	163	126
2-0	277	250	220	187	145
3-0	320	290	256	217	168
4-0	376	340	300	254	197
250M	418	380	333	282	219
300	475	430	379	320	248
400	570	515	454	385	298
500	670	608	535	454	351
750	870	790	695	590	456
1,000	1,070	970	855	725	560
1,250	1,240	1,120	990	840	650
1,500	1,410	1,275	1,125	950	735
2,000	1,700	1,535	1,355	1,150	890

Table II.—*Insulation, 8/32 in. Working Pressure, 5,000 volts. Maximum Temperature, 80°C.*

Size.	Temperature of air in duct, degrees Centigrade.				
	30	40	50	60	70
4	125	112	97	79	56
3	145	129	112	91	64
2	166	149	129	105	74
1	181	162	140	115	81
0	214	192	166	135	96
2-0	251	225	195	159	112
3-0	290	259	225	183	130
4-0	339	303	262	214	151
250M	371	332	288	235	166
300	431	385	333	272	192
400	519	464	402	328	232
500	610	545	472	386	273
750	785	702	609	497	352
1,000	955	855	740	605	427
1,250	1,100	980	850	695	490
1,500	1,255	1,125	970	795	560
2,000	1,510	1,350	1,170	955	675

Table III—*Insulation, 16/32 in. Working Pressure, 15,000 volts. Maximum Temperature, 70°C.*

Size.	Temperature of air in air duct, degrees Centigrade.			
	30	40	50	60
4	107	93	76	53
3	122	106	86	61
2	139	120	98	70
1	152	132	108	76
0	181	157	128	90
2-0	208	181	147	104
3-0	239	207	169	120
4-0	284	246	201	142
250M	312	270	221	156
300	351	305	248	175
400	420	364	297	210
500	490	423	345	245
750	632	548	447	316
1,000	766	664	542	383
1,250	900	780	635	450
1,500	1,015	880	720	510
2,000	1,225	1,060	855	610

IV. CARRYING CAPACITY OF MULTIPLE CONDUCTOR CABLES.

The preceding tables may be used for multiple conductor cables by applying the following factors to the carrying capacity of one-conductor cables having the same total thickness of insulation.

Number conductors.	Type of cable.	Multiply one conductor capacity by
2	Flat or figure 8.	87 per cent.
2	Round.	80 ,,
2	Concentric.	75 ,,
3	Round.	70 ,,
3	Oval sector.	77 ,,
3	Cloverleaf sector.	80 ,,
4	Round.	67 ,,

Thus, the carrying capacity of a 4/32 · 4/32 in. round, three-conductor cable is 70 per cent. of that for an 8/32 in. one-conductor cable.

V. Increase of Temperature Due to Sheath Currents

It happens, not infrequently, that cable sheaths carry considerable current. This current may be stray railway, or neutral or currents induced by alternating currents in neighbouring one-conductor cables.

Let w=watts per foot loss in conductor.
w'=watts per foot loss in sheath.
k, k_1 and k_2=thermal conductivities, for cable, conductor to sheath, and sheath to air, respectively.
θ=Conductor temperature above initial.
θ'=Sheath temperature above initial.

Then $w=k_1(\theta-\theta')$, $w+w'=k_2\theta'$.

Eliminating θ', we have—

$$\theta=\frac{w}{k}+\frac{w'}{k_2},$$

or, the temperature of the conductor is increased by the amount w'/k_2, which is the temperature the sheath would have with the same current in the sheath, but no current in the conductor.

As an example, a 1,000,000 cir. mil 4/32 in., $\frac{1}{8}$ in. lead one-conductor cable which has a sheath resistance of 0·00017 ohms per foot will operate at an increase in temperature of 5 deg., 17 deg. and 40 deg. with sheath currents of 100 amperes, 200 amperes and 300 amperes respectively. The effect of small or moderate sheath currents may be neglected, but large currents must be avoided.

VI. Cables in Duct Lines.

The carrying capacity of a cable is largely determined by the thermal properties of the duct line in which it is installed, and hence, will vary greatly with type of construction and character of soil. In order to determine the proper carrying capacity of cables with any degree of reliability, it is desirable to make a temperature survey of the conduit system.

It will be found that the thermal conductivity of a duct line is a constant, and is

$$k=\frac{w}{\theta-\theta_d}\text{ watts per foot per degree Centigrade, . . (13)}$$

where w=total watts per foot loss in duct lines, θ=mean temperature of air in ducts, θ_d=temperature of air at surface of street.

This equation will apply after the temperatures in the ducts have become steady, usually only after one or two weeks. The temperature of the external air has an important influence, and, under otherwise similar conditions, a duct line will run much warmer in summer than in winter.

In practice, loads are seldom steady; hence the temperature of the air in ducts follows, more or less closely, the load variations, although it will be found that the earth directly in contact with the conduit changes only with the seasonal variation of load.

The problem may conveniently be divided into two parts—viz., one having to do with heat transference from the air in the ducts to the earth directly in contact with the conduit, and the other with transference from the earth to the air at the surface. For the first, the thermal conductivity is

$$k_d=\frac{w_d}{\theta_d-\theta_s}\text{ watts per foot per degree Centigrade . (14)}$$

In this, w_d=maximum watts per foot loss at stationary maximum temperature θ_d for air in ducts. θ_s=soil temperature.

For the second we have—

$$k_s=\frac{w_s}{\theta_s-\theta_d}\text{ watts per foot per degree Centigrade, . (15)}$$

where w_s=average watts per foot loss for a given load cycle.

For most loads the cycle is probably a week.

All thermal measurements on duct lines should be made midway between manholes, as this is the warmest point. Soil under pavements at a considerable distance from unpaved sections rarely has the variation in moisture content found in soil under unpaved streets. Hence, measurements in soil under pavements may be made at almost any time of the year, but in other soil should be taken at the driest season.

The losses w_d and w_s may be calculated from the station load reports, and θ_d is taken with a recording thermometer. Measurements for θ_d should be taken in several ducts, particularly if there is a large number in the run.

After k_d and k_s have been obtained the effect of change in loading for the cables already installed or effect of additional cables may be calculated.

Let w_d' be the maximum duct loss, and w_s' the mean loss over the cycle for the whole conduit, both in watts/feet after the change. Then the new soil and duct temperatures are:—

$$\theta_s'=\frac{w_s'}{k_s}+\theta_d,$$

$$\theta_d'=\frac{w_d'}{k_d}+\theta_s'=\frac{w_d'}{k_d}+\frac{w_s'}{k_s}+\theta_d.$$

It is hoped that the preceding discussion of duct line temperatures may assist in forming a clear conception of the physical principles involved. For only in this way may we expect to make a duct line in any degree amenable to design as a dissipator of heat. The writer does not wish to leave the slightest impression, however, that judgment and experience are not of the highest importance in designing duct lines and may be replaced by some equations and a table of data. But unless backed up with quantitative information, "judgment and experience" are apt to be nothing but snap judgment and mental impressions.

VII. Overload or Intermittent Rating.

If a constant load in amperes is applied to a cable the temperature rise of the conductor, at any time after application of the load is given by the equation

$$\theta=\Theta(1-\epsilon^{-\beta t})=\frac{w}{k-aw}\left(1-\epsilon^{-\frac{k-aw}{c}t}\right), \quad . \quad . \quad . \quad (11)$$

in which θ=temperature rise above initial temperature at time t, Θ=final temperature rise, ϵ=base of Naperian logarithms, $\beta=k-aw/c$=constant, t=time in hours, w=watts loss per foot at initial temperature, a=temperature coefficient of copper referred to initial temperature, c=constant depending upon thermal capacity of cable.

It is sometimes assumed that c is equal to the total thermal capacity of the cable, which is, of course, assuming that the rate of temperature rise is the same for all parts of the cable. This assumption is incorrect. It is at once apparent, for example, that the rate of temperature rise of the lead sheath is not so great as that of the conductor, particularly for heavily insulated cables. The error is not appreciable for small cables, but for large well insulated cables the above assumption leads to results which are in error on the danger side, that is give too small a value for β, and hence a lower temperature rise in a given time.

We may put

$$c=c_1+p(c_2+c_3), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where c_1=thermal capacity of the conductor in watthour per foot, c_2=thermal capacity of the insulation in watthour per foot, c_3=thermal capacity of the lead sheath in watthour per foot, p=constant, depending upon the type of cable.

Some values for p as found by the writer follow:—

Experimental Values for Constant p.

No. conductors.	Size conductor.	Thickness of insulation.	Thickness lead.	p.
1	4/0	7/16 paper.	$\frac{1}{8}$	0·81
...	500,000	5/32 ,,	$\frac{1}{8}$	0·70
...	1,000,000	4/32 ,,	$\frac{1}{8}$	0·70
...	1,500,000	4/32 ,,	$\frac{1}{8}$	0·77
3	4/0	13/64 × 13/64 paper.	$\frac{1}{8}$	0·595
	250 M submarine (6/32 rubber+2/32 Var. Cl.) × 5/32 Var. Cl. 5/32+0·59 No. 4 steel armour wires.			

From data given by Dushman for a one-conductor 250,000, 4/32 in. rubber cable, p was found to be 0·80.

Hence, for practical purposes, it appears that we may put p=0·75 for one-conductor and p=0·60 for three-conductor cables.

The following quantities may be used in calculating the thermal capacity of a cable.

Thermal Capacity in Watthour per Inch Cube.

Copper, iron, steel	0·01525
Lead	0·0064
Rubber	0·00625 (Dushman)
Paper	0·0047

In Fig. 2 is shown some test curves together with those plotted from equations of the form of (11).

With the assistance of a curve giving $(1-\epsilon^{-\beta t})$ for various values of βt, we may very readily obtain the temperature at any time t, provided the final temperature Θ, and the time constant β are known. These, however, may easily be computed with the preceding equations and data.

In general, the duct temperature increases simultaneously with that of the cable, and usually at approximately the same rate. If this increase is small, that is, 5 deg. or 10 deg., we may simply add this increase to the final temperature. For instance, in the above example, if the final duct temperature had been 50 deg. instead of 40 deg., we should have had $\theta=91$ deg., and the time about 40 minutes.

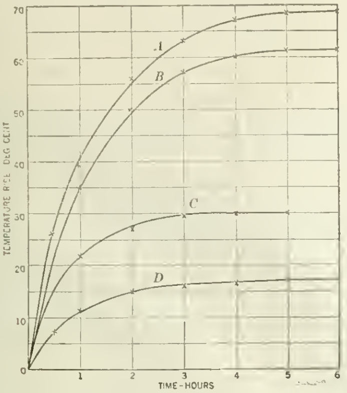

FIG. 2.—RATE OF TEMPERATURE RISE OF CABLES.

Curve.	Type of cable.	Load amps.	Equation.
A	4/0-3 conductor round 13/64 × 13/64 paper 1/8 in. lead	300	$\theta=69(1-\epsilon^{-0{\cdot}83t}$
B	1,500,000 cm. 1 conductor 4/32 paper 1/8 lead	1,500	$\theta=62(1-\epsilon^{-0{\cdot}86t}$
C	500,000 cm. 1 conductor 5/32 paper 1/8 lead	500	$\theta=30(1-\epsilon^{-1{\cdot}4t}$
D	250,000 cm. 3 conductor submarine (6/32 rubber + 2/32 var. cl.) × 5/32 var. cl. 5/32 lead and 41 No. 4 steel armour wires	310	$\theta=17(1-\epsilon^{-1{\cdot}05t}$
	Points calculated from equations shown X.		

If the increase in duct temperature is large, the temperature coefficient of copper should not be neglected. A more correct value for the final rise of a cable is

$$\theta=\theta_1+\frac{k}{k-aw}\theta_2.$$

Here, θ_1 is the final rise the cable would have at constant duct temperature, and θ_2 is the final increase of duct air temperature.

THE EFFECT OF ULTRA-VIOLET LIGHT ON THE EYE.

Of recent years much has been said regarding the effect of invisible rays, particularly the ultra-violet, on the eyes, and claims are not infrequently made for one or another illuminant to the effect that they have little or no ultra-violet light in their constitution and are, therefore, peculiar, hygienic and "restful" to eyesight.

It may, therefore, be of interest to review some of the work that has recently been done in this field.

It has long been known that many effects of sunlight are due largely to the presence of these rays. The tanning of the skin that follows exposure to strong sunlight is now attributed to ultra-violet energy, and the same effect is produced by incautious exposure to naked arcs, the quartz-tube mercury-vapour lamp and other artificial illuminants that are rich in this form of radiation. The marking following small-pox also appears to be due to the influence of such rays. Even in the Middle Ages it was known that the use of red curtains mitigated the marking of the skin, and to-day precautions in the way of avoiding exposure to their action cause the after effects of small-pox to be much less noticeable than in the past.

On the other hand, ultra-violet light is also recognised to have beneficial and hygienic effects. Free access of light into a room assists the destruction of bacteria, and the ultra-violet rays, which are largely responsible for the fading of colours, also appear to have a useful germicidal effect. Exposure to ultra-violet light is believed to have a curative influence on certain skin diseases. The value of the Finsen (concentrated arc) light in the treatment of lupus is a case in point, although it does not seem to be entirely determined how far this beneficial effect is due to ultra-violet light and how far to the visible blue rays which are also admitted through the filter used with this lamp.

There is also good ground for believing that affections of the eyes caused by exposure to strong sunlight are in part due to the action of these rays. Thus the snow-blindness met with in snowy, mountainous districts, as well as the peeling of the skin, are probably largely due to their action. At such high altitudes the percentage of ultra-violet light present in daylight is very much greater than at sea level a condition that was clearly demonstrated as far back as 1885 by Langley as a result of his determination of the energy distribution in the solar spectrum at the top of Mount Whitney in the Sierra Nevadas (15,000 ft. high).

Again, the ophthalmia and eye-inflammation that is apt to be caused by exposure to the glare of the desert may also be due to ultra-violet action, since in tropical clear atmospheres the percentage of such radiation is often noticeably high. The difficulty in researches on such effects is to disentangle the effect of the ultra-violet light from the other effects due merely to excess of visible light, and, therefore, the arrival of artificial sources very rich in ultra-violet energy has been useful in enabling these phenomena to be studied more closely. For, by using artificial light, the intensity and quality of the radiation can be more completely controlled and numerical results more easily obtained.

The general interest in this subject, as regards artificial illuminants, may be said to have been initiated by a series of interesting experiments carried out by Drs. Schanz and Stockhausen, of Dresden, a few years ago.* The combination of a physicist and a physiologist on such problems undoubtedly leads to useful results, although it may not be possible to confirm all the conclusions reached in this case. In the course of these experiments tests of the effect of ultra-violet rays on the eyes of various animals were made. Briefly, it appeared that the ultra-violet rays might be divided into four divisions—(1) those of very short wave-length, which are completely checked by clear glass and even to some extent by air; (2) rays under $300\mu\mu$ which are partially checked by clear glass and do not penetrate the eye, but cause inflammation of the outer eye; (3) rays between $300\mu\mu$ and $350\mu\mu$ which penetrate the eye-lens but do not reach the retina; and (4) rays between $350\mu\mu$ and $400\mu\mu$ which cause fluorescence of the eye-lens and may penetrate to the retina, where, in excess, they cause injury.

The researches also included a series of spectrographic charts of the chief artificial illuminants, from which it was shown that during recent years the percentage of ultra-violet rays has steadily increased.

The suggestion (since also offered by other observers) that cataract is due to chemical changes in the eye, following the fluorescence caused by such rays, was supported by reference to the prevalence of cataract among glass workers and others constantly exposed to glowing material. A form of yellow-green glass was invented ("Euphos") which, while only slightly checking visible light, has a marked absorbent action on the ultra-violet rays. Slightly tinted glass of this kind was recommended for spectacles to be used in snowy, mountainous districts, in the desert, &c., and more deeply tinted varieties were proposed for use in working constantly with artificial sources rich in ultra-violet light. It was even proposed that the bulbs used with metal filament lamps and the chimneys used with incandescent mantles should preferably be made of glass of this kind.

Since that date many forms of yellow-green and other glasses, intended to obstruct the ultra-violet rays, have been made and recommended. One of the most notable series of researches on this point was that carried out by Sir William Crookes in connection with the Committee of the Royal Society for the study of cataract.† There is good reason to think that the blue or slightly smoked glasses commonly used to obviate the glare of brilliant sunshine have the defect of admitting the ultra-violet rays to an undesirable extent. In such cases a form of glass capable of obscuring these rays, preferably used in combination with a more or less obscuring glass suitable for diminishing the glare of the visible light, is probably the most ideal combination. In the case of special work at close quarters on sources rich in ultra-violet light, for example, in working with naked arcs, or mercury-vapour lamps in quartz tubes, or in auto-welding, precautionary measures are highly desirable, for many cases of injury to the eyes have followed lack of caution in this respect. Care is the more to be encouraged because injuries may only reveal themselves gradually. A person may work with such light without experiencing discomfort and yet experience severe inflammation of the eyes hours afterwards, while more deep-seated injury might only be revealed very much later.

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* "Zeit. f. Bel.," Oct. 19, 1907. "Elek. Zeitchr.," Aug. 13, 1908.

† "Phil. Trans.," Series A, Vol. CCXIV., 1914, pp. 1-25.

The study of the action of such rays in causing cataract has always been rendered difficult by the human element, some eyes apparently resisting effects for a lifetime which, in other cases, cause trouble very quickly. Some light on this subject is shed by recent researches of W. E. Burge,* who used gas-filled incandescent lamps and quartz tube mercury lamps, and experimented both on the coagulation of albumen and on the production of turbidity in the eye-lenses of animals. By securing a very powerful illumination coagulation of albumen could be produced in a few hours, but the protein substances in the eye (although substantially similar in composition) were unaffected after even 100 hours' exposure. This suggested that the liability of some eyes to cataract might be associated with the presence, to an abnormal extent, of certain salts which paralysed the resisting power of the aqueous and vitreous humours in the healthy eye. By experiment it was found that the salts of calcium, magnesium and sodium had this effect, and an examination of some thousands of cataract-eyes from India showed that in such cases these salts were usually present to a marked degree.

It was inferred, therefore, that cataract was largely favoured by the presence of two distinct factors : (*a*) A modification of the protein of the eye-lens due to malnutrition or disease, and (*b*) exposure prolonged to powerful ultra-violet radiation such as exists in the sunlight of the tropics.

This conclusion is most important because it suggests that certain eyes are predisposed to injury by ultra-violet light : and that the experience in such cases should not be regarded as indicating the necessity for general precautions for all eyes.

The most important bearing of all these investigations is in relation to the effects of ultra-violet light of artificial illuminants. It is doubtless true that within recent years the brilliancy and concentration of light in artificial illuminants has greatly increased, and at the same time such illuminants have become "whiter" in colour and may, therefore, be expected to contain larger percentages of ultra-violet light. On the other hand, it has been shown by Voege that the percentage of such radiation in incandescent illuminants is in general still minute and smaller than that present in strong sunlight, against which, in normal circumstances, no special precautions are taken.

Luckiesh† and Bell‡ have published quantitative researches leading to the same conclusion. It is not to be gainsaid that constant exposure to the direct glare of such sources as the arc light and the gas-filled glow lamp may have prejudicial effects, and doubtless the ultra-violet component may play some part therein. But the mere effect of the glare of the visible light at close quarters from an unshaded source of this description would also be prejudicial. The obvious remedy would seem to be in the proper shading and sensible use of such lamps, rather than enclosing them in glass envelopes of special composition. It is, of course, conceivable that some minute but cumulative effect of certain rays, even if lamps so shaded, may exist. But the matter has not yet been investigated sufficiently by physiologists for any definite opinion to be advanced on this point.

On the other hand, in special work with arcs, with the quartz tube mercury lamps, and in the case of auto-welding where the operator is necessarily at close quarters with the source, the use of special screens designed to protect against excess both of visible and of ultra-violet light is a natural and necessary precaution.

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* "Elec. World," Oct. 10, 1915.
† "Elec. World," June 15, 1912.
‡ "Elec. World," April 13, 1912.

THE INFLUENCE OF THE TIME ELEMENT ON THE RESISTANCE OF A SOLID RECTIFYING CONTACT.*

BY DAVID OWEN, B.A., B.SC.

The properties of a rectifying contact may be studied by examining the curve connecting its resistance with the value of the steady applied voltage. In a previous Paper† some examples of such curves, or resistance characteristics, were given, and from its properties an expression was found for the sensitiveness of the contact treated as a rectifier of high-frequency oscillatory currents. It is, however, an obvious experimental fact that the resistance of a contact depends appreciably on the time of application of the voltage. Experiments since carried out with the object of more fully determining the influence of the time element form the subject-matter of the present Paper.

The results have a bearing in the first place on the calculation, above alluded to, of the sensibility of a wireless receiving circuit including the contact. They have a further interest in their bearing on the thermo-electric theory of the contact ; in connection with which arises the question of the location to be ascribed to the thermal effects which (on this theory) accompany and give rise to the observed variations of electric resistance.

The subject of the time-lag of resistance at a contact has been previously examined by Pierce,‡ who, in experiments made with alternating currents of 80 ~ was unable to detect the existence of any lag. From the observations recorded below it follows that such a lag is necessarily present, though not to an extent which would be probably appreciable in cathode ray oscillograms taken under the conditions of the experiments quoted.

THE METHOD OF MEASUREMENT.

The Wheatstone Bridge was again employed. It is required to measure the resistance of a contact at a known time, which may be a small fraction of a second, after completing the battery circuit. When the time is a second, or more, the ordinary method of obtaining a balance can, of course, be employed. For the shorter times a ballistic method was substituted. The galvanometer key being closed, the battery circuit is closed for the period determined upon ; the process being repeated until, by adjustment of the variable arm, the galvanometer throw is reduced to zero.

Two methods of making the battery circuit were used. For the shortest periods—from $\frac{1}{40000}$ second to $\frac{1}{200}$ second—the circuit was closed by allowing a polished metal ball or ring suspended by a fine wire to strike the fixed and polished surface of a heavy piece of steel plate. The duration of contact was independently ascertained by measuring the charge communicated, during the collision, to a mica condenser in series with a resistance of known and suitable value. A set of balls and rings was obtained supplying periods of collision over the range quoted.

This collisional method becomes inconvenient when the time of contact required is greater than about 0·005 second. It was supplemented, therefore, by use of a revolving contact maker whose speed was under control ; and thus the range was extended up to 0·5 second.

Theory of the Ballistic Bridge. When one of the four arms of a Wheatstone Bridge contains a resistance which varies during the period of application of the voltage, it is evidently impossible to find a balance in the sense that no current whatever flows in the galvanometer branch. It is possible, however, to adjust the variable arm so that the total quantity of electricity passing through the galvanometer is zero.

Let R denote the instantaneous resistance of the contact under test ; P, Q and S, the resistances of the remaining arms. The resistance of the battery branch may be kept negligibly small ; this results in some simplification in the theory. Let

V voltage across bridge,
v instantaneous voltage across R,
i instantaneous current through R,
t time from instant of closure of battery circuit,
τ total period of closure of circuit,
v and i denote mean values of v and i over the time t.

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* Abstract of a Paper read before the Physical Society of London, Oct. 27, 1916.
† "Proc." Phys. Soc., London, Vol. XXVIII., p. 173, June, 1916.
‡ "Phys. Rev.," 1907.

It may be shown that at balance

$$\frac{P}{Q} \cdot S = \frac{\bar{v}}{\bar{i}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Again $$\bar{v} = V - S\bar{i} = V \cdot \frac{P}{P+Q} \, ; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

whence $$\bar{i} = \frac{VQ}{S(P+Q)} \cdot \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$\bar{v}$ and $\bar{i}$ are thus at once calculable in terms of V and the resistances of the three known arms.

From a series of measurements with different values of τ a curve can be drawn connecting $\bar{i}$ and t. From this may be determined the value of the instantaneous current and voltage, and hence the instantaneous resistance, at the end of any time within the range employed. It was found that the curves connecting R and v were of the same general trend as those connecting $\frac{P}{Q} \cdot S$ and $\bar{v}$. The latter quantities are, therefore, plotted to represent R and v respectively in the characteristic curves shown in the Paper.

The balance is independent of the inductances in the bridge network, since the initial and final values of all the currents are zero.

STATEMENT OF RESULTS OF OBSERVATION.

Experiments were conducted on zincite, galena and carborundum; the other element of the contact being platinum in each case. Two sets of determinations were made, one connecting R and v (τ constant); the other connecting R and t (v constant). The results are expressed in the accompanying curves and tables.

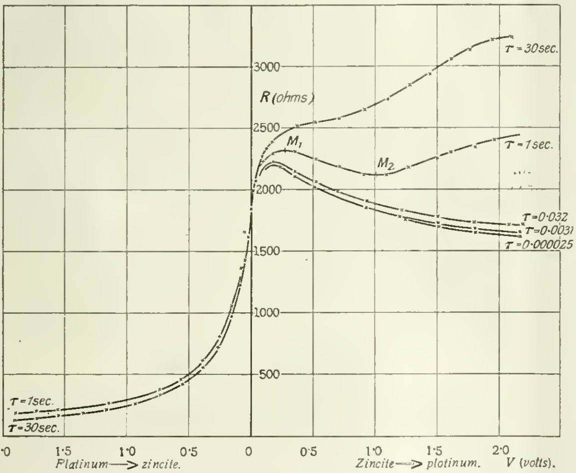


FIG. 1.—RESISTANCE CHARACTERISTICS FOR VARIOUS PERIODS OF APPLICATION OF VOLTAGE. (ZINCITE-PLATINUM.)

Attention was concentrated mainly on zincite, owing to the reliable nature of the contacts which this material furnishes. Many points of contact were tried. Two sets of resistance characteristics, obtained from two of these points, are given; they include the main features found in all the tests (one of these is reproduced in Fig. 1). Parts of the curves are omitted where excessive closeness might cause confusion. It may be seen that—

1. For current across the contact from zincite to platinum the resistances increases with time, the reverse being true when the current is in the reverse direction.

2. The effect in the neighbourhood of zero voltage is a slight increase in the slope, or voltage-coefficient, with increase in the time of application of the voltage.

3. At higher voltages, for current from zincite to platinum (across the contact) the increase of resistance with time may be so great as to produce a minimum point M_2 in the characteristic. This effect is in some cases (*see* Fig. 1) great enough to obliterate the first maximum, which is characteristic of all the curves when τ is small.

4. When the voltage is increased to a value between 2 and 3 volts, there is a steep fall in the characteristic.

Experiments on contacts of *galena* show at low voltages effects of the same kind as those of zincite; that is, the slope of the characteristic at zero voltage is accentuated by increasing the duration of flow of the current.

In the case of *carborundum* the time effect is contrary in sign to that in the two preceding cases. As shown in Fig. 2, the resistance of a carborundum contact decreases as the current is prolonged, when the direction is from carborundum to platinum across the contact; the effect being as before reversed when the current is reversed.

The time-effect may also be examined by determining the resistance of a contact for a series of gradually increasing periods of closure of the battery circuit, the applied voltage being the same in each case. The data shown in Table I. were found in the case of a zincite contact. Applied voltage = 2·08 volts; resistance at zero voltage, R_0 = 1,311 ohms; voltage coefficient = 4·4; current from zincite to platinum across the contact.

The third column shows the rate of change of resistance with time at the end of the period specified in the first column.

Table I.—*Variation of Resistance with Duration of Current.*

Time of application of voltage (seconds).	Resistance (ohms.)	dR/dt(ohms/sec.)
0·000025	1,453	140,000
0·00012	1,463	36,400
0·00082	1,477	13,100
0·0031	1,495	4,820
0·032	1,545	1,220
1·0	1,805	163
30·0	2,245	8

From the above table we gather:—

5. That the rate of variation of resistance becomes continuously greater as τ becomes less.

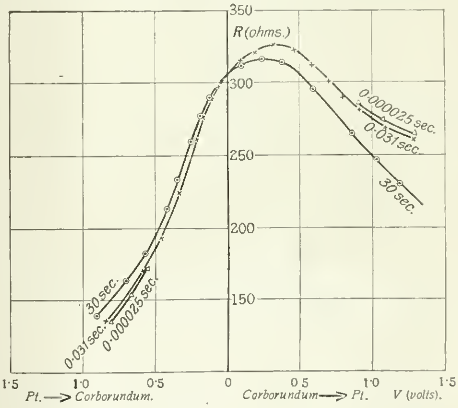


FIG. 2.—RESISTANCE CHARACTERISTICS FOR VARIOUS PERIODS OF APPLICATION OF VOLTAGE. (CARBORUNDUM-PLATINUM.)

INTERPRETATION OF RESULTS.

The above data enable a judgment to be formed of the relation between the characteristic actually described by a contact under an oscillatory voltage of, say, a million frequency, and that obtained in a slow point by point test.

The time of application of voltage has been varied from 30 seconds to a little under one millionth of that time. A further reduction to one-tenth the lower limit would have yielded a period of the order of 10^{-6} second. The degree of extrapolation involved appears sufficiently small to warrant the conclusion that the characteristic at $\tau = 10^{-6}$ second would not materially differ from that obtained at $\tau = 0{\cdot}001$ second, or even 0·01 second; though referred to that found at $\tau = 1$ second or more the correction required would be very appreciable, especially at the higher voltages.

The sensitiveness of the contact, used as a detector of high-frequency oscillations, would in the case of zincite or galena be probably less by some 10 per cent. or 20 per cent. than that deduced from a long-period characteristic; in the case of carborundum it would be greater by approximately the same percentage.

The bearing of the experimental results on the thermo-electric theory of the contact will now be examined. According to this theory the changes of resistance with voltage are not instantaneous, but are a consequence of the thermo-E.M.F. and the temperature variation of resistance that accompany heat development at the contact. The rate of variation actually observed is very great. To quote one case (*see* Table I.), the resistance of a zincite contact under a voltage of 2·08 volts was 2,245 ohms at the end of 30 seconds; at an instant 0·000025 second after application of the voltage it was 1,453 ohms, the rate of variation then being 140,000 ohms per second. The limiting resistance was 1,311 ohms. It appears not unreasonable to suppose that the outstanding difference of 142 ohms occurred in the first 40,000th of a second; and that the whole difference between the resistance at zero voltage and that found at any other voltage is due to and follows the temperature variation at the contact.

As already pointed out, the characteristic at $\tau=0{\cdot}000025$ second does not very materially differ from that obtained at $\tau=0{\cdot}01$ second, whereas the latter differs considerably from the characteristic at $\tau=1$ second. Again, it appears (*see* Fig. 2) that an initial increase of resistance may be followed by a decrease as the voltage is sustained, or vice versa. These facts point to the necessity of modifying the simple view that the Joulean and the thermo-electric disengagements of heat are located in precisely the same volume of the crystal.

They become intelligible if we suppose two regions of heat development. The question of the location of the resistance at a contact was dealt with (from an altogether different point of view) in the preceding Paper (*loc. cit.*). Two views were discussed. According to the first the resistance may be located within the high-resistance element of the contact, in a volume whose linear dimensions in every direction are of the order of those of the interface $\left(R \div \frac{0{\cdot}8\rho r_0}{\pi r_0^2}\right)$. According to the second view the resistance may be assigned to a stratum of molecular thickness, but of considerable resistance, at the interface of the two elements of the contact.

These views are not mutually exclusive, and the data at present under discussion give grounds for the conclusion that the resistance is made up of the two in series, as illustrated in the diagram of Fig. 3.

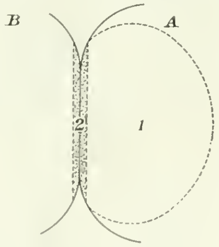


FIG. 3.—DIAGRAM ILLUSTRATING VIEW OF TWO REGIONS OF HEAT DEVELOPMENT AT A CONTACT.

A represents the high-resistance element; *B* the low-resistance element of the pair. Region 1 has linear dimensions of the order of those of the interface; region 2 is a stratum of molecular thickness.

The Peltier heat would be developed solely in the second region. Joulean heat would be set free in both regions, as also would the Thomson heat. Joulean heat is always positive. The Thomson heat, like the Peltier heat, may be either positive or negative; but in contrast to the Peltier heating effect, its sign is (for small currents) unaffected by the direction of the current.

Extremely rapid change of temperature is regarded as associated with heat liberated (or absorbed) in region 2; and slow change with thermal effects occurring in region 1. There are thus two "time-constants," one proper to the molecular stratum, being very small compared with the other.

The Thomson heat may possibly account for the difference in the two types of crystal, one represented by zincite, the other by carborundum (*see* Figs. 1 and 2).

If the Thomson heat develops slowly, then the question of increase or decrease with time of the slope at zero voltage will be determined by the sign of the coefficient *c*. A zincite contact behaves as if *c* were negative; a carborundum contact as if *c* were positive.

The characteristic obtained at a zincite contact when the voltage is sustained for a considerable period is conspicuous by the presence of a second maximum. The curve rapidly descends past this point, and once this has been permitted to happen the limiting resistance of the contact is found to be only a small fraction of the initial value. This drop, which is permanent, is to be assigned to softening due to rise of temperature; this leading in its turn to increase of area and consequent reduction in electric resistance. The effect here outlined is doubtless to be identified with the "breakdown" found in practice when a contact has been subjected to an excessive voltage.

The Values of the Time Constants.—Accepting thermo-electric action as the true basis of the rectifying property, a time lag of resistance must inevitably occur; but this, if it is not to nullify the rectifying action, must be of comparatively small account even at the rapidity of change involved at electric wave frequencies. This can only be the case if an appreciable portion of the resistance of the contact is associated with a time-constant small compared with the period of the impressed oscillations.

It is possible to form estimates of the time-constants corresponding to the regions 1 and 2 of Fig. 3; the dimensions of the contact, the thermal conductivity and the specific heat of the material entering as important factors.

The result of analysis is to show that the variations of temperature and resistance at a contact can only follow the voltage without serious diminution at electric wave frequency—

(*a*) In region 1 if the mean diameter of the area of contact $< 0{\cdot}5 \times 10^{-4}$ cm.;

(*b*) In region 2 if the mean diameter 0·1 cm.

Now in actual practice the mean diameter of the area of a good rectifying contact is as a rule far greater than 10^{-4} cm. The conclusion is that the only variation in resistance that can be effective in causing rectification at very high frequency must have its origin in a stratum of molecular thickness at the actual interface of the contact. What the composition of the stratum is there are not at present sufficient data to determine. It is required of it that it should be very thin—indeed of molecular thickness; that it should have a resistivity far higher than that of the material of the contact treated in bulk; and that it should have a negative temperature-coefficient of resistance.

SUMMARY.

The resistance at a solid rectifying contact, and consequently the exact shape of the resistance characteristic, depends upon the time for which the testing current is allowed to flow. A series of characteristics are given corresponding to durations of contact extending over the range one forty-thousandth of a second to 30 seconds.

The following conclusions are drawn:—

1. That the variation of resistance with voltage may be attributed entirely to thermal effects.
2. That the characteristic obtained by applying the testing voltage for one hundredth of a second is, at moderate voltages, materially the same as that which would be found at the expiry of a period of the order of a millionth of a second
3. That the sensibility of a wireless receiving circuit (in which the rectifying contact is used) does not differ very appreciably from that deduced from a slow period characteristic.
4. That an important fraction of the contact-resistance resides in a stratum of molecular thickness at the interface of the two elements of the contact; and that it is in this region alone that rectifying action at very high frequencies is effected.

THEORETICAL DISCUSSION OF THE AUDION.

BY MARIUS LATOUR.

The interesting article of Dr. Eccles on "Recent Patents in Radio-telegraphy and Radio-telephony" (THE ELECTRICIAN, July 28, Aug. 1, 1916) brings out most clearly the increasing importance of vacuum tubes when used as amplifiers or as generators of sustained oscillations in wireless, or in wire, telegraphy and telephony.

In the United States patent specifications Nos. 921,930 and 1,011,210 (1907) of Dr. E. Weintraub and the author, entitled "Producing amplified current variations" and "Amplifying current variations," the use of the mercury vapour tube as an amplifier was already described. Our amplifier was referred to in the article published by Reisz on the tubes of von Lieben and Reisz ("E.T.Z." 1913, Nov. 27, p. 1359). The experiments of Dr. Weintraub and the author were made in 1905.

We then introduced the idea of negative resistance for repeaters, which has been brought forward again by A. W. Hull (*see* "Physical Review," Jan. 1916). The author has recently based on this notion certain amplifier connections, and the results obtained will be described later. We now intend to deduce the characteristic equations of the amplifier known as the "Audion," which has attained an industrial importance.

The first idea of the audion as a detector may be traced back to an article of L. Zehnder ("Wied. Annalen," 1892, p. 77), but the audion as an amplifier or relay has been first described by de Forest, von Lieben and Reisz and other inventors.

The audion, as is well known, comprises a plate, a grid and a filament heated by current from a battery p (Figs. 1 and 2). The plate, and one of the terminals of the filament, the negative, for example, are connected to a battery P through a resistance R (Fig. 1) or through the primary of a transformer T, the secondary of which is closed on a resistance R (Fig. 2). The resistance R may be some form of receiver (telephone, &c.). The grid and the filament are connected either directly or through a transformer to the source of the current to be amplified.

We have already learned from the numerous articles published in THE ELECTRICIAN that many varied arrangements of the several elements, plate, grid and filament have been proposed by different inventors. The nature, the form, the relative arrangement and the dimensions of the electrodes, the amount and nature of the residual gas are variables which have already been determined in a more or less satisfactory manner. It is not our intention to discuss these physical characteristics. We only purpose to determine the equations of operation of an audion independently of numerical constants which distinguish more or less favourably the several forms of the apparatus and constitute the merit of the different inventors.

In the audion the potential V of the plate and v of the grid are defined with reference to that of one terminal of the filament, the negative, for example. In a general manner it can be imagined that the grid can be brought, by means of an auxiliary battery connected in the circuit between grid and filament (not shown in the figures), to a continuous potential v_0 with reference to that of the filament, in the same manner as the plate is brought, by means of the battery P, to a potential V_0 with reference to that of the filament.

The grid current i is, generally speaking, a function of v and V, that is, $i=f(v, V)$. Under these conditions, in the neighbourhood of an operating point defined by the continuous potentials v_0, V_0 corresponding to a grid current i_0, we have

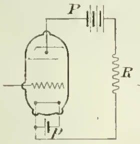


FIG. 1.

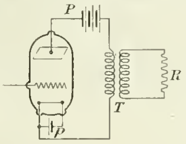


FIG. 2.

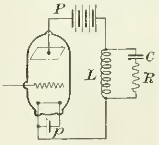


FIG. 3.

$$(i-i_0)=\left(\frac{\delta i}{\delta v}\right)_{\substack{v=v_0\\V=V_0}}(v-v_0)+\left(\frac{\delta i}{\delta V}\right)_{\substack{v=v_0\\V=V_0}}(V-V_0)\ .\ \ .\ \ (1)$$

The derivatives $\left(\frac{\delta i}{\delta v}\right)_{\substack{v=v_0\\V=V_0}}$ and $\left(\frac{\delta i}{\delta V}\right)_{\substack{v=v_0\\V=V_0}}$ are easy to determine experimentally. They are given by the curve representing the grid current as a function of v for a plate potential V_0 and by the curve representing the grid current as a function of V for a grid potential v_0. The reciprocal of these derivatives has the dimensions of a resistance. Let us write

$$\left(\frac{\delta i}{\delta v}\right)_{\substack{v=v_0\\V=V_0}}=\frac{1}{r_1},\quad\left(\frac{\delta i}{\delta V}\right)_{\substack{v=v_0\\V=V_0}}=\frac{1}{r_2}.$$

The equation (1) can then be written :

$$(i-i_0)=\frac{v-v_0}{r_1}+\frac{V-V_0}{r_2}.\ \ .\ \ .\ \ .\ \ .\ \ .\ \ (1^1)$$

The plate current is a function of V and v, that is, $I=F(V, v)$. Our remarks relative to i can be repeated about I; that is, when the operating conditions of the tube are defined by the same continuous potentials V_0 and v_0 on the plate and on the grid and corresponding to a plate current I_0 we have :

$$(I-I_0)=\left(\frac{\delta I}{\delta V}\right)_{\substack{v=v_0\\V=V_0}}(V-V_0)+\left(\frac{\delta I}{\delta v}\right)_{\substack{v=v_0\\V=V_0}}(v-v_0).\ \ .\ \ (2)$$

The derivatives $\left(\frac{\delta I}{\delta V}\right)_{\substack{v=v_0\\V=V_0}}$ and $\left(\frac{\delta I}{\delta v}\right)_{\substack{v=v_0\\V=V_0}}$ are easily determined by experiment. They are given by the curve of plate current as a function of V for a grid potential v_0 and by the curve of the plate current as a function of v for a plate potential V_0. The reciprocal of these derivatives also has the dimensions of a resistance. Let us write

$$\left(\frac{\delta I}{\delta V}\right)_{\substack{v=v_0\\V=V_0}}=\frac{1}{r_3},\quad\left(\frac{\delta I}{\delta v}\right)_{\substack{v=v_0\\V=V_0}}=\frac{1}{r_4}.$$

Equation (2) can therefore be written :

$$(I-I_0)=\frac{V-V_0}{r_3}+\frac{v-v_0}{r_4}.\ \ .\ \ .\ \ .\ \ .\ \ (2^1)$$

Let us now assume $(v-v_0)$ to be an infinitely small alternating voltage u; $(i-i_0)$ becomes an alternating current j, $(V-V_0)$ an alternating voltage U; $(I-I_0)$ an alternating current J; and we thus have for the audion the equations:

$$\left.\begin{aligned}j&=\frac{u}{r_1}+\frac{U}{r_2}\\J&=\frac{U}{r_3}+\frac{u}{r_4}\end{aligned}\right\}\ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ (3)$$

We can obtain a third equation by considering the external circuit plate-filament.

If a resistance R is placed in the filament circuit, we have (assuming E to be the battery E.M.F.)

$$E-IR=V,$$

that is,

$$E-(I-I_0)R-I_0R=(V-V_0)+V_0\,;$$

that is,

$$E-I_0R-V_0=U+JR.$$

The first term is necessarily equal to 0 because, for the operating conditions considered we have, by hypothesis,

$$E-I_0R=V_0.$$

We therefore have

$$U+JR=0.$$

If we suppose the resistance R to be placed in the plate-filament circuit by the interposition of a perfect transformer (zero magnetising current, zero capacity for the primary and secondary windings, zero leakage, zero losses) we arrive at the same equation. The voltage drop introduced by the transformer is, in reality, due to the circulation in resistance R of an alternating current kJ in which k designates the transformation ratio of the transformer in a reducing sense. We therefore have

$$U+k^2JR=0.$$

When the transformer is used the only difference is that the voltage E of the battery corresponds to the potential V_0 on the plate.

In all cases, if the resistance R multiplied by k is considered to be brought into the primary circuit of the tube, the fundamental equations of the tube become :

$$\left.\begin{aligned}j&=\frac{u}{r_1}+\frac{U}{r_2}\\J&=\frac{U}{r_3}+\frac{u}{r_4}\\U&+JR=0\end{aligned}\right\}\ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ .\ \ (4)$$

If the resistance R is purely non-inductive, the vectors j, u, U and J are necessarily in phase and the system of equations (4) corresponds to the following system :

$$\left.\begin{aligned}j&=\left[\frac{1}{r_1}-\frac{r_3R}{r_2r_4(r_3+R)}\right].\,u\\U&=-\frac{r_3R}{r_4(r_3+R)}.\,u\\J&=\frac{r_3}{r_4(r_3+R)}.\,u\end{aligned}\right\}\ .\ \ .\ \ .\ \ .\ \ (5)$$

We shall term the "relay effect" the ratio of the oscillating energy liberated from the plate-filament circuit in the resistance R to the energy supplied and consumed in the grid filament circuit. The "relay effect" corresponds to the ratio $\frac{UJ}{uj}$.

We easily find that

$$\frac{UJ}{uj}=r_1\left(\frac{r_3}{r_4}\right)^2\frac{R}{(r_3+R)\left[(r_3+R)-\frac{r_1r_3}{r_2r_4}R\right]}.$$

There is a value of R, which may be designated as R optimum giving a maximum value for the "relay effect." We find that

$$R\text{ optimum}=\frac{r_3}{\sqrt{1-\frac{r_1r_3}{r_2r_4}}}$$

If a transformer is used we choose a transformer ratio k, so that

$$k^2R=\frac{r_3}{\sqrt{1-\frac{r_1r_3}{r_2r_4}}}.$$

We also find from the system of equations (5) that the apparent resistance Y of the grid filament circuit is

$$Y=r_1\frac{(r_3+R)}{(r_3+R)-\frac{r_1r_3}{r_2r_4}R}.$$

If the source of voltage u has an impedance Z, we choose, to supply current to the grid-filament circuit, a transformer with a ratio in the step-up sense, such that

$$k^2Z=Y.$$

We then derive from the source of voltage the maximum power.

In reality, the transformer being imperfect, we should assume the existence of a resistance W in parallel with the transformer secondary and corresponding to the transformer losses, and at the same time the existence of a certain capacitance or inductance. Then k will be smaller.

In the system of equations (5) we have supposed the resistance R to be non-inductive, but we should imagine that R represents, broadly speaking, any impedance whatsoever, and then resolve the system of equations by the method of imaginary quantities by treating u, j, U, J as vectors with a certain phase difference.

The resistance R (Fig. 2) can evidently be constituted by the grid-filament circuit of a second vacuum tube in the case of a multi-stage amplifier. The transformer ratio k of transformer T will then be such as R optimum$=k^2Y$.

If the alternating voltage applied between grid and filament is fairly high, there can no longer be a question of an infinitely small alternating voltage u: we shall have an appreciable voltage $\varepsilon\sin\omega t$. The apparent resistance Y of the grid-filament circuit is then considered to be an average resistance resulting from the average value of di/dv when v varies between $(v_0+\varepsilon)$ and $(v_0-\varepsilon)$. Generally di/dv becomes rapidly zero for a negative value of v, so that if the tube works at about $v_0=0$, the average value of di/dv then obtained is twice the value of the average value of di/dv, which obtained during the time that v remains positive. This average value can be determined from the curve of the grid current. The reciprocal of this average value of di/dv is used to estimate the resistance r_1.

In reality, the higher derivatives of i should now be considered. If the second derivative is first examined it leads to the study of the well-known detector effect of the audion, and, more generally, when all the higher derivatives are taken into consideration, we find that they concern the deformation of the amplified current. But whatever may be the magnitude of the voltage applied to the grid filament circuit and that of the corresponding amount of oscillating energy liberated in the plate-filament circuit it should be remembered that the notion of a certain R optimum for the latter circuit still subsists.

Referring more especially to high-frequency current, suppose the plate circuit to comprise an inductance L shunted by a capacity C with a resistance R in series (Fig. 3). The several elements act as an ohmic resistance in the plate filament circuit if, at the frequency $\omega/2\pi$, the relation

$$\frac{1}{C}=\frac{L\omega^2\pm\sqrt{L^2\omega^4-4R^2\omega^2}}{2}$$

is established and the value of this apparent ohmic resistance is then

$$R\text{ apparent}=R+\frac{1}{C^2\omega^2R}.$$

When R can be neglected before $L\omega$ or $1/C\omega$ the above relation comes to the condition of resonance $\omega^2CL=1$, and the value of R apparent becomes

$$R\text{ apparent}=\frac{L}{CR}.$$

Now for a given alternating voltage of resonance frequency $\omega/2\pi$, applied to the grid-filament circuit, the maximum output from the tube is obtained when R apparent has a certain value which is a function of the internal characteristics of the tube.

The audion as an amplifier might be compared to a separately excited commutator current generator, the grid-filament circuit being then considered as the field winding circuit, and the plate-filament circuit as the armature circuit.

The self-excitation of the audion is obtained, as is well known, by coupling the plate and grid circuits so that the grid voltage u may be obtained from the plate voltage U (Meissner, de Forest, &c.). The conditions of stability are analogous to those which exist in shunt and series excited dynamo-electric machines. The relay effect diminishes with increase in voltage applied to grid-filament circuit just as the ratio of armature voltage to excitation current diminishes with increased exciting current in a commutator dynamo-electric generator; that is to say, there is a saturation curve.

It should be noted that the self-exciting process implies the production of higher harmonics, as in the arc.

The best tube for generation is that which, for a given working voltage V_0 on the plate, can stand the highest current on the plate for an increasing potential on the grid. Such a tube is no longer defined by the "relay-effect," because the amount of energy consumed in the grid circuit by the self-excitation is supposed to remain always comparatively small and only to have consequently a secondary influence on the heating and the efficiency of the apparatus.

The theory shows that there is an R optimum also for a self-excited audion generator.

It is possible to conceive an audion amplifier in which there is a partial self-excitation effect as already proposed by Meissner, Franklin, &c. The corresponding condition is found in separately excited dynamo-electric machines when they act, at the same time, to a certain degree, as self-excited machines. This is found particularly in the compounding exciters for alternators, which we have studied formerly (*see*, for example, French patent No. 355,274, of June, 1905). The equations of this system are easily determined, as we intend to show in another article. We should remark that amplifiers designed in this manner bear a certain resemblance to repeaters based on the principle of a negative resistance, and they therefore tend to lose the advantages of the audion of having two independent circuits.

THE PARALLEL OPERATION OF ELECTRIC POWER STATIONS.

The following discussion took place after the reading of Mr. John S. Peck's Paper on this subject at the meeting of the Institution of Electrical Engineers on Thursday, November 23. An abstract of the Paper appeared in our last issue, p. 240.

Mr. W. B. Woodhouse, in opening the discussion, said he thought Mr. Peck had given the impression that it did not matter whether generators to be run in parallel were in the same station or not, but that was not so, as the question of transmission was introduced. Mr. Peck might have emphasised more the question of controlling the power factor. The justification for running stations in parallel situated so far apart as to be beyond the economical limit of transmission at their present voltages was that both systems got the benefit of the spare plant and that each could transfer load to the other. If two systems of different frequencies were being dealt with, one would be standard and the other non-standard, and as time went on the supply would be more from the former to the latter, the non-standard frequency would be wiped out, and the station might become an ordinary consumer taking the whole of its supply. The most interesting question was that of the interconnection of stations with the same frequency. The author's first example showed two systems, each with a normal load of 10,000 kw., and provision for interchanging 5,000 kw. The consumers' and station voltages were the same, and there would be no interchange of current if the power factors of the two loads were the same. If it was desired to transmit from station A to station B 5,000 kw. on a power factor of 0·75 lagging, and assuming the total pressure drop—the impedance voltage of the interconnector—was 10 per cent., see what an appalling situation arose. The voltage of station B would drop 10 per cent., and station B, to give its consumers the proper voltage, must raise its voltage to that of station A. If there was no reactance in the line connecting those stations, no power would flow. On a line with impedance, to enable A to transmit 5,000 kw. to B, B must transmit to A a large amount of idle current. Assuming that B was dealing with 5,000 kw. of load at 0·75 power factor, B had to generate 5,000 kw. and have alternator capacity of 4,450 k.v.a. of idle current, B had to supply the idle current of the load that A had supplied—another 4,450 k.v.a.—and if the power had to be got through the line without pressure drop, B to supply an additional 5,000 k.v.a. B must have turbine capacity of 5,000 kw. and alternator of nearly 14,000 k.v.a. That case was as unpracticable as the first. Some means of regulating power factor must be introduced. If that extreme case were taken the power factor of system B would be 0·33. The stations would not continue to run in parallel, but if they did A would have unity power factor. One obvious way of getting over the difficulty was to reduce the percentage voltage drop in the transmission line, which could be done by putting more copper into the line or increasing the transmission voltage. Those who were going to link up existing stations and use existing mains would waste a lot of money if they were not careful, because the voltage with which they were going to connect the stations was too low to be efficient. To increase the transmission pressure, money had to be spent on new cables. Apart from that, either regulating transformers or synchronous boosters could be used. What did Mr. Peck think of the use of synchronous boosters? Regulating transformers were quite generally used for small powers, but for large powers there seemed to be disadvantages. In Mr. Peck's example of transmitting 5,000 from one station to another over a line with a pressure drop of 10 per cent. the pressure drop was got over by putting in a booster transformer and raising the voltage 10 per cent. The power was got to station B at the right voltage, but it was transmitted at a low power factor, and the losses in the line, if compared to the losses at unity power factor, would have been increased by about 60 per cent. Most of the mains proposed to be used were tapped at various points by substations. If this was the case, the amount of boost that could be applied at any one point would have to be limited. It seemed to him that there were cases where the regulating transformer was valuable. A third method, and the one that seemed most likely to be generally adopted, was the use of a synchronous condenser. That had the advantage that it dealt with pressure variation and variation of power factor. One could not only control pressure, but also transmission losses. If the voltages at the two ends of a transmission line were adjusted to be constant and equal at any load, they would be so at all loads. That was a great advantage. One was also up against capital cost. If transmitting from one station to another, a synchronous condenser of 3,500 k.v.a. was required at the receiving end, and if the process were reversed a synchronous condenser would be wanted at both ends, unless a machine were put in the middle of the line, and running that involved losses which at light loads would have to be reckoned with. The indirect advantages of the synchronous condenser were considerable. It reduced the k.v.a. rating of the generators. Power systems were up against the constantly decreasing power factor, and many pieces of apparatus on the system tended to reduce the power factor. Where in the old days they rated their alternator for a power factor of 0·85, they had now come down to 0·7. It was cheaper in some cases to put that alternator capacity into a synchronous condenser, build the alternator for practically unity power factor and let the condenser deal with the idle current. A synchronous condenser tended to balance the load on the different phases. In Yorkshire there was a considerable development in the use of electric furnaces, many of them single-phase, and giving an unbalanced load, so they had to provide in the alternators for the unbalanced load or put in a synchronous condenser. So far as voltage regulation was concerned, the solution of the problem was sufficiently high transmission voltage. He thought 6,000 volts would be sufficient for the domestic load, but power distribution voltage would probably have to be between 10,000 and 30,000, and the interconnection voltages between stations about 60,000. He did not think the close connection between power factor and pressure drop in the transmission line was sufficiently realised. The relation between power factor and pressure drop was (as Mr. Woodhouse showed in a diagram) a straight line, and in regulating for pressure drop one automatically regulated for power factor. On the Yorkshire system there were two stations about 14 miles apart and connected by overhead lines, and they were normally run in parallel; each station was provided with an automatic pressure regulator, so that they looked after one another. If power was transmitted beyond a certain point, it was necessary for the receiving station to run some additional synchronous machines to deal with the idle current. If, however, in the future, 10 stations had to be run together, each controlled by an independent authority, there would be a difficulty in dealing with changes of load, and unless a system could be devised which would regulate itself such joint working could not be carried out. The load on each station must be regulated by the amount of steam it had. This was done at the smaller stations in Yorkshire; they ran, not on the ammeter, but on the pressure gauge on the boiler. He believed that was the method of the future. If one looked after the power factor the pressures would look after themselves.

Mr. G. W. Partridge said he was rather disappointed in the Paper. He thought Mr. Peck would have told them more about the different apparatus used. The question of good parallel running depended on the prime mover. The prime mover of the future might be a steam turbine, the gas turbine or the gas engine. Whatever the system, the parallel running of the prime mover should be made as easy as possible. The adjustment of the pressure of supply was simply a question of static transformers at the generating or sub-stations. He did not see any real difficulty in working up to 50,000 volts with underground cables. It might depend largely in the future on the frequency of the supply. In planning large extensions the frequency had to be settled once and for all, and once settled he did not see how it could be changed. It seemed to him it would be advisable to adopt a low frequency, probably lower than 50. The advantages of low frequency would be less inductance and less chance of systems coming out of step with violent fluctuations on the system; the regulation would be much better than on a higher frequency, and when long systems of trunk mains were run on extra high pressure the capacity current was a very important matter, and this would undoubtedly be less at the lower frequency. He knew of a system on which one of the generators could not be run alone, owing to the great rise in pressure which took place if the charge current of the system was equal to the short-circuit current of the generator, in which case the volts would go up to hundreds of thousands. The rise in pressure was less if the frequency was low, the switching on of large circuits was easier if oil switches were used, owing to the current remaining longer at the zero point, and alternators of low frequency run much better in parallel than those on high frequency. With regard to interconnecting cables, it was essential that there should be plenty of copper in them between the two generating stations, to ensure good parallel running. Referring to the voltage regulator on p. 2 of the Paper, he thought an induction regulator would be preferable. He did not quite see how the reversing switch could be broken on the primary side of the transformer when it was on load. He supposed it was reduced to zero before it was broken or reversed. With regard to the question of earthed neutrals and h.f. currents referred to in the Paper, they had that trouble in connection with parallel running many years ago at the Greenwich power stations. One of the stations switched to earth off the neutral as soon as it was connected into parallel. They designed an automatic switch, which re-connected the neutral to earth at the generating stations in case either was accidentally disconnected from the circuit. He was sorry Mr. Peck did not say more about the phase converter, as in the future there would be many electric furnaces used, and there would also be a certain number of single-phase railways. Where large systems were concerned and the current had to be taken from the three-phase system, he thought the induction motor-generator preferable to the synchronous motor-generator, as being less liable to be damaged or to fall out of step. He used a 1,500-kw. induction motor-generator to interconnect two systems, viz., a three-phase 25 ∼, 7,000-volt system to a single-phase 85 ∼, 10,000-volt system. There was about 20,000-kw. capacity on the three-phase and 10,000-kw. on the single-phase side. The motor had been running satisfactorily for six years, and had never got out of step. It was easy to synchronise one motor-generator, but synchronising a second induction motor-generator after the first was in commission was more difficult, as the slip on the loaded machine was different from the interconnecting machine, making it necessary to synchronise through a special resistance. The ordinary starting resistances would not be suitable. The synchronous phase-changer would be more satisfactory on small systems of supply. On large systems it would be liable to damage from the mechanical strains, unless the machines were very expensively built. In any case, synchronous machines should be provided with a heavy damping winding, and these machines would also require special synchronising apparatus for synchronising the second machine.

Mr. A. M. Taylor said he agreed with Mr. Woodhouse that two stations linked up would involve difficulties if run by separate authorities; otherwise the engineer at each station would be clamouring for the other man to send current through to him to suit his own power factor. Mr. Peck said that for connecting two systems of the same frequency and voltage you had to provide the switchgear, cables, &c. It was the "&c." that had to be provided rather particularly, and it ought to include a large amount of reactance, by which the capacity of the switchgear was governed considerably. Even with the best switches one ought not to have more than about 20,000 kw. to 30,000 kw. connected to the 'bus bars. With two 30,000 kw. stations joined together by a short line 60,000 kw. were connected to the system, and every switch on the system was likely to be called upon to deal with that capacity which might mean disaster. There were difficulties in connection with the induction motor-generator and the synchronous machine. Adjusting two stations with a synchronous frequency changer required a great deal of patience. Stepping up from 25 to 75 (or 16·6 to 50) cycles with static frequency changers was, he believed, perfectly feasible, and one could synchronise practically to an out of phase of about 60 deg. right away, and not worry about close synchronising. The static frequency changers would also stand a short circuit on either side of the system comfortably. He was satisfied with his experience of them, and would undertake to design one for 300 kw. He did not see why a bank of 300 kw. static frequency changers should not be grouped together, making a 3,000 kw. unit. Ordinary transformer makers could deal with the problem. There was nothing difficult in it. One could get 10 per cent. regulation easily, or 5 per cent. if necessary. The expense of the apparatus was in the latter case increased somewhat. He would use in certain cases booster transformers, and would practically wipe out the difficulty of regulation. With the present frequency changers one could change the energy back from the high-pressure system to the other system, probably to the full load of the frequency changer without great difficulty. If more than that were given the step-down feature would be lost, and a triple frequency current would be put into the main current, and a sort of square wave would result instead of a sine wave, boosting up the low-frequency supply and giving the desired result. The efficiency would be quite high—up to 90 per cent. or higher. He had proved experimentally that he could easily step up from 25 to 50 ∾. The conditions were almost identical with a three to one step-up, except that continuous-current excitation had to be used. He believed he could design a frequency changer to-morrow which would step-up from 25 to 50 ∾ and, conversely, would step-down within reasonable limits. He had also experimented with step-down from three to one (50 to 16·6 periods). With a step-up changer he could give either a single-phase current at the higher frequencies or a three-phase current, as required. His frequency changer gave a perfectly balanced current on the three-phase and stepped-up to single-phase.

Sir Charles Parsons said it was many years since he had had anything to do with distribution. They were told what the buyers of machinery wanted in the way of power factor and pressure drop, and therefore were not up against the difficult questions that had been discussed. The tendency of opinion was that the country should be covered by large distribution systems. The difficulty was what was to be done with the present systems, how much scrapping would have to be done, and so on. Probably so much linking up would not be required in America as in this country. Some people thought the uneconomical means of frequency changers, which lost a great deal more energy than pressure equalisers, should not be used in the future. There were many possible means by which electricity might be generated in the future. It might be generated direct from the coal, and there was also the possibility of perpetual motion—*i.e.*, abstracting energy from the motion of the molecules, which was discussed by Clerk-Maxwell 40 or 50 years ago. It was quite a rational thing. The energy could be got out of the sea, the temperature of the sea would be reduced, the energy would be turned into work and would generate heat, and the whole cycle would be got for nothing without burning any fuel. Internal-combustion engines were at present limited by the heat which the metal in the cylinders would stand. At present they were limited to about 200 H.P. per cylinder. A large unit was very costly and very complicated, having so many parts. At present steam machines held the field, and probably would for a long time.

Mr. A. Brazil said efficiency was not everything—safety was equally important. He had run sub-stations with rotary converters, synchronous motor-generators and Diesel engines. When a big pressure drop occurred the rotary converter wanted to take the whole load, and tried to drive the other motor-generator as well, and stripped itself. The Diesel engine would not do any more than a certain figure. The synchronous motor-generators took up the load without falling out of step, though there was an audible change of speed up and down. The induction motor-generators also continued running. The Diesel engine could not be induced to take any extra load. He was in favour of synchronous motor-generators, because of the importance of being able to transmit both ways. Mr. Peck did not point out that an induction motor-generator could not be made to transmit energy back unless there was a synchronous machine running on the system into which it had to transmit. If one had to take over the whole of the load of one of the stations it could not be done with an induction motor-generator unless synchronous machinery was running. Rotary converters were better as regards efficiency, but the question of cutting off the load was much more difficult; there was more likelihood of the supply ceasing in the case of a big interchange of load. He preferred fuses to automatics, as they gave a time lag to prevent sudden rushes of current. Mr. Peck gave four ways of getting over the difficulty of the two earthed neutrals. He did not much like the arrangement in which only one station was earthed. It involved having some apparatus which was liable to go wrong. He had had a case where a breakdown was increased by the neutral point being left out by mistake where the system was normally earthed. The insulated earth cable running from one neutral of one system to the neutral of the other was an ideal arrangement, but involved large expenditure. The third case, "transformers inserted in the interconnecting line," he took to mean that the two systems were not directly connected—the 'bus bars were not directly connected—and that each could have its own neutral point without there being any interchange of current through the earth. The placing of reactances in the earth connection was the best arrangement to his mind. He took it the reference to a resistance of negligible value meant the difference of potential between one neutral of one system and the neutral of another was not high.

Mr. A. P. Trotter said when Mr. Peck read a Paper some years ago which dealt with the subject of the earthed neutral it was fully discussed at three local sections. There were 26 speakers in favour of the earthed neutral, seven opposed it and four were neutral. There had been several converts since to neutral earthing. Assuming that it was to be done, it could be considered from three points of view. First, the supply engineer considered the triple frequency circulating currents which resulted when earthing was done at more than one point. He would have liked to have heard the views of Post Office engineers on the subject. If earthing were done at more than one point the Post Office was likely to be troubled by interference with the telephones. The third point of view was the safety point. One of the main objects of earthing the neutral point was to trip the section breaker in case of a serious leak. If an overhead wire came down, most engineers were ready to shut down that line until it was repaired. Most engineers also wanted to shut down if they had a serious leak to earth. He thought the higher the voltage the more chance there was of a leak to earth developing a "short." The trouble was on the 2,000 to 3,000-volt jobs, where they had to look after both the volts and the amperes. He thought the highest we had in this country was 30,000. There was no limit to voltage in this country, although some users in Manchester said they were greatly handicapped by the limitation of voltage by the Board of Trade. He did not see why one station should not be earthed. It ought to be sufficient to open an overload circuit-breaker or some more modern protection device. One did not want to have insulated cable, and he did not think it was necessary to have insulated cable from one station to another. With 300 or 400 volts it was only necessary to trip the protective device, and the armouring of the cable would do for that. If the earth currents had to be limited from the Post Office point of view, one would have to go down to milliamperes, and it would not be worth while to bother about resistances. They must have a device which would trip the overload circulator, or, better still, a protective device.

In some communicated remarks Mr. Trotter gave the following table showing the frequencies at present in use in this country. The commonest frequency in the case of electrical supply undertakings was 50, and the kilowatts so supplied exceeded twice the whole of the remainder. In the case of power companies, a frequency of 50 was used by 8 out of 16, but more power was supplied at 40 than all the rest put together. This was no argument for the extension of a frequency of 40 outside the district known as the North East Coast. If this was excluded, 50 was the most common. These figures were not official. It seemed undesirable that tees or sub-stations should be connected by linking mains. These should ultimately form a network, and a frequency of 25 seemed suitable. Regulation B4 of the Extra High-Pressure Regulations of the Board of Trade had, for more than 10 years, restricted frequencies to 25 or 50, except in the North East Coast district.

Electrical Supply Undertakings.

Frequency.	Stations.	Thousands of kw.	Frequency.	Stations.	Thousands of kw.
25	10	93	83	5	35
40	20	156	100	15	45
50	161	760	33, 68, 75	10	11
60	9	17	77, 80, 90, 93		

Electrical Power Companies.

Frequency.	Stations.	Thousands of kw.	Frequency.	Stations.	Thousands of kw.
25	4	78	50	8	117
40	3	317	60	1	36

Mr. W. M. Mordey said there was no greater bugbear in distribution than difficulties due to low power factor. He was always looking for some development of the static condenser method of correction. Some years ago he read a Paper on the subject, giving some results of tests, and pointing out—with the view of encouraging manufacturers or station engineers to experiment—the great advantages of the static condenser as compared with the synchronous condenser, the over-excited alternator. He claimed to be a sort of grandfather of the synchronous condenser. In a Paper there 26 years ago he first showed the properties of the synchronous condenser, and that it could supply current to protect against too much capacity or too much self-induction. In the Paper he read seven or eight years ago he showed that the losses in static condensers were only a fraction of those in synchronous condensers, that the cost of static condensers then available was much less, and that there was also the great advantage that they were stationary things with nothing to run. There was also the advantage that there was a distributed correction. He was disappointed to find that such things were not on the market. He could not imagine any more fruitful subject for practical experimental investigations.

Mr. E. T. Williams said a great deal was said in the Paper about connecting two stations together. He agreed with Mr. Woodhouse that unless they were careful they would waste a lot of money. The problem was far deeper than it appeared on the surface. Now that the country had been divided more or less into districts the first thing to do was to decide what frequency was to be adopted in those districts. If the subject had been tackled in the past there would now have been one or two standard frequencies. Engineers might then find it preferable to change their systems to the standard voltage rather than spend a great deal of money on intermediary plant, phase-changers and other things. There would, perhaps, be soon in each district a trunk system, with which the stations would be connected, and which would have a standard pressure and frequency, and any new stations would be built to feed into that system, and engineers would go along with more confidence. On the question of interconnecting those large districts themselves, he took it there would ultimately be a trunk system to connect them, and the sooner the standard frequency and pressure of such trunk system was decided upon, the sooner some real progress would be made. It was better to face the difficulties now than to have to make changes later on.

Mr. Peck, in replying to the discussion, said he thought Mr. Woodhouse had greatly over-estimated the difficulties of parallel operation of a number of systems together. He had piled up difficulties till he had almost smothered the whole thing. If when anything new was proposed we stopped to consider all the difficulties that might arise we would never make any headway. Anticipated difficulties would disappear or be found nothing like so important as they were at first supposed to be. Systems had been operated in parallel—not only two, but half a dozen, stations—and while the problem was complicated by the fact that in this country each of the linked-up stations would have to maintain its own pressure in its mains, he did not think that was an insurmountable difficulty. He would reply in writing to Mr. Woodhouses's question as to synchronous boosters and regulating transformers. Mr. Woodhouse referred to the desirability of higher voltage on interconnectors. For the distances they would have to deal with in the Manchester district, he was of opinion that 6,000 volts would suffice. While, for economy's sake, it would be desirable to go to higher voltages, it would not be necessary to take that step yet. Mr. Partridge wanted to know more about the apparatus to be used for changing from one frequency to another, and about phase changers, phase splitters, changing from three-phase to single phase, or *vice versa*. As another Paper dealing with those questions very thoroughly had been submitted to the Institution, he had thought it better to confine his Paper to the question of load distribution with alternating-current stations operated in parallel. As to the question of low versus high frequency, one difficulty with a low frequency—say 25 ∾—was that the turbine builders wanted speeds much higher than 1,500 revs. per min., the highest which could be obtained with 25 ∾. It looked now as though the limit would be extended very much beyond the limits we had had in the past. Larger units would be built for 3,000 revs. per min. The arrangement Mr. Partridge described of earthed neutrals for breaking circulating currents was very interesting. He did not know before that Mr. Partridge had been using it. Mr. Partridge said a higher resistance could not be used as an earthing resistance, because sufficient current must flow to earth to trip out the heaviest breaker. The general thing now was to put in protective gear, with which a small current was sufficient to trip the breakers. As Mr. Trotter said, if the current had to be limited to milliamperes, it was not worth while to consider resistances at all. Mr. Woodhouse thought voltages should be increased, or resistance and reactance increased, while Mr. Taylor thought there should be more resistance in the feeders. For connecting very large systems it would probably be necessary to use reactances for the sake of the oil switches, but he did not think that would interfere with parallel operation. He was pleased to hear of the progress Mr. Taylor was making with static frequency changers. Sir Chas. Parsons made interesting remarks about linking up in America. He (Mr. Peck) knew they had done a great deal of linking up there, but when they linked up stations in the far west the stations would probably be 100 miles apart. They usually fed into common mains, each station supplying as much as was required of it, or as much as it could. In the large cities large stations were operating in parallel. Mr. Brazil mentioned the fact that the induction motor-generator could not generate energy unless it was connected to synchronous apparatus. He thought he had omitted to mention it in the Paper. The suggestions which he (Mr. Peck) made as to using rotary converters as interconnecting links were made more as suggestions of possibilities where rotaries were used for some other purpose. Mr. Brazil was quite right in interpreting his meaning as to the use of transformers in the interconnector. He meant in the interconnector, and not in the earth connection. Mr. Mordey referred to the static condenser as a means of advancing the phase and improving the power factor. He (Mr. Peck) thought the makers who had attempted to build condensers for the capacities required had been discouraged. That would be a good subject for some of the new research committees. It was suggested, he thought by Mr. Woodhouse and Mr. Williams, that the question of linking up systems of different frequencies would gradually die out. He believed that was true, but it did not help a man to-day who had a system with an odd frequency, and who joined up with stations around him. One of the objects of the Paper was to show how it could be done. If it only meant changing the generating apparatus the problem would not be so serious; but to alter the frequency might mean that a great deal of the customers' apparatus must be altered. It might be possible gradually to change over. For a time two frequencies would have to be run, and kept isolated except for interconnecting machines, and gradually the odd frequency would be wiped out.

A vote of thanks to Mr. Peck was proposed by Mr. Wordingham (who occupied the chair in the President's absence) and carried unanimously.

GERMAN ELECTRICAL MACHINERY.

The Shanghai "Municipal Gazette" for Oct. 19 contains some correspondence between Messrs. Arnhold, Karberg & Co. and the Council relative to the breakdown of No. 3, 5,000-kw. turbo-alternator, which was supplied by the A.E.G. of Berlin.

In a letter dated Aug. 11, 1916, Messrs. Arnhold, Karberg & Co. state that "unfortunately the above-mentioned report (of the Electrical Engineer) only states that the trouble was due to the insulation surrounding the high pressure conductors of the stator breaking down and the conductors going to earth. Apart from the fact that quite a number of possibilities may have caused this breakdown, we certainly should like to get further particulars as to how the electrical engineer arrived at this conclusion, especially as we were informed that the insulation resistance of this particular alternator was very satisfactory, showing 40 megohms when tested a short time before this unfortunate occurrence. This report may be considered absolutely satisfactory by the members of the Electricity Committee, who are not familiar with the technical data, but we must insist upon distinct technical proofs. The breakdown occurred on June 17. A letter informing us about this fact was written by the electricity department on the 20th, and reached us late on the 21st of the same month; in other words, we received your notification about four days after the mishap. As we still have an interest in the plant we have the right to demand an explanation why we were not notified immediately. When our representative was granted permission to enter the Riverside power station he could only ascertain the fact that a breakdown had actually occurred, but found it impossible to locate the real cause, as the machine in question had already been dismantled. Under these circumstances we want to put it on record that we cannot accept any responsibility whatsoever in connection with this accident. Besides, a breakdown of this description should not happen at all provided the switchgear with all its safety devices is of first class design and in good and efficient working order; we should like to mention here that the switchgear was not supplied by us. The report furthermore states the mechanical portion of the turbo-generator also shows serious defects, especially the blading of the wheels discloses signs of, 'extraordinary rapid deterioration,' but, again, no technical reason is given for this. From what we could see when examining the machine we must say that this statement is exaggerated. With reference to a few distance pieces between some of the blades having broken off, which, on the whole, is not very serious, we may remind you that this is due to centrifugal force, and leads us to think that the turbo set must, at some time or another, have been running with considerably increased speed.

"At the end of his report the electrical engineer makes the remark 'that the experience gained since the installation of these machines inclines one to think that further trouble is likely to develop, and the fact has to be faced that the four German machines cannot be regarded as reliable units of the plant,' a remark with which we fully agree, not because the machines are inferior, but because the supervision leaves much to be desired. Not only this particular 5,000-kw. set, but also the other machines vibrate to such an extent that, owing to the small clearance between nozzles and blades, they might touch and cause a serious breakdown at any moment. You certainly can consider yourself very fortunate that nothing of this kind has happened up till now. On the other hand, we want to put on record that the turbines installed under the supervision of our foreign erector did not show any sign of vibration. As a matter of fact, we have in our possession, besides various other letters, one from the electricity department, which distinctly mentions that 'the two 2,000-kw. machines had for long periods run at overloads amounting to 2,700-kw. without undue heating and without vibration.' If the machines vibrate and give so much trouble now we can only draw one conclusion, and that is that the present staff looking after the turbo sets is not quite up-to-date with the management of this type of machine. If it is your desire to make the generating units reliable, we would advise you to balance the machines thoroughly, and to set the thrust bearings properly. As, however, this job cannot be carried out by everybody, especially taking into account the limited facilities here, we even go so far—of course, without prejudice—to offer you the services of a turbine specialist. Had you allowed our representative to enter the Riverside station at any time by issuing the usual passport, which he received regularly for years until the outbreak of the war, we think a lot of trouble might have been obviated. In addition, we would recommend you to insist that the station will be kept cleaner, as cleanliness is essential for the good working of the plant. We only mention the condition of the air filter belonging to the 5,000-kw. machine which we inspected, and which appears to have never been cleaned since the first starting; likewise a number of bearings show considerable oil leaking, which should be strictly avoided, as it may lead to oiling of the machine, and even the windings. In conclusion, we should take it as a favour if you would instruct your electrical engineer to refrain from baselessly running down A.E.G. machinery as he lately did in his official reports. From the above you will easily see that it is by no means proved that the breakdown can be put down to the inferiority of the turbos as he tries to make out. Besides, it appears to us that the electrical engineer is not quite consistent in his judgment of machinery, which you can verify by looking through his former reports (extracts from which are given).

"We trust to have proved to you by the foregoing explanations that we cannot admit that this unfortunate breakdown has anything to do with the quality or workmanship of the machinery supplied by our principal, but that it is due to causes lying quite beyond our control."

In a further report (dated Oct. 11 1916) the electrical engineer reminds the Council that as regards the A.E.G. plant at Riverside there has been no contract between the Council and Messrs. Arnhold, Karberg & Co. The contracts were made in London direct with the A.E.G. Co. of Berlin. The invitation to Messrs. Arnhold, Karberg's representative to view the damaged machine was an act of courtesy extended because the firm represent the A.E.G. in Shanghai, not, however, because they had any direct interest in the contracts. In regard to the breakdown of the stator windings, it was true that an insulation test of 40 megohms had been obtained, but the pressure of the testing instrument was in the neighbourhood of 400 to 500 volts, and was insufficient in the circumstances to show any leakage or fault in the insulation. From the fact that the machine was running satisfactorily until a load exceeding 2,000 kw. was reached led one to believe that with the increased load above 2,000 kw. a certain displacement of the coils may have taken place, and it is possible this was the cause of the original deterioration of the insulating covering which ultimately led to the breakdown of the machine, It is, however, impossible to say definitely what was the true cause, and therefore to attempt to give one on the evidence available would be of little value. It may be noted that since repair work has been going on it was noticed that many of the stator coils were slightly loose in the slots, which suggests that when the machine was running on heavy load vibration of the coils may have been taking place. "I wish to emphasise the fact that the switchgear was in good and efficient working order, and, as proof of this, may mention that on the three occasions before the actual burn-out the machine was automatically cut out of circuit by the operation of the switchgear, conclusively proving that the particular apparatus provided on the switchgear to function in case of faults, such as actually took place, operated perfectly, and I may further state that on the 20th of last month, when the machine again broke down, this switchgear again operated and saved a further disaster." When the final breakdown occurred, which caused the major part of the damage to the stator core, the machine was being tested on the water tank, it was not running on the public supply. The switchgear was at the time under suspicion because the test made on the alternator by the testing apparatus did not indicate that the fault was in the machine itself. Careful examination and test of the switchgear failed to find anything out of order, but in order to settle whether the machine was healthy it was run on the test tank with the automatic switches disconnected, and it was at that time the stator coils finally broke down. The fact that the automatic switchgear operated on three previous occasions, and cut the machine out of action, conclusively proves that there had been a fault on the generator, and furthermore puts beyond doubt that the switchgear was suitable and in proper working order. The accident occurred on Saturday afternoon, and when I first learnt of it I gave instructions for the machine to be dismantled, as it was quite impossible to find the cause of the fault or begin to carry out repairs until the heavy rotor of the machine had been removed. I reported to the Electricity Committee on the 20th inst., at the same time suggesting that Messrs. Arnhold, Karberg's engineer should have an opportunity of examining the machine, and on the same afternoon I wrote to that firm inviting their engineer to make an inspection. It may be said that since Messrs. Arnhold, Karberg were not directly concerned in the contract there was no obligation to offer this invitation. With regard to the defects which were discovered in the turbine itself, I do not think any useful purpose will be served by writing on what may be the possible causes of the extraordinarily rapid deterioration. That rapid deterioration has taken place is beyond dispute, and Messrs. Arnhold, Karberg's attempt to minimise the seriousness of the deterioration is discounted by the actual condition of the turbine which was seen by their engineer, and of which accurate photographic records have been made. Their letter refers to the few distance pieces between some of the blades which have broken off, and reminds the Council that this is due to centrifugal force, and leads them to think that the turbine must at some time or another have been running with considerably increased speed. A little reflection on their part would have made them hesitate before making such a statement, for it should be borne in mind that, in accordance with the specification the turbines are fitted with an emergency governor, so designed as to shut off steam automatically if the speed rises 15 per cent. above normal, and so prevent the machine racing. There is, as a matter of fact, no evidence that the machine has ever raced to that extent, but if this has been the case without my knowledge, it surely shows that the special emergency governor must have failed to operate. In Messrs. Arnhold, Karberg's letter, reference to the eroded blades on the intermediate and low-pressure turbine wheels is carefully avoided. Their engineer states that the condition of the blades is not serious. It all depends upon how one views such matters. In my opinion the condition of the blades is such as to reasonably suppose that their useful life cannot be more than two or three years at the most, and, furthermore, at the present time, owing to their condition, the steam consumption of the machine has increased above the guarantee. I have no doubt in my own mind that further trouble with these machines will develop. With regard to the supervision, results achieved by the electricity department in the enormous increase of the electricity supply during recent years and the continuity of service given, answers the insinuation of lack of supervision. The same staff which supervises the Riverside plant is also responsible for the Fearon-road plant, which has done and is still doing such excellent service. This summer the four British-built turbines there were opened up and carefully examined. Neither the Parsons nor the Willans machines showed the least sign of erosion or other form of deterioration of the blading, although these machines have run for nine and eight years respectively. The same remarks apply equally to the two Howden turbines which have been running for five years, and it is interesting to note in this connection that these two machines are of the impulse type, similar in principle to the A.E.G. machines. As a matter of fact, the 5,000-kw. machine which has broken down possessed the characteristic of wonderfully-smooth running, and it was a matter of great satisfaction that a large machine running at such a high speed should run without any noticeable vibration. The other 5,000-kw. machine, which Messrs. Arnhold, Karberg's representative may have seen running, did vibrate more than could be desired, but owing to the failures of the other machines, opportunity had not then been found to re-balance it. Since then, however, that matter has been taken in hand, with the result that the machine now runs with very much less vibration than formerly. I should mention in passing that I have personally inspected machines of a similar type and size running in Germany with considerably more vibration than No. 4 machine has ever shown. The other two 2,000-kw. machines, generally speaking, have run, at any rate on full load, without appreciable vibration, only at certain loads have they vibrated to a certain extent. These two machines were erected by an erector sent out by the A.E.G., who was unable to cure the vibration which developed at certain loads. The other two machines were erected by the department's station staff. It is quite wrong to state that the machines vibrate unduly, for, as a matter of fact, absence of serious vibration has been a characteristic which is freely admitted. The specification submitted by the A.E.G. with their tender (dated Aug. 21, 1913) states: "The A.E.G. turbine is designed to run at a speed very much less than the critical speed, so that there is no chance of vibration being set up or of the shaft breaking. . . . The important and inherent advantages of the A.E.G. turbines are short length, easy supervision and attendance; reliability; proof against temperature variations, absence of end thrust."

Another paragraph of their (Messrs. Arnhold, Karberg's) letter would lead one to believe that the blade trouble has been caused by the rotor shaft shifting and allowing the blades and nozzles to come too close together. This, however, is not what has actually happened, and the cause of the blade troubles has to be looked for either in the employment of unsuitable metal in the construction of the blades, or in the design of the nozzles and blades being wrongly proportioned. A particular advantage which the A.E.G. claims for its type of turbine is the comparatively large clearances which the design permits. All turbine makers of the impulse type (of which the A.E.G. is one) claim that the impulse turbine is stronger mechanically and more rugged owing to the greater clearances permissible as compared with the smaller clearances necessary with the reaction turbine. I have personally regarded these features as an advantage, and therefore, knowing the claim made on behalf of the impulse turbine, it is a little inconsistent of Messrs. Arnhold, Karberg to write about "the small clearance between nozzles which might touch and cause a serious breakdown." The usual passport to Riverside power station was not issued to the firm's representative, and I think that the reason is sufficiently obvious. I absolutely deny that had their representative had access to the station the troubles would have been avoided, because with reference to the turbine troubles there was nothing to indicate that defects were developing, and it was only upon opening up the machines that the defects were discovered, and these were of such a nature that the damage done was irreparable, and could only be made good by replacing the damaged blading. Those who have seen the interior of the station will recognise that it is a model of cleanliness. At the particular time Messrs. Arnhold's, Karberg's representative was there, after the breakdown of the generator, the station was naturally in a more or less dirty condition, owing to the dismantling process which was taking place. It is true that the air filter has not been cleaned, but its condition is not as Messrs. Arnhold, Karberg & Co. would wish believed; the air circulation through the alternator was not impaired, and I may say that the clean condition both of the rotor and stator—except in the section affected by the burn-out—fully demonstrates the efficiency of the filter. A comparison of the alternator windings of the machines at Fearon-road —where air filters are not installed—with the Riverside machines would convince anyone that the filter was performing the function for which it was installed. The assertion that a number of bearings show considerable oil leaking is absolutely untrue. The fact remains that the turbine plant is most unsatisfactory, and the present position of affairs in respect of the continuity of the public supply is precarious. The insinuation that the staff is not sufficiently up-to-date and is also not fully qualified to operate these German-built machines may be passed over. We know, however, of the troubles which have occurred in other places, and I question whether ignorance or lack of supervision is responsible also for those breakdowns. As an interesting commentary on A.E.G. turbo-alternators, the enclosed letter which I received from the engineer and manager of the Melbourne Electric Supply Co. (Mr. F. W. Clements) will be read with mixed feelings by those who believe our turbine plant to be defective and those who attribute the failure to other causes.

On June 16, 1916, Mr. Clements wrote: "Having had most unfortunate experience with an A.E.G. 5,000-kw. turbo-alternator and learning that besides ourselves the Sydney Corporation, one or two undertakings in the North of England and your own undertaking had equally suffered, we now come across your report for last year's operations in the technical papers just to hand. Our own experience has been as follows: Two 5,000-kw. turbo-alternators were ordered in Berlin instead of in England solely on the point of delivery, which was extremely urgent. Of these two sets one was delivered just before the war, and the other set is, apparently fortunately, still in Berlin. Within three weeks of starting up under ordinary working conditions the first shut down took place, and it was found that the second diaphragm had broken away from the blades on which the central disc portion was hung and had fouled the blading on the following wheel. This was luckily discovered in time before the wheel itself was damaged, as we believe was the case with the Sydney Corporation's machine, so that at present the machine is now running without its second diaphragm and without the blading of the following wheel. It was found that the third and fourth diaphragms were showing signs of going over as well, and in consequence a complete set of new diaphragms is being made in England. A test of the blading showed the well-known fault of high nickel contents—viz., just over 31 per cent. This fault is unpardonable, as at the time both British and American manufacturers were fully aware of the danger of this material, especially in connection with superheats. However, a further most disconcerting trouble has manifested itself, which seriously restricts the output of the machine, for it is found that at anything over 3,000-3,500 kw. lateral vibration of the discs takes place to such an extent that they fouled the diaphragms on both sides. As you are no doubt aware, these discs are extremely thin—so much so, that in the larger ones a man pushing against the periphery can appreciably deflect them—they are thinner than what is considered good practice in the bulk of British-made turbines. However, there already existed at the time of the manufacture of the machine, literature on this subject of wheel resonance, and this is again an unpardonable fault in the design. When the machine is standing, on opening up, certain wheels can be seen to vibrate violently in sympathetic resonance with the otherwise imperceptible vibration caused by other turbines. We should take it as a favour if you could kindly let us know if you as well have been troubled from this latter cause. With regard to the troubles that you have experienced with the electrical end your report refers to a burn-out, but, as far as appears in the papers, it is not stated whether the burn-out was in the stator or the rotor. We have unfortunately experienced trouble with one of the rotors—we luckily had a spare sent out with the machine. As you are no doubt aware, the A.E.G. have always excused the almost utter impossibility of re-winding their rotors outside their workshops by the statement that the workmanship and design were such that breakdowns, and consequently the necessity for re-winding, were impossible. On running one of the rotors supplied it was found that there was an internal leakage to earth, which no amount of drying out would get rid of, and as the re-winding of these rotors is really an art, requiring also special machinery, it is now lying useless on one side. There is no denying that the machine as a whole shows beautiful workmanship and finish, but its behaviour certainly has shown it up to the present to be very considerably inferior to the bulk of machines of British or American manufacture, which quite confirms your experience and evidently that of all other users of A.E.G. turbo-alternators.

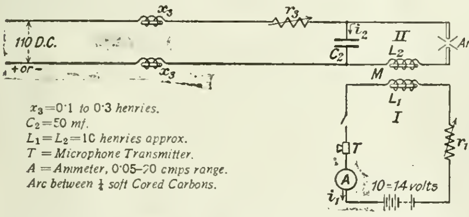
ELECTRIC OSCILLATORY PHENOMENA OF SPEAKING ARC.*

BY J. P. VAN ZANDT.

Summary.—The author describes arrangements for demonstrating and experimenting with the talking arc, and gives approximate equations for the circuits involved.

In 1898 Prof. H. Th. Simon,† of Göttingen, first demonstrated that the column of incandescent vapour of an ordinary electric arc lamp could be set in mechanical vibration by variation of the current through the arc, and that the vibrating vapour path would communicate its disturbances to the air in the form of sound waves. Later ‡ a modified scheme of connections was suggested whereby the effectiveness of the voice currents set up in the transmitter was much increased. The modified form is simple, direct and extraordinarily effective. Since as a lecture demonstration of electric oscillatory phenomena it far exceeds in interest the ordinary Duddell singing arc, it is thought worth while to give a detailed description of the diagram of connections, with the required constants, and establish the approximate electrical equations for the circuits involved. The connections for the apparatus used are shown below.

When words are spoken into the transmitter variable currents flow in the microphone circuit. These, superimposed upon the direct current, act inductively to produce variable currents which flow through the arc and return through the shunt condenser path. When the vapour arc sustains periodic weakening or strengthening of the current flowing through it, periodic decrease or increase of temperature results, with consequent contraction or expansion of the vapour. These changes in the volume of the vapour act upon the surrounding air and reproduce the words spoken into the microphone. The action is reversible, and if microphone and storage cells are replaced by the usual telephone receiver words spoken into the arc will be heard in the receiver.



x_3
r_3
i_2
II
Arc
110 D.C.
C_2
L_2
+ or −
x_3
M
L_1
I
r_1
T
A
10–14 volts
i_1
x_3=0·1 to 0·3 henries.
C_2=50 mf.
L_1=L_2=10 henries approx.
T = Microphone Transmitter.
A = Ammeter, 0·05–20 amps range.
Arc between ½ soft Cored Carbons.

Talking Arc Circuit with Approximate Values of Constants.

The essential feature in the experiment is the character of the arc. To obtain the best results use a long, flaming, steady arc between 0·25 in. soft-cored carbons mounted vertically and separated approximately 3 cm. A current of 5 amperes to 7 amperes is sufficient to ensure steady burning. The condenser should have a capacity of 5 mfd. or more, insulated to withstand several times the normal voltage. Any open core transformer with fairly high inductance and preferably a 1 to 1 ratio may be used. The choking coils should have moderately large values of reactance in order effectively to block the superimposed voice currents. The microphone may be of the ordinary carbon granular type, with as great an ampere capacity as possible. Too much current in the transmitter will cause "frying" of the granules, and consequent hissing in the arc. A large current flows when the arc is struck, and the arc series resistance must be selected with this in mind.

Troubles may usually be traced to the microphone circuit or to the condition of the arc carbons. An ammeter in series with the microphone should be watched constantly for possible open or short-circuits. If the arc hisses badly, cut off the burned ends of the carbons and use perfectly fresh electrodes. Avoid any breeze that tends to blow out the arc. The intensity of reproduction increases directly with the length of the flame.

It is worth while to note that the speaking arc is in no sense an improved Duddell singing arc, for the Duddell arc depends wholly upon the negative characteristic of the carbon arc and the resulting charging and discharging of the shunted condenser across the electrodes. A very short arc is absolutely essential. With the speaking arc, the long vapour path prevents the surging of the condenser, which only serves as an easy path for the variable currents. The negative characteristic of the arc is unimportant, the essential feature being the relation between the temperature and size of the vapour path and the current which flows through it.

If we consider the arc current sufficient to magnetise the transformer core to a point approaching saturation, and that the value of the superimposed voice current is only a few per cent. of the arc current, we may take L_1, r_1, and L_2, r_2, C_2 as constants.

For the coupled circuits, by Kirchhoff's laws, using the symbolic notation :—

$$E_1-Z_1I_1-jX_mI_2=0, \qquad (1)$$

$$Z_2I_2+jX_mI_1=0. \qquad (2)$$

Hence,

$$I_2=-j\frac{X_mI_1}{Z_2}, \qquad (3)$$

$$I_1=\frac{Z_2E_1}{Z_1Z_2+X^2{}_m}. \qquad (4)$$

I_2 is the superimposed voice current. In order that it may be a maximum,

$$Z_1Z_2+X^2{}_m=0. \qquad (5)$$

Expanding,

$$[r_1+j\omega L_1]\left[r_2+j\left(\omega L_2-\frac{1}{\omega C_2}\right)\right]=-\omega^2M^2. \qquad (6)$$

Equating the real terms,

$$r_1r_2-\omega^2L_1L_2+\frac{L_1}{C_2}=-\omega^2M^2. \qquad (7)$$

(r_1r_2) is small in comparison with the reactance terms and may be neglected. Then,

$$\omega^2=\frac{L_1}{(L_1L_2-M^2)C_2}. \qquad (8)$$

If K=coefficient of coupling=$M/\sqrt{L_1L_2}$,

$$\omega^2=(2\pi n)^2=\frac{1}{(1-K^2)L_2C_2}, \qquad (9)$$

$$n=\frac{1}{2\pi\sqrt{L_2C_2(1-K^2)}}. \qquad (10)$$

For a man's voice (n) falls between 60 and 1,000 cycles per second.* If L_2 be chosen 0·10 henry and C_2 be chosen $5{\cdot}0\times10^{-6}$ farad, K for the transformer with open-iron core will be close to 0·90.

Then,

$$n=\frac{10^3}{6{\cdot}283\times0{\cdot}5\times(1-0{\cdot}90^2)},$$

$$=520 \text{ approximately.}$$

For a closed-core transformer K is practically unity, and there is no definite resonant point. The low and high tones are equally satisfactory.

Long-Life Tungsten Lamps.—In the case of an ordinary tungsten lamp the candle-power diminishes in course of time owing to the increasing resistance of the filament and the deposit of vaporised tungsten on the bulb. Hitherto, in order to increase the life of a lamp, it has been customary to introduce into the bulb a small quantity of various solid halogenous compounds of low vapour tension, such as potassium iodide. According to a recent American patent (No. 1,197,705) the useful life of a lamp may be still further increased by also introducing small quantities of inert gas, preferably nitrogen, the pressure of gas in the bulb being ordinarily about 10-50 microns. The candle-power of a lamp so treated was found to diminish to only 96 per cent. of its origianl value in the course of 1,900 hours. The candle-power of an ordinary tungsten lamp, on the other hand, would have fallen to 80 per cent. in 1,000-1,200 hours.

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* From the "Electrical World."

† "Wied. Annalen," Vol. LXIV, p. 233, 1898; Pierce, "Principles of Wireless Telegraphy," p. 254, 1910.

‡ "Physikalische Zeitschrift," Vol. II., p. 253, 1901.

* Helmholtz, "Sensations of Tone."

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ULTRA-VIOLET RAYS AND THE EYES.

It has recently been stated with some persistency that eyesight may suffer from the use of electric light, the alleged harmful effect being due to the emission of ultra-violet rays. We, therefore, think it well to discuss the effect of such rays upon the eyes. In taking up this subject it may be said that certain facts are perfectly well known. For example, the quality of the spectrum of an incandescent body changes as the temperature of the body is raised. Thus, while the ordinary luminous gas flame is not actinic, the light from the Welsbach mantle is more so, owing to the considerably higher temperature. The dominant wave length of most sources of artificial illumination unfortunately lies in the region of the invisible heat rays, but as the temperature is raised the dominant wave-length shifts towards the visible part of the spectrum, and the spectrum occupies more of the region covered by the actinic rays. It follows, therefore, that the spectrum of the light emitted by the tungsten filament is richer in ultra-violet light than the spectrum of a corresponding carbon lamp, owing to the fact that the temperature of the tungsten is considerably higher than the temperature of the carbon. It is also well known that ordinary glass absorbs ultra-violet rays to a marked extent. For this reason, when particularly actinic sources are required, such as the mercury vapour lamp, quartz tubes are used instead of glass. It will be admitted, therefore, that the light of the tungsten filament as commonly used contains a considerably smaller percentage of ultra-violet light than the spectrum of the light as it leaves the filament. It is also recognised that ultra-violet light acts powerfully as a stimulant to chemical reactions and physiologically in the destruction of bacteria.

With regard to eyesight, it may be that snow blindness, which is experienced in mountain climbing in brilliant sunshine, is partly due to the ultra-violet rays. It has also been suggested that such rays give rise to cataract, but to prove any such proposition is a very difficult matter. As will be seen by an article which we publish in another column, the liability of some eyes to cataract may be due to the presence of certain salts to an abnormal extent, thus paralysing the resisting power of the eye to ultra-violet rays. As far as the retina is concerned, there is little reason to suppose that ultra-violet rays reach this part of the eye under any ordinary circumstances. SORET showed that although the cornea and the aqueous and vitreous humours are very transparent, the crystalline lens is opaque to ultra-violet rays. This view has been borne out by the observations of DE CHARDONNET on the sensitiveness of eyes to the ultra-violet part of the spectrum after surgical operations.

When we come to the possibility of electric incandescent lamps causing eyesight troubles through ultra-violet rays, the matter resolves itself very much into a comparison between the spectrum of the artificial light and that of daylight or weak sunlight, for the illumination that is employed never reaches the intensity of strong sunlight. It would seem that there is very little ground for suggesting that such ultra-violet rays as are present can be harmful, especially if the lamps are properly shaded. It has been shown by VOEGE that the percentage of these radiations in incandescent illuminants is in general minute ; the proportion in sunlight is greater and yet in ordinary circumstances no precautions are taken in regard to sunlight.

We think the conclusion may fairly be drawn that there is no good reason to use special glass in the construction of electric glow lamps to provide against this supposed evil. What is far more likely to produce harmful effect on eyesight is the use of sources of illumination of high intrinisc brilliancy, such as the ordinary tungsten lamp or half-watt lamp, unshaded, so that the eye receives light direct from the filament. It is regrettable to see the way in which clear glass lamps are still constantly used without any proper shades. If those who should know better persist in this crude method of illumination more harm will be done to the eyesight than can possibly result through the presence of ultra-violet rays in the spectrum.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Physical Properties of Colloidal Solutions. By E. F. BURTON (London : Longmans, Green & Co.) Pp. vii.+200. 6s. net.

This is an excellent book on a most difficult subject. It is written by a physicist, and will prove most useful to the physicist who finds a constitutional difficulty in studying with proper appreciation the subject of colloidal solutions as presented by the chemist, who as a rule has a superior faculty for formulating and understanding to some extent large and shadowy generalisations.

The treatment of the subject is largely historical, and rightly so, for the subject has not yet reached the stage when it can be treated in the rigid manner beloved by the mathematical physicist. Possibly the war is affecting one's sense of proportion, but the part played by British scientists in the development of the subject seems very important. Graham was one of the most distinguished of the early workers on the subject. He was led to divide all substances into two classes—colloids and crystalloids. He was wrong, for it is now known that the same substance may form a colloidal solution with one solvent and a crystalloidal solution with another solvent. In spite of his error, one gathers from the extracts from his writings that his notions of the differences between the two solutions were far from inaccurate. It may be mentioned that a pleasant feature of the book is the numerous extracts. They read well with the text and they are very helpful. The reviewer, however, wonders whether the abundance of extracts is not largely due to a critical faculty in the author which he does not think it wise to exercise. When a distinguished worker makes an hypothesis or statement which is not above criticism, and yet some hypothesis or statement is necessary, it is just as well to allow the great man to speak for himself.

Faraday first suggested what is now believed to be the true constitution of a colloidal solution of gold. Recent advances have been largely due to the ultramicroscope. This is a microscope in which the incident illuminating beam is not allowed to enter the objective, and in which the colloidal particles are seen by the light which they scatter out of the main illuminating beam. Some of the methods of illumination had been used by English microscopists before colloidal solutions were studied so carefully ; but " only when the manufacturing world began to appreciate the necessity of advancing along exact scientific lines was the whole question of microscopic vision unified. To Prof. Abbe, supported as he was by the faith of the glass manufacturer, we owe more than to any other one man the degree of perfection which has now been attained."

The subjects treated in the book are : The preparation and classification of colloidal substances, the ultramicroscope, the Brownian movement, the optical properties of colloidal solutions, measurement of the sizes of ultramicroscopic particles, motion of colloidal particles in an electric field, the coagulation of colloids, theory of the stability of colloids, practical applications of the study of colloidal substances. There are 10 chapters, each followed by a valuable list of references, and the extent of the latter may be judged by the fact that each on the average, list approaches 10 entries.

A. GRIFFITHS.

A System of Physical Chemistry. By W. C. McC. LEWIS, M.A., D.Sc. Vol. I., pp. xi. + 523 ; Vol. II., pp. vii. + 552. (Longmans, Green & Co., 1916.) 9s. each volume.

The close mutual relationship between electrical science and the science of physical chemistry scarcely requires to be emphasised at the present day. Whilst the discoveries and theories of Volta, Davy, Faraday, Helmholtz, Gibbs, van't Hoff, Arrhenius, Ostwald, Nernst and many others led to the foundation and development of modern scientific electrochemistry, the practical applications of this science may be said to constitute an important and still rapidly developing branch of applied electricity. Although the dream of discovering a primary battery which would form a technically important prime source of electrical power has not yet been realised, the electrochemical accumulator still plays a fundamental rôle in electrical practice, whilst the application of electrical power in the carrying out of chemical reactions both at low and high temperatures has led to the development of very numerous and important industries. The electrical engineer of the present day, seeking for new fields of invention and discovery, cannot be too strongly urged to turn his attention to physical chemistry. In the past the study of this branch of science has been almost totally neglected by the majority of British electricians. This has not been the case in America and Germany, with results which are familiar to everyone acquainted with modern advances in certain very prosperous and lucrative fields.

The present work, written by Prof. Lewis, Brunner professor of Physical Chemistry at the University of Liverpool, may be strongly recommended to the electrician and electrical engineer desirous of obtaining in compact form a sound and fairly comprehensive knowledge of the present state of physico-chemical science. Whilst the older portions of the subject are dealt with in an adequate manner, Prof. Lewis's work is characterised by its lucid treatment of the very latest advances. The development of physical chemistry during the last 16 years has been exceedingly rapid, and the Papers dealing therewith are scattered through many journals not usually read by the exponents of applied electrical science in this country. Prof. Lewis has succeeded admirably in collecting and collating this scattered scientific literature, and presenting the results in a clear and logical form.

If any young electrician or electrical engineer will read Prof. Lewis's work, and in conjunction therewith a book such as Dr. Allmand's "Principles of Applied Electrochemistry," the writer of this review will guarantee him a thousandfold return. The electricians of the past have shown how to move things by electricity, and how to move electricity by things, how to illuminate the darkness and how to signal and speak at a distance. What are the electricians of the future—that is to say, the young men of the present—going to do ? Something quite different.

F. G. DONNAN.

The Principles of Apprentice Training. By A. P. M. FLEMING and J. G. PEARCE. (London : Longmans, Green & Co.) Pp. xiii.+202. 3s. 6d. net.

The purpose of this book is to inquire into the selection of skilled manual workers for particular positions according to inherent suitability, and their education and training along lines tending to produce greatest economy of working. Attention is paid principally to conditions in England and to workers engaged in engineering manufacture, but the treatment and conclusions are of general application.

Of the four parts into which the book is divided, the first deals with the place of the manual worker in industry and the economic importance of proper training. In the second part, the characteristics demanded of manual workers are set forth, and the extent to which these are developed by existing educational (lack of) systems is discussed. Suggestions are made as to the lines on which education may be re-adjusted to suit industrial needs without in any way making it conform to a purely utilitarian ideal.

The third part emphasises the need for a means of careful selection of youths according to their vocational fitness, and points to the haphazard conditions under which boys at present enter the works. The guidance afforded by parents, educational authorities, and the means of selection adopted by employers is considered, and a scheme outlined whereby selection may be effected according to a definite and systematic plan. The fourth part is devoted to the consideration of artisan training. Existing methods in various industrial countries are described, and the underlying requirements of training stated, followed by the development of a plan suited to modern conditions.

Finally, an example is given of a system of training developed by the authors in a large engineering works in which the principles laid down are embodied. As appendixes are given the syllabuses of classes held at the Westinghouse Works School at Manchester, particulars of the trade school at the works of Siemens and Halske, and a useful bibliography.

It is well for us that we have men of such high ideals as the authors of this book, and that we have employers sufficiently broadminded to endeavour to put these ideals into practice. The tendency of late years has been for the State to enlarge its activities, and so far as education of every kind is concerned the results have been disastrous. The majority of our young people when they leave school know little of anything likely to be of the slightest use to them, and if, as we believe, the work of training our juveniles can be better performed by private enterprise we would have employers take the matter in hand, and NOW. Those prepared to do so cannot turn for guidance to a better book than the one under review. Parents also will find much to interest them in its pages, and education authorities will find it invaluable.

RATIONALISATION OF THE MAGNETIC UNIT.*

BY J. H. DELLINGER.

The units used in all electric and magnetic measurements are derived from and based upon the international ohm and the international ampere. These two units are defined in terms of concrete standards maintained at the national standardising laboratories. Using the international ohm and ampere, the centimetre and the second as the fundamental units, the various electric and magnetic units in practical use are derived by the ordinary equations of electrical theory. These units may be considered to form a distinct system, which may be called the international system. Each international unit is the practical representative of the corresponding unit in the theoretical electromagnetic system, and differs from it by only a very small amount. While there is a particular unit used practically universally for each electric quantity, there is not such unanimity in respect to the magnetic quantities. It may, in fact, be said that magnetic units are in a somewhat confused state.

It appears necessary to consider the status of the ampere-turn, which is widely used in engineering but is not usually accorded a place in the formal systems of units. Another potent source of confusion is the advocacy and use of so-called "rationalised" systems of units, and in particular the recrudescence of Heaviside units in recent books on electrical theory. This means that the position of the troublesome factor 4π in the magnetic equations is not yet settled. A further difficulty of the situation is the current use of the word "gauss" as the name of the unit of both induction and magnetising force.

The Gauss.—Arguments from the dimensions of the quantities have frequently been adduced in attempts to settle the question concerning the units of B and H. It has been maintained, on the one hand, that B and H are dimensionally identical in the ordinary electromagnetic system (μ suppressed), and are therefore expressible in the same unit; and, on the other hand, that when μ is retained as one of the fundamental quantities of the electromagnetic system, B and H are dimensionally different, and therefore cannot be expressed in the same unit. The question of the "gauss" has recently been discussed from this latter standpoint, by [illegible].† Such arguments are certainly not conclusive. Dimensional identity or difference tells nothing about the physical differences between two quantities. The argument that dimensional identity indicates physical identity is refuted by the example of energy and torque. Who would measure torque in joules or calories? To maintain, on the other hand, that dimensional difference proves physical difference is not conclusive, as illustrated by the fact that the two very different sets of dimensions, the electrostatic and electromagnetic, apply to every electric quantity. Dimensions are matters of convenience, and dimensional arguments can no more settle a question of the physical nature of a quantity than mathematical convenience can justify physical identification of lines of magnetic force and lines of magnetic induction. Inasmuch as dimensional reasoning has been considered by various writers to be valid to decide the physical relation of B and H, it is thought worth while to consider further in this Paper the actual physical nature of the two quantities.

There are a number of reasons for considering induction and magnetising force to be different in physical nature, just as the deflection of a spring is physically different from the mechanical force producing it. As the names of the two quantities suggest, B characterises the magnetised state of the medium and H is the agency tending to produce a magnetised state. Perhaps the distinction is most clearly seen by the analogies furnished by the magnetic circuit. The induction and magnetising force are analogous, respectively, to the electric displacement, which characterises a state of the medium, and the electric field intensity which produces the displacement. The distinction is even clearer between the analogous quantities, current density in a medium, and the voltage gradient which causes it.

Another analogy which points to the physical distinctness of B and H and to μ as a physical property rather than a mere numerical ratio is based on the energy of the medium. The various kinds of energy are each the product of two factors. Energy may be a force × a distance, a mass × half the square of a velocity, a pressure × a volume, &c. The energy density of an electrified medium is proportional to $D\epsilon$, and of a magnetised medium is proportional to $\int H dB$. The energy density of a magnetised medium may be written (where μ is constant) as $1/8\pi\,\mu H^2$. If μ were a mere numerical ratio the magnetic energy density would involve a "generalised" force without the corresponding "flux." This would be contrary to the usual dynamical ideas.

Again, μ is one of the two quantities (μ and K) which are effective in the propagation of electromagnetic waves. Therefore μ must be an actual physical property (for two physical properties are dynamically necessary in a medium for the propagation of waves) unless K involves both properties. If electricity is of dynamical nature, therefore, either μ or K must be a physical quantity or both may be.

In a number of respects B and H are of quite a different character. At the surface of separation between two media only the normal component of B is continuous, while only the tangential component of H is continuous. It is possible for induction to exist in a material with no magnetising force. An example of such a case is a permanent ring magnet with no applied H, in which, therefore, $H = o$ and B is finite. (An interesting electrical analogue of this is Kammerlingh Onnes's electrical conductor at a temperature very near the absolute zero, in which there was a current with no electromotive force.)

The point under discussion may be considered from the standpoint of convenience. While the conception of B and H as physically equivalent was found desirable in magnetic theories based upon magnetic poles, it is not so useful when the relations of magnetism to electricity are dealt with. While a given H is associated with a given current, it is B that is concerned in the phenomenon of induced electromotive force; that is, induced electromotive force depends on the medium, while current and its accompanying H are independent of the medium. Since these relations are at the basis of most magnetic practice, it is just as desirable to consider B and H to be different quantities as electromotive force and current.

At the present time "gauss" is used more generally for the C.G.S. unit of B than in any other sense, and it is probably well to use it only in that way. A name that is widely used for the C.G.S. unit of H is the gilbert per centimetre, the C.G.S. unit of magnetomotive force being the gilbert. (This is similar to the expression of electric field intensity in volts per centimetre.) The C.G.S. unit of flux is the maxwell. When it is desired to avoid the term "gauss" altogether, the C.G.S. unit of B is called the maxwell per square centimetre.

Rationalisation of the Units.—There have been various proposals from time to time to use new electric and magnetic units which should redistribute the factor 4π in the equations. These proposals would apply both to the electromagnetic units and to the international units, their practical representatives. The first proposal, that of Heaviside, accomplished this very satisfactorily, removing this factor from equations commonly used in practice. The 4π, of course, re-appears in certain other equations. The electric and magnetic equations were made symmetrical. However, this was accomplished at the cost of changing to a new set of electric and magnetic units all differing from the familiar ones by the factor 4π or its square root. It is not to be expected, therefore, that these units will be generally adopted. The term "rationalisation" has persisted in the literature, meaning a redistribution of the 4π's in an advantageous manner.

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* An abstract of a portion of a Scientific Paper of the Bureau of Standards, entitled "International System of Electric and Magnetic Units," from the "Electrical World."

† "Electrical World," Vol. LXVII, p. 876.

The demand for a rationalisation of the units has increased as electric waves have come into prominence, requiring the simultaneous use of more parts of electromagnetic theory than other phenomena require. There have been a number of attempts to evade the 4π difficulty without recourse to the Heaviside system, so as to avoid a wholesale uprooting of the existing units and standards. Prof. John Perry proposed in 1891 that the ampere-turn be taken as the unit of magnetomotive force, and that a new unit of permeability be defined such that permeability of vacuum$=4\pi\times10^9$. This latter proposal is the chief drawback to Perry's units and has prevented their acceptance, although they simplify some of the equations. Other systems have followed Perry's, involving very little change of existing units, but all with the disadvantage of incorporating 4π in the value of μ. The fundamental features of the various systems are compared in Table I.

Table I.—*Proposals Regarding Magnetic Units.*

Author of proposal.	μ_0	Unit of magnetomotive force.	Unit of flux.	Remarks.
Perry.........	$4\pi\times10^9$	Ampere-turn	10^8 C.G.S. electromagnetic	......
Fessenden...	4π	10 ampere-turns	1 C.G.S. electromagnetic	$K_0=1/4\pi$ electrostatic. C.G.S. system rationalised Unit of $R=10^8$ C.G.S.
Fleming......	4π	,,	,,	Unit of $l=1$ C.G.S.
Giorgi.........	$4\pi\times10^{-7}$	Ampere-turn	10^8 C.G.S. electromagnetic	$K_0=8{\cdot}842\times10^{-12}$ electrostatic. "Practical" system rationalised.
Karapetoff*	$4\pi/10$	,,	1 C.G.S. electromagnetic	$K_0=1/4\pi$ electrostatic.

It does not seem to have been noticed that a rationalised set of units is obtained by the use of the ampere-turn without changing the unit of permeability. In the table below are given the equations required to make the ampere-turn fit in with the units of other magnetic quantities. Without the introduction of new units we thus have a complete set of magnetic units, alternative to the ordinary system, which are rationalised at least as satisfactorily as the Heaviside units. The table gives a comparison between the ordinary magnetic units and those which for want of a better name may be called the ampere-turn units. In this table, the units of E.M.F., current, length and time are the volt, ampere, centimeter and second.

The Ampere-turn Units.—The units of the second set in Table II. are similar to those of Perry, Fessenden and Karapetoff, with the very important difference that $\mu_0=1$, and thus no new or strange units are introduced. The only novelty is the presentation of the equations required to make the ampere-turn fit in with the units of other magnetic quantities. It fortunately turns out that these equations contain the factor 4π in appropriate places.

The use of the same unit for magnetic pole strength and for flux is not common, because the two quantities are not equal numerically in the ordinary units. It has, however, been suggested by the authors of systems in which the units are rationalised, the two quantities having the same physical nature. In analogous fashion, dielectric displacement and electric charge density are physically similar, and the same unit is used for both. The use of the maxwell as the unit of m leads to the important consequence that J is expressed in the same unit as the physically similar B.

Perhaps the most striking difference between this and previous systems of units is the shift of 4π in the equations

$$B=4\pi/10\,(\mu H) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\phi=m. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Table II.—*The Two Sets of Magnetic Units.*

Quantity.	Ordinary magnetic units.		Ampere-turn units.		Ordinary units in one ampere-turn unit.
	Unit.	Equations.	Unit.	Equations.	
$\mathfrak{F}$	Gilbert	$\mathfrak{F}=4\pi/10(NI)$	Ampere-turn	$\mathfrak{F}=NI$	$4\pi/10$
	Gilbert per cm.	$H=d\mathfrak{F}/ds$ ...	Ampere-turn per cm.	$H=d\mathfrak{F}/ds$	$4\pi/10$
ϕ	Maxwell ...	$\phi=10^8\int Edt$ ...	Maxwell	$\phi=10^8\int Edt$ ...	1
B	Maxwell per cm.^{2} gauss	$B=d\phi/dS$ ...	Maxwell per cm.^{2} gauss	$B=d\phi/dS$	1
μ	...	$B=\mu H$	...	$B=4\pi/10(\mu H)$	1
$\mathfrak{R}$	Oersted	$\mathfrak{R}=\mathfrak{F}/\phi$	Ampere-turn per Maxwell	$\mathfrak{R}=\mathfrak{F}/\phi$	$4\pi/10$
...	...	$\mathfrak{R}=l/\mu S$	...	$\mathfrak{R}=10l/4\pi\mu S$...	...
J	...	$B=B_0+4\pi J$...	Maxwell per cm.^{2}	$B=B_0+J$ ...	$1/4\pi$
κ	...	$J=\kappa H$	...	$J=4\pi/10\,(\kappa H)$	$1/4\pi$
m	...	$\left\{\begin{array}{l}\mu=\mu_0+4\pi\kappa \ldots\\ \phi=4\pi m\ldots\ldots\\ J=m/S\ldots\ldots\end{array}\right\}$	Maxwell	$\left\{\begin{array}{l}\mu=\mu_0+\kappa \ldots\\ \phi=m\ldots\ldots\\ J=m/S\ldots\ldots\end{array}\right\}$	$1/4\pi$

These equations are thus made more exactly analogous to the electric equations.

$$D=1/4\pi\,(K\epsilon). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\iint DdS=Q. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

It is perfectly legitimate and indeed preferable to have the 4π in the first equation of each pair, B and H being physically different quantities (likewise D and ϵ); and to have it removed from the second equation of each pair, since the quantities on both sides of the equation are physically similar. Thus, B and H are not numerically equal in non-magnetic media, and there is little tendency to regard them as physically the same quantity and measurable in the same unit. There is not much likelihood that a single name will be used to mean both maxwell per square centimetre and ampere-turn per centimetre, as "gauss" has been used for the ordinary units of B and H. The 4π in the relation between D and ϵ has similarly assisted in preventing confusion over their physical nature.

In Heaviside units the 4π is removed from all the equations (1) to (4). This makes electric displacement in a vacuum numerically equal to electric field intensity. These two quantities may then be confused in their physical meanings, precisely as magnetic induction and magnetising force have become confused as a result of their numerical equality in ordinary units. It is, of course, legitimate and is mathematically convenient to make two different physical quantities have the same numerical value, but it is often misleading and troublesome. It would therefore appear that in the ampere-turn equations the 4π's are more advantageously distributed than in the Heaviside system.

In conclusion, the gilbert, the gilbert per cm., and the other ordinary magnetic units, derived from the fundamental international electric units by the generally accepted equations, are satisfactory for most purposes. General adherence to these units is desirable, at least until international adoption of units replaces them. The chief outstanding exception to their general acceptance is the widespread use of the ampere-turn as an alternative to the gilbert. Its use requires modifications in some of the classical equations. The various modifications which have been proposed in the so-called rationalised systems have involved the creation of new units, particularly of permeability. It has been pointed out herein that the ampere-turn may be used and a satisfactory rationalisation attained without the introduction of new units.

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* The values of μ_0 and K_0 are not fundamental but derived in the Karapetoff system. They result from the use of the international ampere and ohm as fundamental units, together with the elimination of 4π from certain equations.

CORRESPONDENCE.

SHOULD REVIEWS OF BOOKS BE SIGNED?

TO THE EDITORS OF THE ELECTRICIAN.

May I be permitted to congratulate you on the accuracy and usefulness of your review of Prof. Kapp's book "The Principles of Electrical Engineering," to which review Prof. Kapp takes such strong exception. I examined the book to see whether I should recommend it to be purchased for the Tate Library and came to the conclusion that the many "Germanisms" it contains made it unsuitable for reading by British students.

All teachers are impressed with the importance of uniformity in nomenclature, symbols, &c., and students who have been used to reading $\log_\epsilon r$ are unnecessarily confused when confronted by *lnr* instead.

There are many faults not mentioned by your reviewer, who was, in my opinion, only too lenient. For instance, on p. 67 it is stated that the "bus-bars receive current from dynamos and give current to the outside circuit," a looseness of expression from which we wish to preserve our students.

Battersea Polytechnic, Nov. 22. A. W. ASHTON.

TO THE EDITORS OF THE ELECTRICIAN.

Apropos of his letter in your issue of 17th inst., if Dr. Kapp cares to turn up p. 258 of your issue of Nov. 14, 1913, he may find something of interest in the two columns of matter I was allowed to contribute under the above heading.

The matter touched on the following points:

The Necessity for Books.
The Necessity for Thorough Reviews and Competent Reviewers.
The Essentials of a Review.
Should Reviews be signed?

I will not here return to the subject, beyond saying that reviewing ought surely to be very careful, conscientious and well-paid work. If authors were confident that such was the case there would be less necessity for signed reviews.

One objection to the latter is that some reviewers would not care to expose themselves to the chance (however remote) of a visit from an irate author armed with a vitriolic tongue or a coke hammer.

Another letter of mine, which appeared early in December last year, may also interest Dr. Kapp.

London, Nov. 21. W. PERREN MAYCOCK.

FINAL GRADE CLASSES IN "ELECTRICAL INSTALLATION WORK."

TO THE EDITORS OF THE ELECTRICIAN.

Mr. Trotter will, perhaps, allow us to point out that he does not say whether we are to infer (from the remarks of his we quoted in our first letter) that final grade classes are (so far as London is concerned) only held at the two London institutions he mentioned

We gather that Mr. Trotter is fully alive to the importance of electrical installation work; but we think he has been misled if he really thinks that principals of polytechnics, &c., are enthusiastic about doing justice to the subject.

If Mr. Trotter desires to see the matter from the point of view of the public we would respectfully suggest that he should first read carefully the City Guilds syllabus of the subject, think of the hundreds or thousands of individuals that would welcome tuition therein, and visualise the treatment and equipment necessary. If after doing this he will take the trouble to walk into the nearest technical institute or polytechnic and ask to see the manner in which the subject is dealt with, the chances are that he will be considerably disappointed at what he finds.

In some places he will possibly find that though electrical engineering is taught "wiring work" (to give it its bad old name) has been forgotten. At some big institutions he will find that seekers after knowledge are recommended to attend at some other institution, perhaps, two or three miles away. And we have heard of instances where the classes have been temporarily dropped because of the war, the authorities presumably fearing that they might have to pay the teacher his miserable pittance for teaching only a few students.

Speaking of teachers reminds us of the treatment generally meted out to them, but that is another story.

We are sorry Mr. Trotter still thinks the demand should precede the supply, as this rather plays into the hands of those who don't encourage the supply. The supply of teaching facilities in a subject like this cannot be dealt with like an order for goods.

London, Nov. 27. A. P. LUNDBERG & SONS.

"SUMMATION WATT" CAPACITY OF FIELD RHEOSTATS.

TO THE EDITORS OF THE ELECTRICIAN.

Referring to Dr. Garrard's letter of the 20th inst., I would point out that the various formulæ advocated by me are in practical everyday use.

For a current range of, say, 1·0 to 1·5, or less, both his and my formulæ closely agree with the theoretical basis; however, if a designer has available sufficient range of ohmic values and ampere capacity in his choice of resisters, then obviously he can in practice closely approach the theoretical size of rheostat required for any current variation. If the designer is limited to a small range of resistance then for such wide current variation the maximum radiation possible of the resistersin circuit cannot be made use of throughout the whole range; that is to say, in this respect it is inefficient, although it is the best that the designer can do under the circumstances, and, of course, is not detrimental in any respect except that the bulk would be greater than another having a wider choice of resister values. This matter of resisters available is the whole crux of the question, and as only the individual designers know of their limitations in this respect, I submit that my formula, based on fundamental principles, is the correct method of determining the size of rheostat. The designer applying a correction factor, if necessary, to suit individual rheostats as each manufacturer, has a large number of sizes and various types of resisters.

This question of "summation watts" is only the preliminary factor that enters into the design.

With reference to Dr. Garrard's remarks on potentiometer rheostats, the following case may be interesting: A potentiometer rheostat was required for a 10-ampere 20-volt battery charging generator having a hot field resistance of 3,200 ohms, separately excited from a 250-volt supply. Obviously, 2 to 4 ohms per volt would not be too high and alternatively two to four times the field resistance would entail either an undesirable very fine gauge wire or a much larger rheostat than that supplied.

The moral of all this is (to quote the words of Mr. T. Carter) "The use of a formula without care and intelligence is certain to lead sooner or later to disaster; a formula is a good angel if a servant, but if it becomes master, it is more subtle in temptation than Satanus himself."

Stretford, Nov. 27. L. BOOTHMAN.

FARADAY SOCIETY.

At the last meeting of the Faraday Society an interesting discussion took place on Refractory Materials. The chair was taken by the president, Sir Robert Hadfield, F.R.S., who opened the proceedings with an introductory address.

Sir ROBERT HADFIELD remarked that the chief sources of refractories were probably silica, chrome clay, magnesite, dolomite, chromite, bauxite, graphite and zirconite. The properties of refractories were summarised in the standard specifications for refractory materials published by a joint committee of the Institution of Gas Engineers and the Society of British Gas Industries in 1912, and in 1908. Mr. F. J. Bywater had read an important Paper on this subject before the former Institution. An interesting *résumé* was given here as to the origin of fire-clays, and it was shown how difficult it was to establish a relation between their fusibilities and compositions based merely on ultimate analysis. "Mechanical" analysis was first necessary, and the material divided up into kaolin, or true clay substance, quartz and felspar. The address next dealt with the classes of refractories in use, including the comparatively new refractory zirconite. A series of exhibits illustrated some differences in practice between good and bad refractories. Thus, the diameter of a magnesite nozzle remained quite unaltered at 1 in. even after 28 tons of steel had been poured through it, whereas that of an ordinary fire-clay nozzle increased to 2 in. The difference might well represent slag embedded in the steel. Some photomicrographs were shown, illustrating the use of microscopy in the study of refractories, and the address concluded with a bibliography of Papers and books and with a series of tables giving complete analyses, largely compiled from the author's own records, of most of the refractories in common use.

The opening Paper, by Dr. J. W. Mellor, dealt with "The Texture of Firebricks." Dr. MELLOR remarked that what constituted a good firebrick was a favourite question, and one which did not admit of a satisfactory answer. Texture was one of the most important qualities of a firebrick, since on this the life and character of the firebrick largely depended. The texture of a refractory might vary from that of the light porous bodies used in making bricks for insulating boilers, &c., to non-porous or vitreous bodies used in making crucibles, acid-resisting bricks for acid towers, &c. There were quite a number of intermediate types. The different types of textnre were exhibited. The refractoriness of a firebrick under ordinary conditions of measurement was dependent to a small extent on the grain size. For bricks which had to resist the abrasive action of streams of flue dust, coal ashes, slags, &c., a close texture was necessary; but a close-textured brick was liable to split with abrupt variations of temperature. To reduce the tendency to splitting in this way a uniform texture was desirable. The chemical composition of the brick in relation to that of the dust and slag it had to resist at high temperatures was of great importance. Examples illustrating the importance of both texture and chemical composition were shown.

Prof. W. G. Fearnsides, in a Paper on "The Application of Petrographic Methods to the Study of Refractory Materials," remarked that, though there was a woeful lack of scientific data of refractory materials, there was among the foremen brickmakers and furnacemen a great deal of information which only needed to be collected, codified and interpreted to make it as scientific as the best laboratory product. Scientific workers ought to go through the works and bring out such information in terms of time and inversion temperatures, of grain sizes and chemical compositions. Though in its best developments the art of making refractory materials was in advance of the science, the practice of the art by unskilled makers left much to be desired, and a scientific study of the craftsman's methods would yield valuable results. Referring to the application of the microscope to the study of refractory materials, Prof. Fearnsides recalled the pioneer work done by the late Henry Clifton Sorby, of Sheffield, some 50 years ago. The study of thin slices of material under the microscope was now very helpful.

Dr. R. Lessing showed a series of specimens illustrating a method of testing he had devised five or six years ago for ascertaining the texture and rational composition of refractory mixtures before firing. The method consisted of a simple process of elutriation, by which the true clay substance of the "green" clay was removed by a gentle current of water and separated from the water by allowing it to settle out on standing. The rate of flow of water was so adjusted that the "grog"—*i.e.*, the previously fired portion of coarse particles which eventually formed the rigid skeleton of the firebrick, and also the heavy and coarse grain residue of the "green" clay, consisting of sand, shale or carbonaceous substances—were left behind in the elutriating vessel. The test has been used successfully for the daily control of manufacturing operations.

Dr. H. G. Colman gave a short account of the work on refractory materials carried out by the joint committee appointed on this subject by the Institution of Gas Engineers and the Society of British Gas Industries. This committee, consisting of representatives of both the users and manufacturers of refractory goods for gasworks purposes, had, after determination of the conditions prevailing in gas-retort settings under present day conditions, drawn up provisional specifications relating to the different classes of fire-resisting goods commonly in use in gasworks—namely, retort material, ordinary firebricks and silica bricks—prescribing, among other more general matters, the physical tests with which these goods must comply. In addition, the committee were carrying out investigations on matters likely to be of value to both users and manufacturers, and to assist in the provision of the fire-resisting materials most suitable for the above purposes.

Mr. J. Allen Howe made a statement on the "Recent Work of the Geological Survey on Refractory Materials." The statement indicated what the Survey had done since the war, in prepartation for the forthcoming report on British refractory materials. The country had been blocked out into field areas, and from each samples of raw materials have been secured and classified, the geological character of their locality and the nature of the deposits having been exactly noted. In each main centre both producers and users of refractory materials had been consulted. The main groups of material might be classified as the silica group, the fireclay group, refractory sands and dolomite, and the report would probably be issued in corresponding sections. Well over 1,500 samples had so far been received, and the collection of the raw material—the first stage of the work—was almost completed. The next stage—putting into shape the field notes and the chemical, petrological, mineralogical and textural examination of the specimens—was already well advanced. Arrangements were being made to test the refractoriness and determine other physical characteristics of the materials, and the data so obtained will be included in the report.

Mr. T. Crook, of the Imperial Institute, stated that the Empire was well provided with resources in the less common refractories, such as graphite, in India and Canada; chromite, which is abundant in Rhodesia and India; magnesite in Victoria, South Africa and British Columbia; bauxite in India and British Guiana; and zircon in Natal.

Mr. Cosmo Johns read a Paper on the "Use of Silica as a Refractory Material in Steel Manufacture," and pointed out that the silica or Dinas brick was never pure, and the brick itself was a mineral aggregate of extreme complexity.

Mr. Albert Cliff contributed a Paper on "The Manufacture of Refractory Materials" from the makers' point of view. Some of the present temporary difficulties in the supply of materials he himself was overcoming by fastening working surfaces of chromite, magnesite or other materials not liable to corrosion on to ordinary fire or silica bricks. Some samples of these faced bricks were exhibited. As a manufacturer, he advocated the closest possible union between the chemist and the craft in the carrying out of organised investigations—mere laboratory tests were insufficient—into the commercial value of the minerals, chromite, magnesite, graphite and others reported that evening as abundant in the colonies. Above all, improved education was necessary in those who were to carry on the business of making refractories; the men of science must come down to them and talk to them freely of principles and facts, and so accelerate a rise of specialised intelligence among clay workers.

Mr. E. P. Page read a Paper on "The Classification of Refractory Materials and some Notes on Method and Points for Investigation." The author remarked that an easy method of classifying refractory materials had been to divide them into three sections—namely, acid, basic and neutral, according to their chemical composition and their behaviour towards each other, and the acid or basic compounds brought into contact with them under such conditions as were favourable for reaction to take place. The essential property of any material claimed to be refractory was stability at the temperatures to which it was exposed, with sufficient reserve of stability to resist chemical and mechanical influences externally applied. The first quality was a classification of pure refractoriness, and the second was one of refractoriness plus skill in application. However, the successful issue was generally the result of compromise.

Mr. W. J. Jones, of the Ministry of Munitions, said the discussion had brought out clearly the necessity for closer co-ordination between science and practice, between the laboratory, on the one hand, and the brickmaker and the steel-maker on the other. It was the enormous increase of production necessitated by the war that had brought home to the steel industry the importance of their refractory materials. He urged as a further reason for co-ordination the different results that so often were obtained with the very same material in different works.

Mr. A. A. McDougall Duckham, of the Ministry of Munitions, also emphasised how much the output of munitions depended on refractories. It was clear that we had at home and in the Empire ample material to enable us to hold our own.

Dr. W. Rosenhain, F.R.S., of the National Physical Laboratory, spoke of the necessity for paying attention to the highest class of refractories now that metallurgists, especially in the electric furnace, were utilising very high temperatures. Metallurgists should know all about materials like carborundum, alundum, silicon and similar products now being produced at Niagara Falls. There was great promise in zirconia, especially the highly purified material. Dr. Rosenhain went on to discuss the cracking of refractories. This was caused by physical forces involving nothing but determinable constants, and the *coefficients of thermal endurance* could be worked out, as had been done for glass.

Prof. T. Turner reminded the meeting that the subject was also of interest to the glass, pottery and porcelain industries, and referred to the work on glass being done at Sheffield University.

Dr. R. S. Hutton pleaded for more work at the very high temperatures of the electric furnace. For example, the properties of completely shrunk magnesia were quite different from those of ordinary calcined, and the shrinking could be economically effected electrically.

Dr. W. H. Hatfield remarked on the work to be done on the resistance of refractories to slag erosion. He gave examples of the great disparity in behaviour of different grades of silica bricks. Before more progress was possible much more accurate instruments for registering high temperatures were necessary: at present, calibration between 1,000°C. and 2,000°C. was difficult and uncertain.

Prof. F. G. Donnan, F.R.S., spoke of the necessity for a standard quantitative specification for silica bricks.

Dr. P. G. H. Boswell, of the Geological Department, Imperial College of Science and Technology, read a Paper on "Refractory Sands." The author remarked that many of the sands used for refractory purposes were not true sands in the geological sense; they frequently contained a proportion of refractory clay, &c. There was no doubt that we could replace from home resources a large proportion of the refractory sands hitherto imported from abroad. The admirable work of H.M. Geological Survey in collecting, recording and in part subjecting to analysis supplies of refractory materials worked in this country needed to be supplemented by much research work, for in certain directions the properties of desirable sands, for example, were not fully known, and geologists do not know what to look for. The time had passed for the scattered and haphazard methods and results, of which we had had so large a number. The pure scientific work would indicate the likely materials to be tried in indnstrial practice and would eliminate the improbable. The closest British analogues to the very suitable foreign materials would then be found. The refractory sands used in industry might be divided into three chief classes: (*a*) The high silica sands (with 98-99 or more per cent. of SiO_2); (*b*) the high silica and alumina sands bearing variable proportions up to 20 per cent. alumina, as kaolin, &c., and little else but silica; (*c*) sands for greensand moulding, carrying a strong and highly refractory natural clay bond. All class (*a*) sands hitherto imported might be replaced from the abundant and excellent British supplies. (The economic factors, freight, &c., would have to be considered.) We had also valuable deposits of class (*b*), but so far as those sands of class (*c*) which were used for high temperature steel moulding were concerned, it must be admitted that the best foreign sands hitherto used here had not been equalled by known British resources. In brief, research on British and foreign refractory sands was desirable in the following directions (among others): (i.) Mechanical analyses, to gain more accurate ideas of grading, carried out scientifically; (ii.) chemical analyses of each grade, not bulk analyses; (iii.) mineral analyses, to realise the importance of constituent minerals, especially those prone to decomposition which yielded the "bonds" of these sands. (iv.) the water-holding capacity at 10 deg. intervals at temperatures below 110 deg. and at suitable but greater intervals above; (v.) the conductivity; (vi.) the refractoriness of each grade; (vii.) pore space and permeability. It was to be hoped that before long a detailed account of British resources of refractory sands, with analyses and notes on their peculiar properties, might be in the hands of manufacturers.

Mr. **Ezer Griffiths**, M.Sc., read a Paper on "The Thermal Conductivity of Materials employed in Furnace Construction." The Paper dealt with the methods employed for investigating the thermal conductivity of bricks and tiles of commercial sizes. One of the practical difficulties was the attainment of a uniform temperature over the hot face of the sample, since the surfaces were always irregular. It was found possible to obtain good thermal contact as well as a very uniform distribution of temperature over the surface by the use of a shallow bath of molten metal electrically heated. Values of the thermal conductivity and its variation with temperature were given for two typical materials employed for thermal insulation, the one composed principally of diatomaceous earth baked at a high temperature to form a rigid brick of friable texture; the other manufactured by blowing steam through molten blast-furnace slag, which converts it into a product bearing a resemblance to cotton wool. This material was tested in the form of a mat, the faces being covered with wire meshing.

A considerable number of specimens of minerals and refractory materials and products were exhibited to the meeting by the authors of the Papers and others.

LEGAL INTELLIGENCE.

Telux Co. v. Efandem Co. and Efandem Co. v. Telux Co.

Last week the Lord Chief Justice heard these combined actions. The Telux Co. alleged that their company was formed by the Efandem Co. for getting rid of their goods. The Efandem Co. are manufacturers of electric batteries and cases, and the claim was for £852. 15s. 5d. as damages for loss on the re-sale of goods not delivered. The Efandem Co. counterclaimed for an account of all goods supplied and re-sold.

At the outset Mr. **Abinger** (for Mr. Thos. M. Gordon) claimed that his client was the sole partner of the plaintiff company, and that the action had been instituted without his consent or authority. Mr. Gordon refused to make an affidavit, and no order was made in an application to commit him. Mr. Gordon took out a summons asking to be indemnified in costs, on the ground that he was not a party to the action, which had been brought without his authority, and the Master made no order. He intervened because if it was found that Mr. Gordon was the sole partner the time of the court would only be wasted by hearing the case.

Mr. **Hugo Young**, K.C., on behalf of the Efandem Co., said, of course, if Mr. Gordon was the sole partner, as he was not bringing the action, defendants had no case to answer. If the other parties were partners, then he had an answer to the case.

Mr. **Disturnal**, K.C., then opened the case for the plaintiffs, and said defendants were in a large way of business; they had works at Wolverhampton with a London office. The plaintiff firm consisted of Percy Arthur Cooper, Sydney Gerald and Thos. Malcolm Gordon, the active manager being no doubt Gordon, and he had the main control of the business. Cooper was the sales manager of defendant company at their London office, and Brown was the order clerk. The Telux Co. was formed in May, 1915, for the purpose of selling defendants' goods to the retail trade, and in fact they had no other business. It had a short life, and was in fact dissolved in December, 1915. The claim was for breach of contract in failing to deliver goods. Defendant company was formed in March, 1911, to take over the business formerly conducted by one Fahn and another, who had brought their appliances from America. Mr. Fahn was the vendor to the company; he was the managing director of the company, and the active moving spirit from the very beginning. A Mr. Varley joined the board in 1913, and the present matter arose out of a conflict between the Varley and Fahn groups. Messrs. Cooper and Brown were in the employ of the vendors. Up to this time defendants had made a practice of supplying the very smallest retailers. This entailed a large amount of work, and a change in the method was started by Mr. Fahn in 1914-15. Just before May, 1915, Messrs. Cooper, Brown and Gordon had a small shop in the Harrow-road, where they did a retail business as "The C.M.G. Electrical Co." This was not very successful, and as a result of a discussion with Mr. Fahn they started a wholesale business, Mr. Fahn providing the money with which to open the account at his bank. Matters went on until the present difficulties arose, when defendants said plaintiffs were acting in competition with them.

Mr. Percy A. Cooper stated that he formerly acted as London export sales manager. Defendant company were anxious to devote their attention to the wholesale trade and to eliminate dealings with retailers, and the Telux Co. was started at Hammersmith to deal with the retail side, witness becoming a partner in that business. After the start of the business witness was informed by a representative of defendant company that he must resign his position either in the Telux Co. or the Efandem Co. Witness [illegible] a month's salary in lieu of notice by defendant company. He, together with Mr. Gordon and Mr. Brown, were the partners in the Telux Co., which was formed with the approval of Mr. Fahn, who was formerly managing director of defendant company.

On the point raised by Mr. Abinger that Mr. Gordon was a partner of plaintiff company, and was not a party to the action, his lordship said that Mr. Gordon should be added as a defendant.

Mr. **Reg. Vaughan**, of Messrs. Vaughan & Williams, solicitors to plaintiffs, said the action was concurred in by the three parties.

Mr. **Hugo Young**, K.C., said the orders were accepted in ignorance by Fahn, and defendants denied the authority of Fahn, and no sanction he gave could have any authority behind the backs of the company.

Mr. **Kendrick**, chairman and one of the directors of defendant company, gave evidence to the effect that defendant company knew nothing about the members of plaintiff firm being employés of their company. Mr. Fahn was joint managing director of defendant company, and had general management. It was common knowledge that in 1915 the orders were heavy in that trade, and really the trade was unable to cope with it.

Mr. **Jesse Varley**, accountant, and a director of the Efandem Co., said it was not known at the time that those negotiations were entered into for the sale of their goods to plaintiff company, that any of their employés or Mr. Fahn had anything at all to do with the Telux Co. After it was found out that they had the matter was brought before the board, and it was decided to dispense with the services of Cooper and Brown. In cross-examination, he said it was not a fact that he had sanctioned Cooper having anything to do with the Telux Co. in an interview he had with him at Wolverhampton.

Mr. **Peter Smith**, secretary to the Efandem Co., said after it came to the knowledge of the board that Cooper was connected with the Telux Co. he had an interview with Cooper in London, and he (witness) tried to persuade Cooper to drop his connection with the Telux Co.

Mr. **Hugo Young**, K.C. (for the Efandem Co.), submitted that if Mr. Gordon was the sole partner of the Telux Co. there was an end of the matter. And supposing it was found that he was a partner with Messrs. Cooper and Brown, who had brought the action, then he had repudiated the action, and had no claim as against defendants.

His **Lordship** said if Gordon was the sole partner, then it appeared that the whole action should be struck out. His lordship said the general position as it appeared to him was this: The defence set up was that Cooper and Brown had no authority to accept orders on behalf of the Efandem Co., and these orders were never accepted by anybody who had authority from the Efandem Co. There was a question as to policy—whether or not they should deal with wholesale firms or factors rather than retailers. If the case rested solely on that, he would think there was authority to make the arrangement in Fahn, as the managing director; but that did not seem to him to touch the real point. The real question, as it seemed to him, was whether Fahn had authority to make the arrangement with two employés to enter into a business, with which he (Fahn) was to be connected, and which might act in competition with his company, and have the effect of depriving the company of profits which would otherwise have gone to them. He (his lordship) said he drew the conclusion that it was intended from the outset that Fahn should be interested in the Telux Co. And he was of opinion that there was no authority from the Efandem Co. to the Telux Co. The result of that would be that the company itself had no knowledge of the carrying on of that business by two servants of the company, and if that were so the two servants could not enforce their claim.

Mr. **Warren** (for plaintiffs) contended that there was knowledge at any rate on the part of Smith and Varley, in the month of August that Cooper had an interest, and it may be inferred that they knew that Brown had an interest in the Telux Co. Cooper had an interview with Mr. Varley at Wolverhampton in August, and as to the mention of the Telux Co. at that interview, his (counsel's) contention was that Mr. Varley's recollection was inaccurate. After the month of August, and right away up to December, goods were being sent in part execution of nearly every one of these orders, and these goods had been manufactured by the Efandem Co. at their works at Wolverhampton. His point was that, after knowledge of the full particulars, the defendant company continued to deal with Cooper and Brown, who were both servants of theirs at that time.

His **Lordship**, giving judgment, said the Telux Co. was founded for the one purpose, to purchase the goods of defendant company at the lowest wholesale price and to re-sell them to customers of defendant company at retail prices. According to the evidence, at the meeting of the company Mr. Fahn had come to the conclusion that their business policy ought to be to exclude as far as possible the retail customers and to deal exclusively with wholesale customers. The company never was consulted as to the Telux Co., which was a matter determined by Fahn himself, and the Telux Co. was formed to carry out this policy. There were other factors and wholesale dealers in existence already in relations with the defendant company, and it was not necessary for the carrying on of the business that the Telux Co. should ever have come into existence. That company was started in May, 1915, and very soon after Mr. Fahn, who was the managing director of the Efandem Co., and Cooper, Brown and Gordon were discussing a draft of a partnership deed, in which Fahn was to have the largest share of the profits—he was to receive 50 per cent. In truth, the deed never was signed, and according to the evidence Fahn never actually got an interest in the business, because while that discussion was going on defendant company (through Mr. Varley, one of the directors) became acquainted with certain facts, and it was enough to say that their attention was specifically called to the facts. Unfortunately, some of the most important actors could not be called. Mr. Fahn, who was apparently very ill for some time before the action came to trial, had since died. Mr. Holcroft was also dead, and Mr. Brown was overseas, serving in H.M. forces. Mr. Varley had become acquainted with some of the events that had happened with regard to Fahn, and he sent for Cooper, who went to Wolverhampton to see him, and the conclusion he (his lordship) arrived at on the facts were that where he found Cooper in conflict with Varley he preferred Varley's story, and where he found Cooper not agreeing with Smith he preferred Smith's recollection. He thought Mr. Smith had given his evidence with great care and scrupulous honesty. Mr. Varley's evidence was not so satisfactory—his memory was not so clear as to some of the events. His account was not clear and reliable as to what he knew as to the interest Cooper and Brown had in the Telux Co. Inquiries were set on foot which terminated in the company calling upon Cooper to elect whether he would serve with defendant company or remain a member of the Telux Co., but he must choose because he could not be both. Towards the end of November notice was given by the Efandem Co. to terminate the services of Cooper, which led eventually to this action, because the Efandem Co. determined that it would accept no further orders, and would not complete those they had taken for the Telux Co. In his lordship's opinion defendants were justified in refusing to complete these contracts, and in refusing to accept further orders for the Telux Co.—that firm constituted solely of their own servants. Up to August, 1915, defendants' directors and Smith were in ignorance of the constitution of the Telux Co., or that Cooper and Brown were interested in it, let alone partners. Cooper said Smith knew all about it, but there was one very significant fact which diminished the value of his testimony. It turned out that Smith left London and took up duties in Wolverhampton two months before the Telux Co. came into existence. Smith said he knew nothing about it until August, and he accepted implicitly what Smith said upon that point. It was clear that it was in contemplation that Fahn was to have an interest in the business of the Telux firm, and Cooper must have known it Fahn produced the capital at 5 per cent. interest, and went to inspect the premises to be taken for the Telux Co. He (his lordship) declined to accept the view that an agent for a principal was entitled to enter a secret agreement with two servants of the principal to carry on a business in which he (the agent) was interested, and which might be in competition with his principal.

His Lordship then entered judgment for defendants on the claim, the counterclaim being withdrawn, and the question as to Mr. Gordon's interest as sole partner was left over to be discussed later.

C. P. Medley v. T. E. Dingwall.

In the Shoreditch (London) County Court last week plaintiff, trading as the London Hoist & Machinery Co., sued defendant, a packing case maker and shipper, to recover £40. 3s. 6d., balance of £150. 3s. 6d., for supplying and fitting a second-hand electric gear to a lift, with accessories.

Evidence was given for plaintiffs that they entered into the contract for the fitting up of an electric lift, which they carried out. The motor, which was fixed on a c i. bed, was complained of, so they put in another, but to save time they banked it up with blocks of wood, on top of the c.i. bed. They left it in perfect running order.

J. Shearman Wilkerson, foreman bale packer, called for the defence. said that after the new motor was installed the lift worked so badly that he went across and implored plaintiffs to come and put it right, but things got no better. It was fitted to take 10 cwt., but at times would not take 5 cwt. If the rope was pulled for it to go up it would at times go down, and it became dangerous to work it, as they never knew when it might deposit the operator and the load in the well of the lift. He had told the operator to put less weight on, which meant that two journeys had to be taken for one.

Mr. Thos. E. Dingwall also gave evidence, and said that a few hours after the new motor was put in he had complaints. The controller was the cause of most of the trouble, as it worked so erratically that when pulled one way it went the other. As an electric lift it was quite a failure.

Four electrical experts, Mr. E. Ellison, Mr. Bourne, Mr. Gallon and Mr. Percy H. Arber were called, all of whom said the lift would not do its work properly as it was. It stopped, reversed, would not start with its full load at times, &c. Mr. Bourne said that to put it in proper working order as an electric lift of good quality would cost £200.

Judge Cluer said he went to the factory; he paid a special visit to view the electric lift; it did not reverse while he was there. He thought the fault lay in the human operator being incompetent, as plaintiffs could work it quite well. The motor had been put on wood blocks instead of cast-iron, which might cause vibration, so he would allow £2 for that, and give judgment for plaintiff for £38. 3s. 6d.

Leave to appeal was granted, on the amount of the claim being paid into Court.

Collieries and Electricity Supply.

Vice-Chancellor Stewart Smith, of the Chancery Court of Lancaster has granted the application of the Hulton Collieries (Ltd.) for power to manufacture gas and to generate electricity from their coal, &c. It was explained that the company wanted an extension of their powers, so that, instead of selling their coal to consumers and gas companies, they would be able to manufacture gas, generate electricity, and extract the valuable by-products for which at present there was a great demand; and to make aniline dyes, synthetic drugs, &c. The capital was £45,000 fully paid up, and the company owned two collieries. For several years past the company had been experimenting with its coal with the object of seeing what kinds of by-products it could supply and the possibility of turning them to commercial advantage.

Mr. Rutherford opposed the application on behalf of Atherton Urban Council and 17 holders of long leases in the neighbourhood of the collieries. The Council were manufacturers of gas, and they did not wish to have competition.

The objection was overruled, and the order asked for was granted.

Breach of Mining Regulations.

At the Newcastle-on-Tyne Moot Hall last week John McKenzi, a rolleyman and lamp inspector at the Lizzie Pit, of the Burradon & Coxlodge Coal Co., was charged with an offence likely to endanger life.

Mr. E. Clark (who prosecuted) said it was part of defendant's duties to take charge of an electrical apparatus for the re-lighting of safety lamps, to re-light lamps and to examine same before they were taken back into the workings. The apparatus was enclosed in a metal box, and the regulations provided that, except when in use, it should be kept locked, and the person in charge should have possession of the key. He was charged with failing to keep the box locked. The box was found open on Oct. 24 by the manager, and it transpired that defendant had been in the habit of entrusting the key to boys, and consequently the box was frequently left open. In a fiery pit such conduct was extremely dangerous.

The manager of the pit (Joseph Heald) said he found the padlock lying on the top of the box and useless. The principal danger consequent upon his negligence was that of defective lamps being re-lighted and taken into the workings.

Defendant was fined £5 or one month's imprisonment, the Chairman (Col. Fenwick) observing that his conduct might have led to a serious explosion.

PARLIAMENTARY INTELLIGENCE.

REGISTRATION OF BUSINESS NAMES BILL.

The Committee stage of this bill was taken in the House of Commons last week, and certain amendments were introduced, mainly with the object of securing more precise the definition of the persons required to register and of the times and conditions under which the provisions would apply.

On the motion of Mr. Butcher, the following paragraph was added to the description in Clause 1 of the firms and persons to be registered: "Every individual or firm having a place of business in the United Kingdom, who, or a member of which, has either before or after the passing of this Act changed his name, except in the case of a woman in consequence of marriage."

The clause as amended was agreed to, as was also Clause 2 (Registration of true name by nominee, &c.).

On Clause 3, setting out manner and particulars of registration. Mr. Joynson-Hicks moved to add the following sub-section: "Where it appears to the satisfaction of the Board of Trade (*a*) that the name which it is proposed to register under this Act contains the words 'British' or 'Imperial,' or any word or words calculated to lead to the belief that the individual or all the individuals carrying on business under that name is or are British subjects; and (*b*) that such individual or individuals, or any of them, are not British subjects, the Board of Trade shall refuse registration of such name and require another name to be put forward for registration instead thereof."

Mr. Pretyman expressed sympathy with the object of the amendment, but said the sub-section in the form in which it was proposed might prove ineffective. This bill was not solely a war measure dealing with German firms; it was intended to be a permanent statute, and it affected firms which were British and American, and those of our Allies as well as of our enemies. If the sub-section were applied to firms now in existence it might deprive a large number of a valuable goodwill. He asked that the matter might be left over until the Report stage in order that the Board of Trade might consider whether it would be necessary to introduce a separate bill to deal with companies.

After further discussion Sir Geo. Cave said that the departmental attitude was not to allow the matters complained of to continue. The clause as it was did not go far enough and could not stand.

The amendment was then withdrawn, and the clause agreed to.

On the seventh clause, which provided that if any firm or person makes default in registering, the Board of Trade may (either upon application of any person interested or without such application) call upon such firm or person to remedy the default, and that if the default is not duly remedied the parties may be punished by fine on summary conviction, Mr. Butcher took exception to the proposed necessary intervention of the Board of Trade, and moved an amendment to sanction independent proceedings.

Mr. Pretyman explained that the object of the provision criticised was to prevent blackmailing and frivolous or vexatious proceedings.

The Solicitor-General also pointed out that if a man sent in particulars from which there were omissions he would be liable to a penalty. There was accordingly risk of proceedings against persons who were not morally to blame. If the matter was allowed to stand over it would be further considered before report.

The amendment was negatived, and the clause was added to the bill.

An amendment to Clause 11 was accepted to the effect that the certificate of registration should be exhibited in a conspicuous position at the principal place of business of the firm or individual.

There was objection to Clause 17, on the ground that it would harass trade and commerce. The clause provides for the publication of the true name and nationality of every individual or firms registered in all trade catalogues, trade circulars and business letters sent out of the United Kingdom.

The clause was agreed to and added to the bill, and the remaining clauses were agreed to.

On Tuesday the Bill, as amended in Committee, was considered. Mr. Pretyman moved a new clause providing that where any business name contained the word "British," or any other word which, in the opinion of the registrar, was calculated to lead to the belief that the business was under British ownership or control, and the registrar was satisfied that the nationality of the persons by whom the business was owned or controlled was at any time such that the name was misleading, he should refuse to register that business name, or remove it from the register. The clause allowed an appeal to the Board of Trade, whose decision would be final.

After discussion the clause was passed; and Mr. PRETYMAN moved an amendment to clause 2 by which a firm acting as agent for a foreign firm would only have to register if it acted as general agent and not as agent in a particular transaction. This was agreed to, as was a Government amendment striking out the proviso in clause 7 requiring the consent of the Board of Trade before any proceedings for the recovery of penalties under the section could be instituted.

Mr. PRETYMAN moved an amendment to clause 17 imposing on every individual or firm requiring to be registered the duty of setting forth their true names on all "letters and cards containing any offer or invitation to transact business."

Mr. CURRIE opposed, and said the amendment was "undiluted inquisition," and after much discussion it was withdrawn.

An amendment moved by Mr. PENNEFATHER, extending the application of the clause to catalogues, circulars and business letters sent to any person in the British Empire, was agreed to.

The consideration of the Bill as amended was concluded, and the Bill was then read a third time.

SALE OF ENEMY BUSINESSES.

In the House of Commons last week Mr. Pretyman stated that the number of businesses under the provisions of Sec. 1 of the Trading with the Enemy Act under which enemy property had been sold by the controller, or enemy-owned shares had been sold by the Public Trustee, was approximately 200. The particulars of sale had not been submitted to any committee before the offer was accepted. In a few cases the advisory committee under the Act had made suggestions so as to the persons to whom the property might be offered. They had dealt with 600 businesses. All the enemy businesses were being dealt with.

PARLIAMENTARY NOTICES.

The following official notices of intention to promote Bills or Provisional Orders in the ensuing Session have been given:—

PROVISIONAL ELECTRIC LIGHTING ORDERS.

Electrical Distribution of Yorkshire (Ltd.) (for urban districts of Garforth, Featherstone, Luddenden Foot, Otley, Rawdon and Yeadon, Clayton and Queensbury, Penistone, Horbury, and parishes or townships of Bradfield, Ecclesfield and Tankersley in Wortley Rural District); South Metropolitan Electric Tramways & Lighting Co. (to extend area of supply to Parishes of Ewell and Cuddington in Epsom Rural District); Wimbledon Corporation (for Parish of Cuddington in Epsom Rural District); and Ripon Corporation.

ELECTRIC SUPPLY AND TRACTION BILLS, &c.

Blackpool Corporation: To extend borough boundaries, to extend the gas, electricity and other powers, to supply electricity and gas in the excluded parts of Carleton and Marton, &c., to construct tramways and tramroads, &c.

West Kent Electric Co. (Ltd.): To authorise amendment of capital powers, to incorporate all or some of the provisions of the Companies (Clauses) Acts, 1845 to 1900, the Electric Lighting Acts, 1882 to 1909, and any Act amending same, to vary, amend or repeal or to extend and apply to the Company all or any of the provisions of the Kent Electric Power Act 1902, the Kent Electric Power Act, 1906, and to alter, extend or repeal all or any of the provisions of the Act of 1909 and any other Acts affecting the Company, &c.

Ashton-under-Lyne Corporation seek powers to purchase tramways authorised by Oldham, Ashton-under-Lyne, Hyde and District Electric Tramways Order, 1896, to acquire powers of purchase vested in Waterloo or Bardsley Parish Councils, to postpone purchase of tramways, to construct new tramways in Ashton-under-Lyne, to obtain running powers over and enter into agreements in respect of neighbouring tramways, to run omnibuses, also to make further provision for supply of electricity.

Nottinghamshire & Derbyshire Tramways Co.: To transfer to and vest in company the tramway undertaking of Ilkeston Corporation, to confirm agreement between Corporation and company, to provide as to re-purchase of tramway undertaking by Corporation, &c.

Aluminium Corporation (Ltd.): To authorise the re-arrangement, increase or reduction of its capital, the amendment of its memorandum and articles of association, &c.

Bedwas and Machen Urban District Council: To provide and work omnibuses, &c.

Sheffield Corporation: To acquire land for erecting generating station, to generate and supply electricity, to construct and lay down electric lines, &c., to extend limits of Corporation for the supply of electricity and water, &c.

Caerphilly Urban Council: To provide and work omnibuses, &c.

EDUCATIONAL.

Swansea Technical College. It is announced from Swansea that Messrs. Baldwins (Ltd.) have given £10,000 to the local Technical College for the endowment of a chair of metallurgy.

Sheffield University. At the annual meeting of the Governors on Tuesday the Pro-Chancellor (Mr. A. J. Hobson) spoke of the war work done by the University.

Mr. Hobson referred especially to the founding of the new department of glass technology, which had received Government as well as trade support. To meet capital expenditure grants had been received of £1,500 from the Advisory Council of the Privy Council, £2,000 from the Glass Manufacturers' Association, and £3,000 from the Ministry of Munitions, while the Advisory Council of the Privy Council had also given an income grant of £1,200 a year.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

13,585 THOROARSON. Electric transformers.
15,003 B.T.-H. Co. (G.E.Co.) Systems of electric ship propulsion.
15,185 B.T.-H. Co. (G.E.Co.) Alternating-current electric motors.

Relates to a single-phase induction motor having two displaced primary windings, one of which is provided with phase-advancing means and a secondary winding having high impedance when the slip is large and low impedance when the slip is small.

15,287 RELAY AUTOMATIC TELEPHONE CO. & AITKEN. Automatic and semi-automatic Telephone systems.
17,834 WILSON. System of electric welding.

1916 SPECIFICATIONS.

859 SIEMENS & HALSKE AKT. GES. Electrical relay systems. (10/4/15.) 100,262.

The circuit to be supervised is carried in series through two or more contact devices which are controlled by the alternating current, so that as long as latter is flowing the circuit to be supervised is always interrupted by one or other of the said contact devices. The arrangement is such that the one half-wave of the alternating current removes the armature of the one relay (or the armatures of a group of relays) from the corresponding fixed or stationary contact. The other half-wave in a similar way removes the armature of the other relay or the armatures of the other group from the corresponding fixed or stationary contact. Thus the local or supervised circuit is kept open constantly so long as the alternating current is flowing.

1,628 REUSS, E., and ROBERTS, V. Electrolytic apparatus for laundry and other hygienic purposes. 101,820.
2,600 LANDIS & GYR SOC. ANON. Electric supply meters. (22/2/15.) 100,109.
3,062 AUSTIN, A. T. Sparking plugs for internal-combustion engines. 101,828.
9,139 BARRACLOUGH, W. Switch-operating mechanism for use with electric transformer starters and the like. 101,853.
9,826 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Time limit electric relays. (12/7/15.) 100,892.

An induction motor-type electric relay in which the magnetisable core is provided with a main winding, a secondary winding and four auxiliary windings, two of said auxiliary windings being connected in series with said secondary winding and the primary winding of an easily saturable transformer, the secondary winding of which supplies current to the other two auxiliary windings of the relay which are wound so as to oppose the first two auxiliary windings.

12,015 BIDDLE, W. H. Means for producing audible signals on trains (18/8/15.) (Divided application on 11,941/15.) 101,857.
12,400 HOLMES, W., HOLMES, E. T. D. & HOLMES, H. S. Signalling apparatus for mines and the like. 101,858.

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 19, 1916.

14,842 MORRIS, TRITTON, WILSON & METROPOLITAN CARRIAGE, WAGON & FINANCE CO. Electric apparatus controlled from a distance.
14,849 COLLIE. Gland for passing electric cables through bulkheads or decks.
14,859 BLADES & BRITISH INSULATED & HELSBY CABLES. Electric multi-core cable dividing boxes, &c.
14,886 MIDGLEY. Dynamo-electric machines.

October 20, 1916.

14,927 BILL. Electric cut-outs and distributing boards.
14,930 COMSTOCK. Controlling electric arcs. (20/10/15, U.S.)
14,946 COOKE. Magnets for magneto-electric machines.
14,949 OULIANINE. Transmitting apparatus for electric signalling.
14,957 OULIANINE. Electric relays.
14,960 OULIANINE. Automatically-controlled relay commutators.

October 21, 1916.

14,975 ETCHELLS & GREAVES. Conductive hearth for electric furnaces.
14,983 SHARMAN. Electric signalling systems.
15,007 ANDERSON & ELLISON. Electric motor controllers, &c.
15,008, 15,009 & 15,010 JULLIN. Regulating voltage of dynamos. (9/6/14, 16/6/14 & 28/7/14, France.)

October 23, 1916.

15,023 LAWRENCE & MAVOR & COULSON. Carriers for fusible electric cutouts.
15,033 CRAWFORD, SANDERS & PRESTON. Contacts for electric switches, &c.
15,053 CAR[illegible]E. Electric candle fittings.
15,051 ANDERSON. Control switches for electric measuring apparatus. (11/11/15, Sweden.)
15,072 BIGUET & PERI. Vacuum tubes of audion type. (23/10/15, France.)
15,076 VAN WIJK. Overload electric switches or cutouts. (15/6/16, Holland.)
15,077 HAY & SULLIVAN. Loading coils for superimposed telephony, &c.
15,078 HEMMING & WESTLAKE. Sparking plug.
15,079 MARSLAND. Order telegraphs.

October 24, 1916.

15,089 KNIGHT. Reciprocating hammers, &c., by means of electric driving.
15,095 HALL. Electric flash lamps.
15,123 EDWARDS. Automatic electric plug and switching contrivance.
15,137 WHEELER. Electrolytic cells. (30/10/15, U.S.)
15,147 SOC. ELEC. METALLURGIQUE FRANCAISE. Manufacture of hollow ingots. (15/12/15, France.)

October 25, 1916.

15,153 ELLIS & PETERSEN. Electrical radiant heat fire.
15,177 COULSON. Portable electric signalling lamps.
15,187 RENFREW & BRITISH ELECTRIC TRANSFORMER CO. Electric transformers.
15,274 BETHENOD. Generation of sustained electric oscillations for wireless telegraphy and telephony. (5/11/15, France.)

October 26, 1916.

15,236 HAMILTON & HOLLAND. Electrodes for furnaces.
15,242 STOBIE. Electric heating and melting furnaces.
15,252 WHITE. Uniting metals, &c., by electric welding.
15,2[illegible] [illegible], EVERETT & HAMILTON. Electric measuring instruments.
15,[illegible]69 HOLLANDSCHE ELEMENTENFABRIEK JULIANA. Batteries for pocket lamps. ([illegible]/10/16, Holland.)
15,[illegible]00 WA[illegible] (Mills.) Electric current rectifiers.

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COMMERCIAL TOPICS.

Registration of Firms. After many delays and after a good deal of agitation there appears to be a good prospect of the Registration of Business Names Bill being passed this year. The Bill has already been through the House of Lords, and the Committee stage in the House of Commons was taken last week, when several amendments were made and the Bill was ordered to be reported. A report of the proceedings is given in another column. The scope of the Bill has been much widened, and it will now be necessary for every firm to register—(1) if the name of the firm does not disclose the actual names of the partners, and (2) if the firm or any of its partners have changed their name at any time. If any of the partners are of foreign origin they must, if they have changed their name, register their original name and their country of origin. Moreover, these particulars must appear on the business letter paper of firms.

The Report Stage was taken on Tuesday, when further amendments were made. A full report of the proceedings is given in another column, and it will be seen that the scope of the Bill was further widened. Though we are in favour of the general principles of the Bill, we are not sure that the penal clauses do not require some modification in order to make sure that British trade and business do not suffer. At present the Bill applies to every firm or person, British as well as foreign, having a place of business in the United Kingdom and carrying on business under a business name which does not consist of the true surnames of all partners. All these firms and persons must register under penalty of a fine of £5 for every day's default, and anybody may commence proceedings. Moreover, the courts of law are not to enforce contracts entered into by firms or persons who omit to register, during the time they are in default, unless the court sees fit to give them relief. Every registered firm must put the registered particulars in every catalogue, circular or business letter it sends out, in default of which there is a fine.

* * * *

Economy in Metals. The Minister of Munitions has appointed a committee, under the chairmanship of Mr. C. W. Fielding, to advise him upon the steps which can be taken to secure the most economical use of the metals required in the manufacture of munitions of war.

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After War Industrial Problems. There was an interesting discussion at the last meeting of the North-east Coast Institution of Engineers and Shipbuilders on three papers on "Works Organisation," with particular reference to after-war conditions.

Mr. D. B. Morison, managing director of Messrs. Richardsons, Westgarth & Co., made an important contribution to the discussion. He regretted there had not been a fourth contributor, namely, Mr. Radcliffe the trade union delegate of the A.S.E., for, in order to obtain progress in industry, which from now onwards was of vital importance to the nation, it was imperative that labour should not only be sympathetic, but that it should be actively helpful. Papers such as those delivered afforded a display of prophetic possibilities, but in order that these possibilities might materialise they must appeal to labour so strongly as to secure its enthusiastic co-operation. Yet, what did we find? Never in his experience had so much time been frittered away by business men as had been wasted by those in control of war work in attending meetings to consider incessant trade union demands, many of which were so trifling that they could, without any danger whatever to trade union principles, be left for settlement until after the war. After citing examples of these, Mr. Morison said he had looked in vain for a reference in the papers to the imperative necessity for the active assistance of labour in the promotion of industrial progress. Mr. Parsons, in his paper, did say: "Whether the works are large or small, whether the apparatus manufactured is standard or special, the human element is bound to play an all-important part. No works can ever be independent of this factor; indeed, the co-operation of individuals and departments is so vital that it may well be considered as the foundation of the system." This was what may be termed the "delicate touch," but what was required were sledge-hammer blows before an impression could be made on our fatuous optimism. For many years he (Mr. Morison) had been intimately familiar with what may be termed "Continental industrial methods," and after every visit he had returned hopelessly pessimistic, because of our sluggish reluctance to see what was going on under our very eyes; and he ventured the opinion that, had there been no war, another twenty years would have left us high and dry industrially. When every other country had found the advantage, indeed, the necessity, for co-operation in research, standardisation of product, and community of commercial interests, not a few manufacturers in our own district had as a goal the ruin of each other by suicidal competition, the stronger speculating on the possibility of crushing the weaker, with the result that every one emerged from the fray necessarily poorer, and in a more or less dilapidated financial condition, from the opulent magnate who could pay an occasional 5 per cent., to the impoverished competitor who had difficulty in "carrying on." On the labour side we had had the recognised policy of restricted effort with the deliberate object of minimising output, and so spreading a given demand over the longest possible period. We knew such a policy led to financial ruin, that it was fundamentally and economically unsound, that if the policy was persisted in we should be hopelessly outclassed by foreign competition, and we knew that for the past twenty years restriction had been preached as a religion, and that to a trade unionist it was now a first principle. He believed the leaders of labour had at last had their eyes opened to the economic fact that high wages must be accompanied by high production, and that they were wishful to correct the teachings of the past, but unless the rank and file understood that the conditions arising out of the war demanded that deliberate restriction should give place to maximum effort, with corresponding remuneration, there would be, before many years, unparalleled industrial chaos in this country.

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British Creditors of Enemy Firms. In the House of Commons on Tuesday the Chancellor of the Exchequer (Mr. McKenna) stated that all debts returned by British creditors of enemy firms under the Proclamation of Sept. 7, 1916, were being recovered by the custodian.

The returns numbered some 17,500, amounting to £79,000,000. Returns were still daily being received. The approximate value of enemy assets now being vested in the Public Trustee was £10,000,000.

In reply to a question as to what steps had been taken to establish a clearing-house in this country where British creditors of enemy firms and individuals could receive payment of their debts from the moneys belonging to enemy firms now in the hands of the Public Trustee, Mr. McKenna said the suggestion had frequently been considered, but the establishment of a clearing-house had been found to be impracticable while the war continued, unless it was proposed to confiscate the property of individual enemies in this country for the benefit of creditors of other enemies. Such a step undoubtedly would lead to reprisals and a further complication of the situation, and any scheme of the character proposed required the consent of the departments concerned and the assistance of the enemy Governments.

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Fiduciary Position of Companies' Employees. An interesting action is reported in our legal columns, which raised the question of the position of a company's servants who had, with the consent of the managing director, but without the knowledge of the other directors, formed a subsidiary company to act as agents, &c., of the company which employed them. The judge held that the latter company was entitled, on discovering the facts, to repudiate a contract for the delivery of goods.

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Trade Policy after the War. It is reported that the Committee, which is presided over by Lord Balfour of Burleigh, has presented its report to the Cabinet. The report, which deals with the resolutions passed at the Paris Trade Conference, is not supported by all the members of the Committee and the Cabinet are engaged in considering the situation.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Nov. 18, 1916, *to* Nov. 24, 1916.

IMPORTS.

Folkestone.—*France:* Elec. carbons, 17 c.s.; elec. apparatus, 10 c.s.

Liverpool.—*Spain:* Elec. carbons, 24 c.s.

London.—*U.S.A.:* Wire and cable, £422; elec. machinery, £4,161; carbon candles, £38; glow lamps, £300; unenumerated, £7,318. *Holland:* Elec. glow lamps, £114; elec. lamps, 116 pkgs.; elec. machinery, £300. *Japan:* Glow lamps, £107; unenumerated, £2,844. *Switzerland:* Unenumerated, £25. *France:* Carbon candles, £1,221; glow lamps, £280; elec. counters, 21 c.s. *Canada:* Unenumerated, £117. *Denmark:* Unenumerated, £1,350. *Norway:* Unenumerated, £1,270. *Italy:* Unenumerated, £470.

EXPORTS.

To Australasia.—*Auckland:* Unenumerated, £437. *Melbourne:* Wire and cable, £5,039; elec. machinery, £93; elec. meters, £54; unenumerated, £1,003. *Sydney:* Elec. machinery, £1,304; elec. lamps, 3,630 n.o.; wire and cable, £85; unenumerated, £1,012. *Wellington:* Elec. machinery, £178; unenumerated, £1,392. *Lyttelton:* Wire and cable, £157; unenumerated, £22. *Adelaide:* Unenumerated, £83. *Christchurch:* Unenumerated, £173. *Brisbane:* Wire and cable, £1,963; unenumerated, £197. *Dunedin:* Wire and cable, £14. *Hobart:* Unenumerated, £51. *Broome:* Unenumerated, £45. *Perth:* Unenumerated, £67.

Africa.—*Durban:* Elec. machinery, £763; elec. lamps, 4,000 n.o.; unenumerated, £1,523. *Cape Town:* Elec. machinery, £198; unenumerated, £1,048. *Port Elizabeth:* Elec. machinery, £347; unenumerated, £112. *Ascension:* Unenumerated, £14. *Mauritius:* Unenumerated, £23. *East London:* Elec. lamps, 2,600 n.o. *Zanzibar:* Elec. crane, 44 tons.

Morocco.—Unenumerated, £10.

Malta.—Telegraph material, £26.

Egypt.—*Alexandria:* Telegraph material, £52; unenumerated, £86. *Port Said* Elec. machinery, £160.

Canary Islands.—Wire and cable, £170.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Unenumerated, £375. *Calcutta:* Elec. wire and cable, £65; elec. lamps, £164; unenumerated, £348. *Madras:* Elec. machinery £257; unenumerated, £1,036. *Ceylon:* Unenumerated, £180 *Singapore:* Telegraph material, £100; wire and cable, £58; unenumerated, £307. *Bankok*, elec. machinery, £602; unenumerated, £620. *Penang:* Unenumerated, £649. *Karachi:* Elec. lamps, 7,700 n.o. *Kilindini:* Elec. machinery, £81; telegraph material, £65.

China.—*Shanghai:* Elec. lamps, 1,250 n.o.; unenumerated, £1,127. *Hong Kong:* Wire and cable £40; unenumerated, £18. *Hankow:* Elec. machinery, £133.

Japan.—*Tokio:* Unenumerated, £192.

South and Central America.—*Buenos Ayres:* Unenumerated, £581. *Seconde:* Unenumerated, £25. *Rio de Janeiro:* Telegraph material, £131. *Montevideo:* Unenumerated, £49. *Chili:* *Mejillones:* Unenumerated, £42. *Puerto Mexico:* Elec. lamps, 12 n.o.; unenumerated, £13.

Holland.—*Amsterdam:* Wire and cable, £280; unenumerated, £160. *Rotterdam:* Wire and cable, £382; unenumerated, £54.

France.—*Paris:* Elec. machinery, £17; unenumerated, £53. *Bordeaux:* Unenumerated, £587. *Calais:* Unenumerated, £90.

Gibraltar.—Elec. machinery, £89; unenumerated, £27.

Norway.—*Trondhiem:* Unenumerated, £370.

Sweden.—*Gothenburg:* Telegraph material, £202.

Portugal.—*Lisbon:* Unenumerated, £49.

Italy.—*Genoa:* Unenumerated, £225.

Russia.—*Vladivostock:* Elec. machinery, £619.

Canada.—*Quebec:* Unenumerated, £40. *St. Johns:* Elec. machinery, £49.

U.S.A.—*New York:* Unenumerated, £826.

FOREIGN GOODS (duty paid and free).

Calcutta: Unenumerated, £76. *Auckland:* Unenumerated, £32. *Bombay:* Unenumerated, £34.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The Indo-European Telegraph Co. notify that the whole of the radio-telegraphic business hitherto carried on by them has been transferred to Messrs. Creed & Co. (Ltd.), of East Croydon, to whom should be addressed all communications on subjects previously dealt with by the Indo-European Co. The Board of Creed & Co., Ltd. (until recently known as Creed, Bille & Co., Ltd.), has been enlarged to accommodate (amongst others) two directors of the Indo Co.

Owing to the Government having taken over Canada House, Kingsway, W.C., for the period of the war, the Fuller Electrical & Mfg. Co. have temporarily removed to Old Serjeants' Inn chambers, 5, Chancery lane, London, W.C. Their telephone number and telegraphic address remain unchanged.

Shares for Sale by Tender.—The Public Trustee invites tenders for the purchase of the whole (or any part) of 26,001 £1 preference and 7,400 £1 ordinary shares of the Sterling Telephone & Electric Co. (Ltd.), vested in him as Custodian by an order of the Board of Trade dated Aug. 1, 1916. Tenders are to be delivered to the Public Trustee (Mr. C. J. Stewart), Kingsway, London, W.C., by noon on Friday, Dec. 8. Forms of tender from the Public Trustee or from Messrs. W. B. Peat & Co., 11, Ironmonger-lane, London, E.C. Particulars of the issued capital, profits, location of offices and works, &c., are given in an advertisement.

The Public Trustee also invites tenders for the purchase of 2,090 ordinary shares of £1 each (fully paid) in the Flottmann Engineering Co. (Ltd.). The issued capital of the company consists of 3,600 fully paid ordinary shares of £1 each. The company owns leasehold works at Cardiff, equipped for the manufacture of Flottmann compressed air hammer drills, &c., but is at present engaged mainly on munition work as a controlled establishment. Tenders must be delivered to the Public Trustee, Kingsway, London, W.C., at or before noon of Friday, Dec. 15. *Further particulars are given in an advertisement.*

Plant for Sale.—Messrs. Marshall, Sons & Co. (Ltd.), 79, Farringdon-road, London, E.C., advertise for sale a Willans high-speed enclosed engine direct coupled to Siemens c.c. dynamo, 230 v., 500 amperes, 350 revs.

Sale by Auction.—Messrs. Brodie, Timbs & Co. will sell by auction at 10, Campden-hill-square, London, N.W., on Thursday, Dec. 7, some photographic, electrical and scientific instruments, including cameras, optical lantern, and about 200 slides, cinematograph camera and projector, Ayrton-Mather galvanometer, Wimshurst machine, optical bench, transformers, &c. Catalogues of the Auctioneers, Weavers' Hall, 22, Basinghall-street, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A second and final dividend (1s. 10⅝d.) will be payable on Dec. 4 at 132, York-road, S.E., to creditors of Jas. Brockie, mechanical engineer, 41, London-road, Forest Hill, London, S.E.

Claims against the Leitner Electrical Co. (Ltd.), Maybury, Woking, are to be sent by Dec. 14 to the liquidator, Mr. G. E. Corfield, 119, Finsbury-pavement, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Poplar (London).—The London County Council have been asked to sanction the borrowing of £4,236 by the Borough Council for laying electric supply mains, &c.

Willesden.—The effect of the Daylight Saving Act during the midsummer quarter reduced the revenue from private lighting by £518 below the corresponding period of 1915.

The electrical energy purchased from the North Metropolitan Power Co. during the two summer quarters amounted to 2,735,843 units, or 110,398 units above the estimate. The cost had been £8,218, or £590 less than estimated, due to the improved load factor and to the greatest care being exercised in the use of the battery. The average cost per unit compared with the previous year was 0·725d. in the June quarter (against 0·781d.) and 0·717d. in the Michaelmas quarter (0·828d.).

In October, 1914, the Council agreed to lay a new feeder to Willesden Green Library, the cost thereof being included in a loan of £21,000 sanctioned by the L.G. Board in August, 1914. Owing to the restrictions upon borrowing the work was not proceeded with, but the electrical engineer (Mr. A. W. Blake) urges the importance of this being done at an early date in order to avoid the possibility of interference with the supply of current to factories in the district. Application has, therefore, been made for sanction to a loan of £5,000 for the work. As sanction has been received to a loan of £2,887 for the extension of mains and the erection of two transformers for giving a supply of alternating current to a company and to certain works in the district, Mr. Blake has been instructed to take all necessary steps to expedite the work in view of the urgency of the demand.

The committee having considered a letter from the Board of Trade on the possibility of linking-up electrical undertakings, view the proposal favourably, and the Electrical Engineer has been instructed to make such inquiries as will show whether the suggested reciprocal supply in the Metropolitan area may be utilised to the advantage of Willesden.

GENERAL.

Aberdeen.—Coun. Thos. Gibb has been re-elected Chairman of the Electricity Committee and Coun. Alex. B. Robertson of the Tramways Committee.

Aylesbury.—It was reported at the last meeting of the Council that 38,424 units of electric current had been generated during September, against 37,611 in August.

The engines continued to run successfully on tar oil, and the fuel costs were 0·51d. per unit, against 0·74d. when running exclusively on American oil. The trouble with the blocking up of the pulverisers had practically been overcome by the fitting up of three-way cocks to the paraffin oil tanks and at intervals running on paraffin.

Electricity in Copper Mining.—At the recent meeting of the Tanganyik Concessions (Ltd.), it was stated that it was proposed to put down an installation to produce 50,000 tons of electrolytic copper per annum by the application of the hydraulic power scheme planned by the Swiss engineers sent out by the Union Minière Co. some years ago.

Exeter.—The Electric Lighting Committee reported to the Council last week that, owing to the order of the Ministry of Munitions restricting the manufacture of copper wire and cables to that necessary for work certified to be of national importance, no further cable was available at present for connections to ordinary consumers.

Kilmarnock.—Mr. Lorimer has been appointed convener of the Electric Committee.

Kiveton Park.—The Rural Council has appointed a sub-committee to report on the refuse destructor and sewage disposal works, and the surveyor has been asked to report on the feasibility of substituting electrically driven machinery in place of the present steam driven engines and pumps.

Nottingham.—Employés of the electricity department have been granted 1d. extra per hour on the hour basis, and 1s. per day on shift, with equivalent advance to all piece rate workers.

West Ham.—The electrical engineer (Mr. J. W. Beauchamp) having reported upon the difficulties experienced in regard to the 5,000 kw. generator and the arrangements which he had made for repair, the Electric Lighting and Tramways Committee have instructed him to bring up a further report upon the matter, and also to report upon the general question of the capacity of the plant at the station.

The Electrical Engineer having asked for instructions with regard to furnishing certain statistics and information concerning the electricity department which had been applied for in connection with the proposed linking up of electricity supplies, the Committee authorised him to give such data from time to time as might, in his opinion, be advisable.

York.—The street lighting is to be improved, and in future more than half of electric lights, which were previously out of use, will be in use again.

TRACTION NOTES.

Birmingham.—The Committee of Production has awarded the workmen in tramway, electric supply and gas departments of the Corporation an advance of 2s. 6d. a week.

The chairman of the Electric Supply Committee (Ald. Jephcott) has announced that the committee hopes to be able to give sufficient current to enable an attenuated service of cars to be run during the hours at which at present there is a total stoppage. The work of repair and extension at Nechells power station is making progress, and the committee anticipates that the new 6,000 kw. turbine and generator would be installed by the middle of this month.

Dublin.—A new electric tramway service between Fairview and Westland-row, via Lower Abbey-street, has been recently inaugurated.

Newcastle-on-Tyne.—The tramway service will cease at 10:0 each evening in future.

Tramway Services during Fog.—At the meeting of the L.C.C. on Tuesday the Highways Committee reported on the tramway service during the dense fog which prevailed in the metropolis on November 13.

It was stated that, notwithstanding the difficulties encountered, the car services were well maintained, the tramcars, by reason of the certainty of their route and direction, having fewer difficulties to contend with in comparison with other forms of road traffic when fog prevails. There could be no doubt that the manner in which the tramway service was maintained on the evening in question was of considerable advantage to the travelling public, many of whom, but for the tramways, would have experienced the greatest difficulty and delay in travelling under the weather conditions then obtaining.

West Ham.—Owing to the extra responsibility placed upon Mr. Hopkins, the chief assistant of the tramways department, during the change of managers, a gratuity of £20 has been voted to him by the Corporation.

TELEGRAPH AND TELEPHONE NOTES.

Radiotelegraphy in S. America.—A radiotelegraphic station was inaugurated recently at Viacha (Bolivia), which permits of communication with Argentina.

Radio-Telegraph Apparatus on Dutch Ships.—"Het Volk" announces that a Dutch company is being formed with the support of various big shipowners for the manufacture and delivery of apparatus for wireless installations on board Dutch and other ships with a view to being independent of the Marconi and Telefunken Companies.

Wages in Australian Postal-Telegraph Service.—In the Commonwealth Court of Conciliation and Arbitration Mr. Justice Higgins recently agreed to vary the award of 1913 with respect to wages to be paid by the Postmaster-General to men in the electrical branch of his department.

The 1913 award fixed £168 per annum for electrical mechanics, the most numerous class in the branch, and the men asked that, in view of the abnormal cost of living, the rate should be increased to £198. His Honour decided that £191 should be the minimum. He proposed to vary his award by adding £18 a year to the several minimum wages mentioned in the class, excepting as to lads under 21 years, whose pay must be increased proportionately. His Honour's award granted the following increases: Junior mechanics, 14 years, £39 to £45; 16 years, £54 to £66; 17 years, £66 to £78; 18 years, £84 to £96; 19 years, £102 to £114; 20 years, £120 to £132; 21 to 22 years, £132 to £150; 22 years and upwards, £144 to £162. Battery men, £138 to £156; foremen battery men, £186 to £204. Mechanicians are to be entitled to a maximum salary of £420. The variations in the case of the maintenance union are: Linesmen, £150 to £174; men in charge and senior linesmen, £130 to £198; line foremen, £198 to £222; line inspectors, £228 to £276. Line inspectors are to be entitled also to such further or greater increments as the commissioner shall determine, up to a maximum of £372. Exchange foremen, mechanics and inspectors are to be entitled to a maximum salary of £324.

EMPIRE NOTES.

Australasia.—Kandos (N.S.W.) is to be lighted electrically by the Kandos Cement Co.

The New South Wales Parliament have recently passed an Electric Lighting and Gas Emergency Act. The State Government has issued a proclamation to enable the City Council to conserve the coal resources in the event of the strike continuing. Under the proclamation the use of electricity for lighting is prohibited excepting for public institutions and streets. Electric power is also prohibited excepting for works connected with water supply, sewerage and the manufacture of foodstuffs.

Renark (S. Australia) Council has taken over the local electricity supply works, and it is proposed to add a new 75 kw. unit.

Electric power is to be used in connection with the irrigation scheme which has been adopted for the Inkerman (Queensland) district.

Melbourne City Council recently adopted a report of the Electricity Supply Committee recommending the installation of additional generating plant, in order to meet the growing demands for power. The Committee recommended an additional 5,000 kw. generating set, to be in operation during the winter of 1918, the cost (ex customs duty) being estimated at £22,500. Ald. Cabena, chairman of the Committee, stated that this year the demand for electric supply had increased by nearly 20 per cent., and there was reason to believe that that rate of progress would be maintained.

The President of the Victorian Legislative Council (Mr. J. M. Davies) recently introduced a deputation representing the City Council to the Premier (Sir Alex. Peacock) to protest strongly against the supposed proposal of the Government that the new Metropolitan Tramway Trust should take over the control of the Council's electric supply undertaking. The Lord Mayor, Sir D. V. Hennessy, said for some time after the commencement of the concern, which had been established in 1894 to supply light and power, the Council had had to bear heavy losses. Through careful management the undertaking was now one of the Council's principal sources of revenue, and had been the means of keeping the rates down. If the Council were deprived of its electric supply business it would probably have to impose an additional 5d. or 6d. on the rates, and with the increased taxation rendered necessary to meet the war expenditure the rates would probably have to be advanced another 8d. The tramways, if electrified, would not consume for the whole of Melbourne more than £100,000 worth of current a year. At present the turnover of the Council's electric undertaking represented over £200,000 a year for lighting and power.

Ald. Cabena, chairman of the Electricity Supply Committee, said it the electrical undertakings were taken over by the Government they would not be so carefully managed, and it would be unfair if the Government took over a business yielding a profit of £48,000 a year without paying the Council compensation.

The Premier replied that the statement by the City Council that the Government proposed to give the suggested new tramway authority power to acquire compulsorily the Council's electrical undertaking without compensation or allowance for loss of profits was made under a misapprehension. The Cabinet had appointed a sub-committee to draft a Bill and submit a report to Cabinet regarding any proposals. When the question was under consideration the representations of the deputations would receive consideration.

Some time ago a Melbourne syndicate applied for permission to employ the waters of the Kiewa River (Victoria) for the generation of electricity, with the object of selling it in country districts, and parts of Melbourne. The matter was brought to the notice of the Victorian Minister of Water Supply (Mr. H. McKenzie), who was asked to extend the syndicate's tenure of water rights to 50 years. The Minister said the Water Commission had no objection to the proposed use of the water, but he could not undertake that the necessary Bill would be introduced this session.

Wellington (N. Z.) Council has decided to extend the tramways along Waterloo Quay and, if the necessary material can be obtained, to carry out a further duplication of the Island Bay line.

The people of Elmore (Victoria) are considering the question of electric supply. Elmore has a population of about 700, and kerosene is used for street lighting. At a recent meeting of residents it was resolved that Huntly Shire Council be asked to consider the erection of a municipal plant to supply Elmore with electric light and power, or, alternatively, that the Council forego its right in favour of a suitable company.

South Africa.—A report has been prepared by a Committee of the South African Institute of Electrical Engineers on the possibilities of manufacturing in South Africa, by the aid of electrical power, several products of commercial importance which are necessary for the agricultural and mining industries which require annually £2,000,000 worth of fertilisers, cyanide and nitrates.

The essential elements for the manufacture of these materials exist in

South Africa. Estimates are given for the manufacture of calcium carbide, and cyanamide and derivatives of cyanamide, &c., with the cost of the electric power required.

The report for 1915 of the South African Mining Engineer states that new machinery and plant introduced into mines in the Union during 1915 were valued at £606,682. Amongst the chief items were steam engines and compressors £16,240, electric generators and engines, hoists, locomotives, and motors, £90,143, power lines, transformers, bells, telephones, &c., £80,180. Amongst the most important items were electric winders for mines and increases in the electrical plant at central power stations in the Eastern Rand district, while new power lines, transformers, bells, telephones, &c., to the value of £11 223 were introduced into diamond mines in Cape Province.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Argentine National Government has authorised an expenditure of $198,659.45 m n. (about £17,500) on the first section of an electrical installation at the Asilo Colonia Regional de Niños Abandonados in Olivera (Province of Buenos Ayres).

On Sept. 28 the main power station of the Compañia Italo-Argentina de Electricidad was formerly inaugerated. Till the advent of this concern, says the "Review of the River Plate," the Compañia Alemana Transatlantica de Electricidad exercised a vitual monopoly of the electric supply industry. The new company some time ago secured, in competition with its powerful rival, an important Government contract for the supply of current for the port of the capital. It is supplying current also to about 12,000 private consumers, besides having obtained a substantial participation in the electric lighting service of the city of Buenos Ayres. The concession was approved by the Municipal Council on Oct. 1, 1912, and the company, with the collaboration of Messrs. Franco Tosi, Pirelli & Co., and Brown, Boveri & Co., commenced the construction work at the end of 1913. The capital invested in the company up to date is about £2,000,000. There are five stations which are both generating and transformer stations, the generating plant consisting of Diesel type engines, made by Franco Tosi, each of 800 H.P., each driving a 500 kw. dynamo, and there are 13 such units total 6,500 kw. The transformers used aggregate 10,560 kw. and were made by Brown, Boveri & Co., while many accessories were manufactured in Buenos Ayres by the Cia Industrial de Electricidad. The cables were supplied by Pirelli & Co., and a length of 744 miles has been laid. The company has supplied current for some time to 1,400 arc lamps for the municipality, and the number will soon be increased to 2,000. Supply to about 1,600 arc lamps in the port of the capital was also commenced recently. At the main steam power station there are eight boilers, using oil as fuel, and these with the economisers, pumps, &c., were supplied by Franco Tosi, while of the three 6,000 kw. turbo-generators, two were made by Brown, Boveri & Co., and the third by Franco Tosi. A third set of from 10,000 kw. to 12,000 kw. is to be delivered by Brown, Boveri & Co. early next year. Three phase current is generated by the turbo-generators at 50 cycles, and from 6,000 to 7,000 volts between phases. The h.t. switchboard was also supplied by Brown, Boveri & Co.

Colombia.—It is stated that Tumaco municipality, following the example of the city of Buentaventura, proposes to establish electricity supply works.

France.—The Budget Commission has decided to raise the postal, telegraph and telephone rates.

It is estimated that the additional receipts will amount to £2,400,000 sterling. Telegrams up to 50 words will pay a supertax of 2½d., and above 50 words 5d. The pneumatic post rates will be 4d. and 7½d. Telephone rates will be: Private, £18 yearly, instead of £16; service flats, £20; cafés, hotels, &c., £32.

Italy.—A decree has been promulgated as to new financial measures estimated to produce an additional revenue of 200 million lires, or about £8,000,000 per annum. They include an increase in the tax on war profits, an increase in the tax on automobiles and a revision of the telegraph and telephone tariffs.

Portugal.—Concessions have been granted to Senhor M. P. de Miranda Montenegro, of Castelo de Paiva, for the use of the waters of the river Paiva, at two different points in the Aveiro district, for the generation of electrical energy. Two hydro-electric power stations are to be established, each having three 2,500 H.P. turbo-generators.

State Electricity Supply in Saxony.—The Saxon Diet recently passed a law authorising the erection of a State monopoly of electricity supply, and has also voted £1,000,000 for this purpose.

MISCELLANEOUS NOTES.

Application for Restoration of Lapsed Patent.—Huntalite (Ltd.) has applied for the restoration of the Patent granted to Christopher Harvey for "Improved incandescent electric lamp and holder therefor" (No. 23979/1911), which expired Oct. 30, 1915.

Enemy Firms Wound Up.—The Board of Trade have ordered the winding up of 370 businesses controlled by alien enemies.

The following are included in the latest list: Rochester Engineering Co. (Ltd.), Rochester, Kent, engineering company making machinery for cement works (Controller, A. Dangerfield, 56, Cannon-street, E.C.); Meyer & Co., 47, St. Paul's-square, Birmingham, export hardware mechant (Controller; J. W. G. Hill, Sun-chambers, 9, Bennett's-hill, Birmingham); New Polyphon Supply Co. (Ltd.), 2, Newman-street, London, W. (Controller: J. H. Stevens, 6, Clement's-lane, E.C.); Sanitas Electrical Co., 61, New Cavendish-street, London, E.C., dealers in medical electrical apparatus (Controller: Jas. Fraser, 31, Copthall-avenue, E.C.).

London Street Accidents.—The Home Secretary has prepared a return showing the number of deaths, persons injured, and the number of accidents known to the police to have been caused by tramcars, motor-omnibuses and other motor vehicles in the Metropolitan Police District in 1914 and 1915 and up to the end of October in 1916. The tramcar and motor-omnibus figures are:—

TRAMCARS.

	Killed.	Injured.	Accidents.
1914	37	3,171	5,254
1915	86	4,001	6,142
1916	63	3,085	4,594

MOTOR OMNIBUSES.

	Killed.	Injured.	Accidents.
1914	148	3,007	6,251
1915	154	2,572	4,981
1916	135	1,810	3,394

TENDERS INVITED.

Steam Turbines, &c.

SUNDERLAND Corporation invite tenders for the installation of a Steam Turbine, Alternator and Condensing Plant at their Hylton-road electricity works. Specification and forms of tender may be obtained from the general manager, Mr. Alfred [illegible] Blackman, and tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Sunderland, must be delivered at the office of the town clerk, Mr. Henry Craven, Town Hall, Sunderland, by first post Saturday, Dec. 9. *See also an advertisement.*

Telegraph and Telephone Material.

Tenders are required by Dec. 13 for the supply and delivery to the POSTMASTER-GENERAL'S DEPT., State of Queensland, of Caps and Lamps for Switchboard (schedule 388), Covered Wire (schedule 393), and Binders, Sleeves and Tapes (schedule 398); and by Jan. 10 for Conductor (schedule 389), Switchboard Parts and accessories (schedule 392), Measuring Instruments (schedule 396), and Telegraph Instruments (schedule 397). Tender forms, specification, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *See also an advertisement.*

Telephone and Telegraph Material, Stores, &c.

Tenders are invited up to Dec. 22 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492,

Turbo-Alternator and Condensing Plant.

DURBAN Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-alternator and Condensing Plant. Specification (No. S.238) from Borough Electrical Engineer.

Motor-Generator, &c.

DUNEDIN (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

Oil Engine, Generator, &c.

The Deputy Postmaster General, Sydney (N.S.W.), requires tenders by Dec. 14 for the supply and erection at the Telegraph Office, ARMIDALE (N.S.W.), of an Oil Engine and Generator, Switchboard and Accumulators. (Schedule No. 338A N.S.W.) Specifications from the Deputy Postmaster General, Sydney.

Diesel Engines, Dynamos, &c.

The Department of Sanitary Works, BUENOS AYRES, requires tenders by Dec. 11 for the supply of three units each, consisting of a Crude Oil Diesel type Motor with Dynamo and Switchboards and Accessories.

Motors, &c.

CAPE TOWN (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

Meters, Time-Switches, &c.

JOHANNESBURG (Transvaal) Corporation require tenders by noon Dec. 9 for supply of 1,427 House Service Electricity meters, 7 Switchboard meters and 100 Time Switches (specification 104). Forms of tender from the Municipal Offices.

Tramcar Materials, &c.

JOHANNESBURG Corporation require tenders by noon Jan. 3 for Iron Axles and Bushes (contract 163). Specifications, &c., from the Municipal Offices (Room 53).

Pressure Regulators.

JOHANNESBURG Corporation require tenders by noon Dec. 20 for Automatic Pressure Regulators for a.c. Turbo-generators. Specification from Municipal Offices (Room 53), Johannesburg.

Electric Crane and Coal Transporter Plant.

The N.S.W. RAILWAY AND TRAMWAY DEPARTMENT require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Tenders are invited for the supply, delivery and erection in MELBOURNE, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Ppty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders by noon Dec. 11.

Electrical Fittings, &c.

Messrs. Walter Scott (Ltd.), TRIMDON GRANGE COLLIERY, co. Durham, require tenders by Dec. 3 for six months' supply of Electrical Fittings, Iron, Steel, Castings, &c. Forms of tender from the Storekeeper.

Electricity Supply Concession.

Extension of Time.—The time for sending in tenders for Generating and Supplying Electrical Energy for Lighting and Power in ST. GEORGE (Grenada) and its suburbs is extended to Dec. 31. Particulars from Colonial Secretary, Grenada (British W. Indies).

TENDERS RECEIVED AND ACCEPTED

BETHNAL GREEN (LONDON).—The Guardians have accepted the tender of Popes' Electric Lamp Co. for the supply of 1,000 electric lamps at 1s. 3½d. each.

LONDON COUNTY COUNCIL.—The Asylums Committee has accepted the tender of Pope's Electric Lamp Co. for electric lamps for all asylums for five months at £156. 1s.

MELBOURNE (VICTORIA).—The City Council has accepted the tenders of Johnson & Phillips for insulated cable, £7,628, and British Insulated & Helsby Cables for bare copper cables, £1,626.

JOHANNESBURG (TRANSVAAL).—The following tenders have been accepted by the Town Council:—

Telegraph Mfg. Co., 10,000 lb. braided copper wire, £912, and 10 miles underwriters' wire, £1,800; Griffin Engineering Co., 10,000 Edison metal filament traction lamps, £333. 6s. 8d.; Sykes & Co., six 150 k.v.a. Burnand transformers, £900, and spares, £47.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government departments:—

Postmaster-General's Dept., Adelaide.—Unbehaum & Johnstone, 200 accumulator cells (specification 287A), £681. 8s.; Edison & Swan U. Elec. Light Co., apparatus for telegraph power board (specification 573), £124. 8s. 6d.

Postmaster-General's Dept., Brisbane.—Edison & Swan Electric Co. power board for G.P.O. Brisbane, £152. 10s.; Warburton, Franki (Ltd.) 300 80 ampere-hour accumulators, £518.

Postmaster-General's Dept., Perth.—Moreland Metal Co., scrap bare copper wire (about 5⅓ tons), £88 per ton; A. W. Dobbie & Co., 5 tons ditto, £95 per ton.

Department of Defence, Melbourne.—Edison Swan Elec. Co., elec. light globes, £189. 17s.

Public Works Dept., N.S.W.—Strachan, Murray & Shannon, four 5-ton elec. travelling cranes, £4,260.

Victorian Railway Commissioners.—Thompson & Co., railway and electric tramway crossing for Whitehorse-road, Deepdene, £140. 5s.; W. Lucy & Co., fuse distribution boxes and fuses for electrical equipment of Ballarat and Bendigo Workshops, during five years, at rates; Electric Construction Co., motor-generator set (5 kw.) for battery charging of baggage trucks, £195, and switchboard and connections for single-phase motor drive, £233. 10s.; Edison Swan Elec. Co., six months' supply of incandescent elec. lamps, at rates; Gibson, Battle & Co., plant for impregnating elec. apparatus with insulating varnishes, &c., £2,234; R. W. Cameron & Co., transformers during five years at rates.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Gravesend.—The accounts of the electricity department for the year ended March 31 show total capital expenditure on the Gravesend undertaking £87,527 (increase £3,107), of which £55,487 is outstanding.

Revenue was £16,922, and working expenditure and special charges amounted to £11,561 (against £7,727), leaving gross profit £5,361 (£5,571). Interest required £2,219, and repayment of loans £3,560, the net result being a deficit of £595 (compared with a profit of £827). On the Northfleet extension the capital expenditure is £12,947 (increase £383), of which £9,493 is outstanding. Revenue was £3,348 (compared with £1,709), total cost £3,095 (£994), gross profit £203 (£715). Interest required £454 (£309), and repayment of loans £352 (£339), and the net deficit was £703. Units generated were 3,[illegible]0,557 and sold 2,194,019. Total maximum supply demanded was 1,150 kw.

Mr. C. F. McInnes (borough electrical engineer) says in his report the charges for current are temporarily increased by 25 per cent. When fuel is down to 25s. per ton the increase will be reduced to 10 per cent., and when fuel is down to 20s. the increase will be discontinued. The year dealt with by the accounts is the first since 1904 in which there has been a net deficit (£1,298), in consequence of increased cost of fuel and loss of revenue due to lighting restrictions. Average cost of fuel was 29s., compared with 18s. 3d. per ton.

Greenock.—The accounts of the electricity supply department for the year ended June 30 show gross capital expenditure £366,897 (increase £36,787), of which £83,920 has been repaid from revenue.

Revenue was £85,650 (compared with £62,705 in previous year), and working costs were £52,612 (£30,587), leaving gross profit £33,037 (£32,117). Interest and special expenditure required £10,160 (£9,298) and sinking fund and depreciation £15,879 (£12,421), leaving net profit £6,998 (£9,447). The reserve fund now amounts to £32,377 (£24,635). Coal and other fuel cost 0·373d. (0·273d.) per unit sold, total works costs were 0·505d. (0·372d.), and total costs, exclusive of capital charges, were 0·659d. (0·520d.). Maximum load was 7,480 kw. (6,042 kw.) and load-factor 28·99 (26·84) per cent. Units generated were 23,235,816 (16,881,777) and sold 19,001,464 (14,207,575). The number of consumers increased from 1,740 to 1,889.

Mr. F. H. Whysall (chief engineer and manager) says in his report a coal clause was introduced in some of the large power agreements, and a 10 per cent. advance was made in the rates to other large consumers, but ordinary rates to small consumers were not increased. The average cost of coal was 4s. 7d. per ton more than in the previous year and the increased cost of fuel was £7,917. Units generated from the destructor steam were 1,100,085 (4·7 per cent. of the output of the power station). 16,314 tons of refuse were burned, giving 70 units of electrical energy per ton. The new 5,000 kw. Westinghouse turbo-generator was started up early in the year, and the a.c. generating machinery now amounts to 14,000 kw. The publicity work has practically been suspended owing to the war, but a large business was done in radiators, kettles, irons, &c.

Ipswich.—The accounts of the electricity supply department for the year ended March 31 show gross capital expenditure £150,029 (increase £3,623), of which £36,409 has been repaid.

Revenue was £33,969 (compared with £22,886 in previous year), and working expenses were £23,030 (£17,285). Interest required £4,838 (£4,272), instalment of loan £6,787 (£5,786), war service allowances £378 (£199), and contributions for capital outlay £1,022 (£1,199). £2,100 is being taken from the rates to cover the net deficit of £2,086 (including the £1,022 spent on capital works). Units generated were 4,619,209 (3,541,525) and sold 3,734,158 (2,966,968). Maximum load was 1,475 kw. (1,400 kw.) for lighting and power, and 424 kw. (415 kw.) for traction.

Mr. Frank Ayton, engineer and manager, says in his report, the revenue from power and traction was greater by 25 per cent. than that from revenue for lighting. The demand for power (excluding traction) increased by 54 per cent. In the eastern district many more consumers could probably have been obtained if they could have been offered the rental wiring system but the L.G. Board has prohibted such expenditure during the war, except out of revenue. Tenders were obtained, and, Fraser & Chalmers' tender was accepted in February, 1915, for coal handling plant, the L.G. Board sanctioned the work in the autumn and it was only half-way towards completion at March, 1916. The high cost of coal per unit (0·613d.) was due to the use of coal which had deteriorated through weathering, and also coal with high ash content. It points to want of care at the collieries, and Mr. Ayton says the Committee on Coal Saving would be better employed looking into the working of the collieries than adjuring electric supply undertakings to reduce their consumption by methods which will not produce the result aimed at. There are now four electric vehicles, including one owned by the department, running in the town, and another is on order. This new outlet for sale of current is very profitable.

The tramway accounts show total capital expenditure £115,675 (no increase), of which £22,928 has been repaid or provided for repayment. Revenue was £28,286 (£23,288), working expenses were £19,178 (£19,289), war allowances £586 (£236); interest required £3,490 (£3 660), and instalment of loan £2,274 (£2,206), the net balance being £2,756 (compared with a deficit of £2,104 last year). Average total revenue per car-mile was 10·947d. (8·705d.), and working expenses, including power, were 7·422d. (7·210d.). Passengers carried were 6,798,589 (5,610,332), car-miles run 620,115 (642,092), and units used 686,328 (670,809)—1·107 (1·045) per car-mile. Parts of the track (Mr. Ayton says) are badly in need of re-laying, but it is nearly impossible to get new rails rolled at present.

Wallasey.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £233,440 (increase £11,412), of which £47,920 has been repaid or placed in sinking fund, while £71,398 has been applied to reduction of rates.

Revenue was £66,320 (compared with £64,505 in previous year), working expenses £44,568 (£42,454), including war allowances and bonus, interest required £5,769, sinking fund £4,093, and instalments of loans £1,065, and £8,460 has been contributed in aid of rates, leaving a credit balance of £1,938. Average total revenue per car-mile was 12·92d., and working expenses, including power, were 8·01d. Passengers carried 14,306,621 (compared with 13,555,876), car-miles run 1,231,469 (1,284,938), and units used 1,871,658 (= 1·52 per car-mile).

COMPANIES' MEETINGS AND REPORTS.

Amazon Telegraph Company (Ltd.)

The twenty-second annual general meeting was held at 42, Old Broad Street, E.C., on Tuesday, Mr. CHARLES WOODBYNE PARISH (chairman of the company) presiding.

The SECRETARY (Mr. M. S. Munns) having read the notice convening the meeting and the report of the Auditors,

The CHAIRMAN said: Gentlemen, I have received a letter from our colleague, Major Quilter, who has asked me to express his regret to the shareholders that he is unable to attend the meeting to-day, but his military duties have called him away, and it is absolutely impossible for him to be with us on this occasion. Before commencing our business, I wish to refer to the great loss we have sustained in the sudden death of Mr. George Keith, our Chairman and managing director. It is nearly 20 years ago that Mr. Keith was elected a director of this company, becoming in 1902 its chairman and managing director, and since then he has most ably directed our business. He possessed very special qualifications for the responsible post which he held, for he had very considerable technical knowledge, and his long residence abroad as general manager of the Cuba Submarine Telegraph Co. had well accustomed him to all the engineering and other difficulties connected with cable companies in foreign lands. His remarkable patience and perseverance were invaluable in the conduct of our business, and we greatly regret his loss. I would ask you to join with your board in offering Mrs. Keith and her family our deep sympathy in the very heavy loss they have sustained.

I have now to submit for your approval the report and accounts for the year ended June 30 last, which, I am pleased to say, are somewhat better than those we were able to place before you at our last meeting. As you may remember, there was a serious falling off in the Amazon rubber crop during the past two years, but this year, I am glad to say, there has been a slight improvement, the amount of rubber produced being 1,365 tons more than in the preceding year. There have also been greater fluctuations in the price of the commodity this year, which have tended to increase our business. Our traffic receipts show an increase of £3,719, due to an improvement in business during the second half of our financial year, and to an increase of 10 per cent. in our local rates, which automatically came into force on April 1 last, owing to the fall in the traffic during the year 1915. The total revenue, including subsidy, interest and transfer fees amounts to £61,587, or £3,654 more than it was last year. The expenses at stations show a decrease of £1,201, part of which is due to the lower rates of exchange in force during the year. The total expenses in the maintenance of cables amounted to £14,590, as against £16,819 last year, showing the satisfactory decrease of £2,229. Of these expenses the "[illegible]" shows a reduction of £2,935, largely owing to a portion of the cost of extensive repairs having been provided for in last year's accounts; the expenses of the "Ramos" are also slightly reduced, as, fortunately, she is able to burn wood instead of coal for steaming down river, otherwise her expenses would have been considerably increased, as coal on the Amazon is now at famine prices; but, on the other hand, cable used for repairs shows an increase of £1,344, due to a larger number of breaks, &c. The aggregate of the other charges in the revenue account comes out £198 more than last year; and altogether, the working expenses amount to £31,707, or £3,232 less than in the previous year, which I consider a very good result, due largely to the careful manner in which all local expenses have been watched and kept in hand. The results, therefore, show that while our receipts are £61,587, or £3,654 more than last year, our expenditure was only £31,707, or £3,232 less than last year, so we have an actual improvement of £6,886, or a gross profit of £29,880, as against £22,994. From the £29,880 we have provided £13,255 for debenture interest and £9,578 for debenture sinking fund, leaving a balance of £7,047, and from this amount we have the pleasure of proposing a dividend of 3 per cent., less income tax, and adding £859 to the balance carried forward from last year, thus proving the correctness of Mr. Keith's forecast, when he told us last November that he hoped for some "increased activity and better business on the Amazon." As regards the current year, our traffic receipts up to the present are a little higher than they were at this time last year. The rubber crop is expected to again show an increase, and, provided the growers have the advantage of a low rate of exchange and the Brazilian Government do not further increase their duties and taxes, which are already so excessive as to seriously interfere with the proper development of the industry, the prospects on the Amazon appear somewhat brighter than of late. I think, gentlemen, that one of the most responsible duties which fall upon a board of directors is the filling up of any casual vacancy arising from death or otherwise, and when that vacancy occurs from such a loss as we have sustained in the death of Mr. Keith, the difficulty is certainly increased. But I am pleased to tell you that, after careful consideration, we have satisfactorily overcome our anxiety by electing Mr. Nosworthy as a director and have appointed him our managing director. Mr. Nosworthy joined our staff in Brazil in 1897, which, curiously, was the same year as that in which Mr. Keith was elected as a director, and in 1904 he became our general manager. He has had, of course, the entire control of the local business on the Amazon, and he has had the responsibility not only of surveying for new cables, but of laying them, as well as directing the repairing ships, and I may safely say there is nothing about our business or cables which he does not know. He, therefore, brings to our board most valuable knowledge and experience, and I am sure you will join us in giving him a hearty welcome after his long services on the Amazon. I propose that the report of the directors and statement of accounts to June 30, 1916, be approved and adopted.

Mr. E. B. ELLICE-CLARK seconded the resolution.

Mr. F. E. NOSWORTHY said it is unnecessary for me so refer as much length to the early years of the company—how the first cable worked a very short time before parts of it became interrupted; how half of its length had to be relaid about 18 months afterwards, and how this new cable was also subject to frequent interruption. All this is ancient history, but the experience gained during those years enabled us to overcome many of the difficulties encountered, with the result that to day we maintain a very good service. In 1906 the uppermost section, some 76 miles in length, which was most subject to interruption, was duplicated; this improved the service very much, as it was rare for both sections to be interrupted simultaneously. It became evident that the only means by which we could give a satisfactory service was by having two cables the whole of the way between Para and Manaos, and in 1907 Mr. Keith, the late chairman and managing director, instructed me to make surveys with the object of finding, if possible, a new route entirely apart from the main river, or as near so as could be. Two years were spent on this survey, and in the end a suitable route was found. The new cable has a length of 1,094 miles, of which only 146 miles is in the main river, the remainder being laid in lakes and small rivers where there is shallow water, perfect bottom, and next to no current. To make connection between some of these rivers it was necessary to lay some 28 miles of underground cable, mostly through virgin forest. The laying of the duplicate cable was commenced in December, 1909, and completed in February, 1911. It may seem a long time for laying 1,000 miles of cable, but when I say that in some of the back waters we only progressed half a mile or less a day it will be realised there were many obstacles to overcome. Many of these streams were never used, except, perhaps, by canoes, and had become completely blocked with floating islands, through which we had to cut our way and haul through with ropes, small barges and ships' boats being used to carry the cable. Since the completion of this cable it has been interrupted on 28 occasions. Of this total, five have been due to damage by natives, five occurred in the cable of the 1906 upper section duplication, part of which was incorporated in the main duplication; consequently, there have only been 18 breaks in the 1910 duplication, that is, 18 breaks in a period of six years, which is an exceedingly small average, so I think the route selected may be considered successful. At the present time it is very rare for through communication to be interrupted, and an excellent service is being maintained. As regards our prospects in the future, I think we may safely consider we have left the worst time behind us. Rubber, which is the principal product of the district served by our cables, stands at a price, and seems likely to do so for some time to come, which is remunerative to both collectors and merchants. Both the Para and Amazonas State Governments, recognising that if they are to compete with Eastern rubber, the cost of production must be reduced, are encouraging agriculture with the object of producing the necessaries of life locally, instead of importing at high cost. Cultivation of cocoa is also being encouraged again, having been neglected during the times when rubber was fetching such high prices. Brazil generally appears to be making some recovery from the financial crisis which commenced before, but was doubtless aggravated by, the European War. I think we may safely look forward to improving conditions in that part of the world, and that this company will share in them.

The resolution was then carried unanimously, and a dividend of 3 per cent. on the share capital, as recommended by the directors, was declared.

Mr. Ellice-Clark was re-elected a director, and Messrs. Welton, Jones & Co., chartered accountants, were re-elected auditors, a vote of thanks to the chairman and directors and to the staff abroad terminating the proceedings.

AMALGAMATED ZINC (DE BAVAY'S (LTD.)—In the report for the past half year it is stated that experts conducting the electrolytic investigations have reported that the project is commercially sound, with power available at price at which horse-power secured from the hydro-electric department of Tasmania (£2 per horse-power per year). First unit will have a capacity of 10-11 tons of electrolytic zinc daily, and will utilise 4,000 H.P. The unit will demonstrate the commercial soundness of the undertaking under local conditions before the erection of a larger installation is proceeded with. A separate organisation entitled Electrolytic Zinc Co. has been established to handle this project, with a capital of £1,000,000 in £1 shares, of which this company holds 100,000 shares. The directors are of the opinion that the consolidation of zinc producing interests of the Broken Hill Companies under the Zinc Producers' Association will prove of substantial benefit from a national as well as a commercial point of view.

CASTNER-KELLNER ALKALI CO. (LTD.)—The report states that no accounts can be submitted for the year ended Sept. 30, as the directors are not able to estimate the liability of the company for "excess profits" tax. The amount payable for the previous financial year has not yet been settled. The directors announce that the profits have exceeded those of the previous year, and that the business, though carried on under considerable difficulties, is proceeding satisfactorily. As soon as the amount payable for "excess profits" has been ascertained the directors propose to submit the accounts, and suggest that the meeting convened for Nov. 30, after formal business has been transacted, should be adjourned. The auditors think the profits are sufficient to warrant a final dividend of £13 per cent. be declared, which, with the interim dividend of £9 per cent. paid in May, makes £22 per cent. for the year. The usual sum of £5,000 has been paid to the trustees for the debenture stockholders for the sinking fund, and the debenture debt is now reduced from £250,000 to £172,099. During the year the capital of the company was increased to £1,000,000 by the creation of 250,000 shares of £1 each, issued as fully paid to Messrs. Brunner, Mond & Co. in exchange for 200,000 shares of the latter company.

CONSOLIDATED SIGNAL CO. (LTD.)—Mr. S. P. Wood, who presided at the meeting last week, said that the subsidiary companies were distributing £14,347 in dividends, and the company's share was £14,000. After bringing into account sundry other dividends and interest received, and paying expenses, the profit was £14,169, which, added to the amount brought forward, made a total of £19,645. The interim dividend absorbed £5,461. They proposed to pay the balance of the preference dividend and a dividend on the ordinary shares of 6d. per share. Their relations with Government Departments were most excellent, and the reputation acquired for good work and fair dealing would without doubt ensure to them a continuation of orders so long as labour and materials were available; and could additional suitable skilled labour be obtained, all their factories would very materially increase their output. The directors considered that, with the certainty of even more difficult and strenuous conditions ahead, they would not be faithful to their trust if they did not retain a substantial proportion of the year's profits. Certain changes were made in the management of some of the subsidiary companies to secure economies and greater efficiency. Much remained to be accomplished, but only as and when circumstances permitted. It rested to a great extent with organised labour whether the future was to be prosperity or chaos. Limitation of output, if not abolished, would mean certain disaster after the war, as they would then be unable to compete successfully in the overseas markets.

MOUNT LYELL MINING & RAILWAY CO. (LTD.)—The half-yearly report states that the Lake Margaret hydro-electric installation (of 5,000 H.P.) is only just sufficient for present requirements. It has therefore been decided to increase the capacity immediately by one-third at a cost of £30,000, and the utilisation of the full resources of the lake is contemplated. The company has exercised its options over the zinc-lead sulphide mines on the West Coast formerly owned by the Tasmanian Copper and two other undertakings, and a fresh concern has been formed with a capital of £1,000,000 to deal with the properties. The current year's output of copper has been sold to the British Munitions Department at a price equivalent to £120 per ton c.i f. London.

FRASER & CHALMERS LTD.)—Mr. A. W. Tait, who presided at the meeting last week, said that the net profit (£24,668) was more than double that of the previous year. The progress during the last four years had been most satisfactory. The work of the year at Erith had been made up of turbine work recognised as necessary to operate plants for war purposes, and of regular mining machinery business. Progress in the manufacture of steam turbines and turbo blowers had been still further increased, and their position was now an important one in the trade. The policy of the board included a programme of development by which they hoped to maintain a leading position in turbine work. Turbines of over 5,000 kw. had already been built, and still larger units were being prepared. There was every reason to believe that the department should continue to grow and expand in a most satisfactory manner. The coal-conveying and coal-handling department was also showing a most healthy expansion. Last year he mentioned that substantial orders had been obtained from the French Government and also for South Africa and China. The erection of those plants was proceeding satisfactorily, although some were delayed owing to the difficulties of the freight situation. One of the plants in France, however, had been in operation for some time, and has been accepted by the Government officials, and admitted by them as exceeding guaranteed capacity. Further substantial orders had since been received from the French Government. There was very little to report with regard to Bettington boilers, except that those which had been installed continued to run with advantage to their users. With regard to mining machinery, the company has only been able to execute such work during the year as has been regarded as sufficiently urgent work necessary for the maintenance of the production of metals. The business in South Africa had shown substantial improvement and the results obtained were satisfactory. The trading in Australia and also in Canada had necessarily been restricted during the year. They were, however, keeping in close touch with their offices and agencies, and informing them of the progress in their various departments, in the hope that they might be able to resume operations in an active manner in these spheres when conditions permit. During the year we have made arrangements for taking up the representation of certain manufactures in Australia, which should assist the development of their business there. With regard to Russia, they had established an office in Petrograd, and their representative (Mr. Catlin) had been busily engaged in making their name and manufactures known to prospective users there. They had already received several orders for turbines, and there was every promise of a large business to be done in that line of machinery, and also in the other branches of the company's manufactures, when monetary conditions improved. They were in negotiation with a well-established Russian firm with a view to working in conjunction with them for the development of certain trade in that country. One of the company's representatives made an extended tour in China and the East, and had been successful in obtaining substantial orders, and also in strengthening their connection there. The large power-station at Erith had operated satisfactorily, and had been the means of effecting considerable economies.

VENEZUELA TELEPHONE & ELECTRICAL APPLIANCES CO. (LTD.)—Including £11,821 brought forward, the profit for the year ended June 30 was £30,076. After providing for debenture interest, &c., and £2,399 for excess profits duty for the past two years, a dividend of 30 per cent. is declared on the preference shares (thus discharging arrears to Sept. 30, 1910), is proposed, adding £6,000 to reserve for renewals, and carrying forward £11,223.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

ASSOCIATION OF SCIENCE (LTD.) (145,326).—Reg. Nov. 17, as a company limited by guarantee, and not having a capital divided into shares with 20 members, each liable for 5s. in the event of winding up, to carry on the business indicated by the title. The management is vested in a Council, the first members of which are Dr. H. Woods, G. W. Lloyd, E. J. Schwartz, M.A., D.Sc.

SELSON ENGINEERING CO. (FRANCE) (LTD.) (145,319).—Reg. Nov. 16 capital £3,000 in £1 shares, to carry on the business of mechanical electrical and general engineers, manufacturers of and dealers in machine and hand tools, appliances, implements and instruments, founders, boiler makers, motor and engine builders, &c. Private company.

TYNE ELECTRIC STEEL FOUNDRIES (LTD.) (145,350.)—Reg. Nov. 20, capital £39,750 in 35,000 preference shares of £1 each and 95,000 ordinary shares of 1s. each, to take over the business of the Electro-Flex Steel Co. (Ltd.), to acquire any patents and inventions relating to electric furnaces and the electrical smelting of ores and refining of metals, or to electric batteries or electro-chemical or electro-thermal processes, &c., and to adopt an agreement between W. Swan and R. P. Sloan. First directors are F. S. Newall, R. P. Sloan, W. H. McAlpine, A. D. C. Parsons and R. E. E. Spencer. Reg. office, Dunston-on-Tyne, Durham.

MORTGAGES AND CHARGES.

BRECKNELL, MUNRO & ROGERS (LTD.)—Memorandum of satisfaction in full on June 29, 1916, of debentures dated Aug. 9, 1915, securing £2,500, has been filed.

DERBY LAMP WORKS (LTD.)—Memorandum of satisfaction in full on Oct. 20, 1916, of debenture dated March 30, 1916, securing £2,000, has been filed.

A. HIRST & SON (LTD.)—Memorandum of satisfaction in full on Sept. 7, 1916, of debentures dated Feb. 11, 1910, securing £3,600, has been filed.

FARAD ELECTRICAL CO. (LTD.)—Debenture dated Oct. 11, 1916, to secure £150, charged on company's undertaking and property, including uncalled capital. Holder, Mrs. F. Whitehead.

FERGUSON, PAILIN & CO. (LTD.)—Mortgage or charge by resolution of Nov. 14, 1916, relating to deposit of deeds, charged on property in Higher Openshaw, Manchester, to secure all moneys due or to become due from company to Williams, Deacon Bank.

NOTABLE ELECTRIC CO. (LTD.)—Particulars of £1,000 debentures, created Oct. 9, 1916, have been filed, amount of present issue being £150. Property charged company's property, present and future, including uncalled capital. No trustees.

RECEIVERSHIPS.

WILLIAM DENTON (LTD.)—Notice of appointment of H. Allison, 85, Gresham-street, E.C., as receiver on Oct. 30, 1916, under powers contained in instrument dated April 20, 1915, has been filed.

LESTER B. BETTS & CO. (LTD.)—J. E. Myers, Trafalgar-buildings, Northumberland-avenue, W.C., ceased to act as receiver or manager on Nov. 17, 1916.

CITY NOTES.

MEMORANDA (Nov. 29).—Bank rate 6 per cent. (since July 13, 1916). Consols, 55½. Consols Pay Days, Dec. 1 and Jan. 4. Stocks and Shares Ticket Days, Dec. 13 & 28. Pay Days, Dec. 14 & 29. Price of Silver, 35½d.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT (BERLIN).—It is announced that last year's profits were more than 27,000,000 marks (£1,350,000), an increase of about £200,000 over the previous year. A dividend of 12 per cent. has been declared, against 11 per cent.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The dividend on the 6 per cent. cumulative preference stock for the half-year ended Sept. 30 has been declared.

CANADIAN GENERAL ELECTRIC CO.—A quarterly dividend of 2¾ per cent. has been declared for the quarter ended Dec. 31, making 8 per cent. for the year on the common stock.

SHAWINIGAN WATER & POWER CO.—A quarterly dividend of 1¾ per cent. has been declared.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings (including those of the Rand Mines Power Supply Co.) for the quarter ended Sept. 30 were £215,264.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 23, the following as the present basis prices of—

New Metals.	Per lb.		Per ton
Solid Drawn Brass Tubes	18¾d.	English Lead	Nominal.
Solid Drawn Copper Tubes	22d.	Antimony	Nominal.
Brazed Copper Tubes	22d.	Old Metals.	Per ton
Brazed Brass Tubes	20¼d.	Clean Copper Scrap	£125 0 0
Brass Wire	17¼d.	Clean Brass Scrap	73 0 0
Copper Wire	21d.	Braziery Copper Scrap	100 0 0
Rolled Brass	16¾d.	Old Lead	27 0 0
Brass Sheets	17¾d.	Old Zinc	40 0 0
	Per ton.	Hollow Pewter	135 0 0
Copper Sheets	£187 0 0	Black Pewter	100 0 0
Spelter	59 0 0	Gun Metal	100 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Nov. 28, the following approximate prices of Scrap Metals:—

	Per ton.		Per ton.
Aluminium Cuttings	£110 0 0	Old Lead	£27 10 0
Clean Mixed Brass	75 0 0	Tea Lead	26 10 0
Clean Copper	130 0 0	Old Zinc	42 0 0
Braziery Copper	100 0 0	Hollow Pewter	135 0 0
Gun Metal	100 0 0	Shaped Black Pewter	95 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £84, Commercial Tinman's Solder, £105, Blowpipe Solder, £115.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 28.

Shrs.	Last Dividend	NAME.	Price, Tues., Nov. 28	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	6%	Bournemouth & Poole E.L. Ord.	8¼	7 1 2	Mar., Sept.
10	4½%	Do. 4½% Cum. Pref.	7¼	5 16 2	Feb. Aug.
10	6%	Do. 6% Cum. 2nd Pref.	9¾	6 1 6	Feb. Aug.
5	10%	Brompton & Kensington Ord.	6¹³⁄₁₆	7 6 9	Mar, Sept
5	7%	Do. 7% Pref.	6¼	5 9 10	Mar, Aug
St	4%	Central Elec. Supp. Co. Deb. St.	80¾	4 19 5	..
St.	4%	Charing Cross West End & City Debs.	79¼	5 0 8	Jan July
5	2/3	Do. 4½ Pref	3⁷⁄₁₆	6 10 10	..
5	5%	Do. Ord.	3½	7 2 10	Aug, Feb
5	4½%	Do. City Pref	3¼	6 18 6	Jun, Dec
5	4%	Chelsea Elec. Supp. Co. Ord.	3⅛	6 8 7	Mar, Sept
St	4½%	Do. do. Deb.	87	5 3 5	Jan, July
10	8%	City of London Elec. Lt. Ord.	11⁹⁄₁₆	6 18 5	Feb, Aug
10	6%	Do. 6% Pref.	9¾	6 3 1	Mar, July
St	5%	Do. 5% Deb. St.	97½	4 17 6	Jun, Dec
St	4½%	Do. 4½ Debs.	79	5 11 0	Jun Dec
10	7%	County of London Ord.	10½	6 13 4	Mar, Sept
10	6%	Do. 6% Pref.	9⅞	6 1 6	Feb., Aug.
St	4½%	Do. 1st Deb.	85	5 5 11	Jan, July
St	4½%	Do. 2nd Deb.	84¼	5 6 6	May, Nov
St	4½%	Edmundsons's Elec. Corp. 4½% Debs.	73¼	6 2 5	July
5	7%	Kensington & Knightsbridge Ord.	5¹⁄₁₆	6 18 3	Feb, Aug
St	4%	Do. Deb. St.	75¼	5 6 4	Jan, July
5	6%	London Elec. Supply 6% Pref.	4⅜	6 18 2	..
St.	4%	Do. 4% Mort. Deb.	80¼	4 19 10	Jan, July
5	3%	Metropolitan E.S. Co. Ord.	2⁵⁄₁₆	6 9 9	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 12 6	Jan, July
St	5%	Midland Elec. Corp. 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% [illegible]	99¼	6 0 6	Mar, Sept
St	5%	Newcastle-on-Tyne [illegible] St.	87	5 14 11	Mar, Sept
1	6%	North Metropolitan [illegible] 6% Pref	†	6 11 9	Apl, Oct
4	5%	South London Elec. Ord.	2⅞	6 19 7	Mar, Sept

† Ex dividend or interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price Tues., Nov. 28	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6⅛	6 10 7	Feb, Aug
5	7%	Do. do. Pref.	5²⁷⁄₃₂	5 19 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St	4½%	Urban Elec. Supp. 4½% Db. St.	67¼	6 15 2	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1¼	6 8 0	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5¹⁵⁄₁₆	5 17 11	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	3⅞	5 16 2	Jan, July
		Electric Railways and Tramways.			
St	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St	6%	Do. 6% Cum. Pref.	77½	7 14 10	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	65	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70⅜	5 13 8	..
St.	4½%	Do. 4½% Pref.	82¼	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	74¼	5 7 6	Jan, July
St.	4%	City & S. London Deb.	67	5 19 1	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1¼%	London Electric Ry. Ord.	2³⁄₁₆	5 14 4	Jan, July
St.	4%	Do. 4% Pref.	60⅞	6 11 5	Mar, Sept
St.	4%	Do. 4% Debs	70¾	5 13 1	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23⅞	4 3 9	Feb, Aug
St.	3½%	Do. 3½% Pref.	59	5 18 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	53	6 12 1	Feb, Aug
St	3½%	Do. 3½% A Debs.	61	5 14 9	Jan, July
St.	3½%	Do. 3½% Debs.	64½	5 9 5	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15½	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	69⅞	6 7 3	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105¼	5 13 6	Jan, July
St.	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 17 7	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2³¹⁄₃₂	5 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1¹¹⁄₃₂	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1¹⁵⁄₃₂	4 15 4	Mar
100	5%	Do. Prior Lien Debs.	89	5 12 4	Jan, July
1	6%	Do. 6% Pref.	²⁹⁄₃₂	6 12 5	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12	7 5 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⁵⁄₃₂	5 16 4	Jan, July
.	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	¹⁵⁄₁₆	6 8 0	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅜	6 7 4	April
100	6%	Do. 6% Prior Lien Debs.	99⅛	6 0 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12¹³⁄₁₆	7 16 1	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A £3 pd.	½	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1⅛	6 13 4	May
1	7%	Do. 7% Cum. Pref.	1¹⁄₃₂	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	13½	7 8 2	July
10	6%	Do. 6% Pref.	9²⁵⁄₃₂	6 2 8	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16⁵⁄₈	6 3 9	Feb, Aug
5	4½%	Do. 4½% Cum. Pref.	3¾	6 0 0	..
St.	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	13	7 13 10	Feb, Aug
10	5%	Do. Pref.	7⅞	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	37⅞	6 6 9	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	7½%	Vickers Ord.	1⁵⁄₃₂	6 11 2	May, Aug
1	5%	Do. 5% Pref.	²⁷⁄₃₂	5 18 6	May, Aug
St	4%	Do. 1st Debs.	77½	5 3 3	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99⅞	4 10 2	June, Dec
St	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95	6 5 0	Fb, My, Aug, N
St	1½%*	Do. Def. Ord.	23½	7 2 3	Fb, My, Aug, N
St.	4%	Commercial Cable 4% Debs.	70½	5 13 6	Ja. Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6¼	6 8 0	Ja, Ap, Jly, O
St.	8%	Eastern Tel. Co. Ord.	140¼	5 14 1	Ja, My, Jly, O
St.	3½%	Do. 3½% Pref.	62½	5 12 0	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	72	5 11 1	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	13⅞	5 16 3	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. With Coup. 11	37¼	5 18 1	Ja, My, Jly
25	13%	Indo-European	51⅛	6 7 2	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2²⁹⁄₃₂	3 8 10	April
1	7%	Do. 7% Pref.	2¹¹⁄₃₂	2 19 9	July
10	½%	West India & Panama Ord.	1¹⁷⁄₃₂	3 4 9	May, Nov
10	6%	Do. 1st Pref.	7⅞	7 12 5	May, Nov
10	8%	Western Telegh. Co.	14	5 14 3	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	72	5 10 3	June, Dec
..	4½%	Western Union 50-yr. Bds.	99⅛	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	²⁹⁄₃₂	6 12 5	Nov
1	10%	Oriental Telephone Ord.	2¹⁄₃₂	4 18 6	Apl, Oct
St.	4%	Do. Db. St.	78¾	5 1 7	Jan, July
St.	4½%	Teleph. Co. of Egypt Db. St.	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	6¾	5 18 6	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅜	5 14 3	Jan, July
St.	4½%	Do. Deb. Stk.	80½	5 11 10	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	12⅜	4 17 0	Sp, Dc Mr, Jn
10	6%	Do. 6% Pf.	10	6 0 0	Sp, Dc, Mr, Jn
100	5%	Mackay Companies' Common	85⅛	5 17 6	Ja, Apl, Jly, O
..	4%	Do. $100 Pref.	70	5 14 3	Ja Apl, Jly, O
100	6%	Submarine Cable Trust Certs.	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply Co. Pref.	4¹⁵⁄₁₆	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	94½	5 5 10	Jun, Dec
10	6/0	Bombay E.S. & T. 6% Pref.	10⅛	5 19 1	..
St	4½%	Do. 4½% Debs.	82½	5 8 5	Jan, July
5	9%	Calcutta E.S. Corp. Ord.	6⅜	7 1 2	May, Nov.
5	5%	Do. 5% Pref.	4⁵⁄₁₆	5 16 0	Mar, Sep

* Plus 3/6 bonus. † Ex dividend or interest.

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NOTES.

Scientific and Industrial Research.

A most important step in the proper recognition by the State of research was taken last Friday, when a large and representative deputation waited upon the Marquis of Crewe, Lord President of the Privy Council and President of the Committee of the Privy Council for Scientific and Industrial Research, to urge upon him the desirability of the Government aiding to an increased extent scientific and industrial research. The deputation was the result of steps taken by the Conjoint Board of Scientific Societies recently formed by the Royal Society, and was introduced by Sir J. J. Thomson, President of the Royal Society, who was supported by Sir Maurice Fitzmaurice, President of the Institution of Civil Engineers, and Prof. H. Brereton Baker. Sir J. J. Thomson emphasised the importance of pure science, and as an illustration of the way in which a purely scientific discovery may become of great practical value he mentioned the X-rays. In this case the discovery was made as the result of work upon the nature of electricity, a very academic subject, and one which certainly would not have been financially supported by a commercial syndicate. Yet X-rays had become of enormous importance in surgical operations; moreover, it was extremely unlikely that such a discovery would have been made in working on the location of bullets in wounds. Sir Joseph also appealed for more efficient laboratories at the universities, and for greater support for the work of the National Physical Laboratory. Sir Maurice Fitzmaurice, as Chairman of the Standing Committee on Engineering, spoke with great hope of important results being obtained if only sufficient encouragement were given. Prof. Baker referred to the discovery of induced currents by Faraday as an instance of work which was probably looked upon as of little value at the time, but which has proved to be the foundation of the electrical industry.

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Lord Crewe, in his reply, was very sympathetic, and while suggesting that there was always difficulty in Parliament voting money which could not be dealt with in the ordinary form of estimates, and which might not lead to results for some time, made the important announcement that the Government had decided to institute a new department presided over by the President of the Council to deal with research work, and to spend four or five times as much as at present on such work, from which we gather that a yearly contribution of something like £200,000 is contemplated. As for carrying on industrial research, Lord Crewe favoured the creation of commercial associations for this purpose, the idea being that such associations would assess the contribution which the industry was able to make towards systematic research, and would presumably receive Government grants to supplement their own funds. In order to encourage contributions by individual firms it has been decided to allow such contributions to form part of their working expenses for the purpose of income tax. Lord Crewe also felt that technical schools run by local authorities were at present on an unsatisfactory financial basis, that they ought to receive State aid, and that the salaries of teachers should be more commensurate with their labours. We are glad to see this realisation on the part of the Government that research is important, for we feel that even if the work that is so undertaken becomes largely public property for the benefit of the world at large the prosecution of such work in this country must react profitably upon the science and industry of the country as a whole.

◆

Feeding the Munition Worker.

An instructive and well-illustrated pamphlet on this subject has recently been prepared by the Canteen Committee of the Central Control Board at the request of those interested in the establishment and management of canteens for munition workers. The committee is to be congratulated on an excellent piece of work, and the pamphlet will unquestionably be useful to those who are interested in the welfare of their employés. Three methods of management are discussed. These are direct management by the employer himself, if possible with the assistance of a committee of the workers; management by a voluntary society and the employment of an outside caterer. We are strongly in favour of the first named method, and we believe it has given satisfaction for many years in a large number of works. That the committee has given attention to all sides of the question is evident from the wide range of subjects dealt with, and one of the most pleasing features is that none of the schemes described is Utopian. Some of them are even homely, and there is none of the "frightfulness" which one usually associates with official publications. It is to be regretted that war conditions have compelled reforms along the lines suggested in this booklet. Such reforms will go a long way towards promoting a better understanding between employer and employed, and, in view of the conditions which have prevailed during the last 10 years, no one will deny the need for a very much better understanding in the future.

* * *

The Héroult Electric Furnace.—The number of Héroult furnaces operated or contracted for in the United States and Canada is now 80, says the "Iron Age," while at the beginning of the year it was 43 only.

Cable Ship Sunk.—Among the ships reported to have been sunk yesterday (Thursday) was the cable ship "Dacia," of the India Rubber, Gutta Percha & Telegraph Works Co. The "Dacia" was a ship of 1,856 tons.

Research in the Coal Tar Industry.—A report to the governors of the Technical College Huddersfield, describes the proposed additions to the buildings and equipment for research on coal tar colours. It is stated that the arrangements when completed will provide the best laboratories available at any educational institution in this country for coal tar colour chemistry. The provision of research scholarships is being considered, and a fund for their endowment is already in being.

Canada's Water Power.—According to the "Journal of Commerce," Montreal, Canada's available water-power, allowing for limitations imposed by international agreements in connection with Niagara Falls, and one or two other sources, amounts to 17,716,000 H.P. Excluding the North-West territories and the Youkon, about 1,712,000 H.P. out of this total is already being utilised. If the present rate of progress continues it is calculated that something like 8,000,000 H.P. will be made available during the next 15 years.

Women Employes in Electricity Works.—The Local Government Board has forwarded to local authorities and electric supply companies throughout the country a memorandum prepared by the Home Office and Board of Trade dealing with the substitution of women for men in municipal services, particularly in electricity undertakings.

For some time past the Marylebone electrical supply has been employing women to carry out the duties, among others, of junior engine drivers, volt regulators, lamplighters, meter testers and maintenance attendants.

Turbo-Electric Propulsion.—In the United Kingdom there are two vessels being built to Lloyd's classification in which the Ljungstrom turbo-electric propelling plant will be fitted, one a single-screw vessel in which the power will be 1,500 shaft H.P., and the second a twin-screw vessel, with a total shaft horsepower of 5,100. In the Ljungstrom turbine there are no stationary blades, the steam passes across two sets of blades which revolve at equal speeds in opposite directions, so that the effect is similar to that which would occur with one set of blades stationary and the other set moving at twice the velocity. Each half of the turbine is directly coupled to its own alternator producing a three-phase current of about 50 alternations per second with a voltage of about 800. The alternators of each set are electrically locked, ensuring exactly equal speed, and consequently equal power, of each rotating half of the turbine. In each vessel there will be two turbo-alternator sets, so that the stoppage of one will not disable the vessel. The two alternators of each set work in parallel. They have each only one pair of poles, and supply current to two motors each having five pairs of poles, which will, therefore, rotate at one-fifth the speed of the turbines. These motors are connected to pinions with spiral teeth which gear in the ordinary manner with a large gear-wheel secured to the screw shaft. The combination of electrical and mechanical reduction gear will enable a speed of turbine of 3,600 revs. per min. to rotate the screw at 76 revs. per min. The reversing of the screw is effected by the motor, the steam turbines always running in one direction. Reduction of speed is effected down to about 80 per cent. of the full speed by varying the steam supply to the turbine. For slower speeds the regulation is secured by interposing resistances in the circuit.

The Transport Problem.—We have received from Messrs. The New Transport Co., Ltd., the following copy of a letter addressed to the Editor of "Railway News":

To the Editor of "The Railway News."

Sir,—You have on several occasions, and particularly in your last issue, stated that the scheme of the New Transport Company was "impracticable" or "unpractical."

When you recently visited our works I asked you to point out in what direction you discovered any impracticability, or, indeed, any flaw in the many details then explained to you. You replied evasively that you were "not an expert."

I am now writing to offer to pay you the sum of one hundred pounds if you will specify one single particular in which the scheme of the New Transport Company, as specified in my various lectures, is impracticable, and prove it to be so.

I suggest that unofficially the matter be submitted to one of H.M. Judges to adjudicate upon, and that his decision is to be final.

That all interrogations and replies shall be published, and in the event of your failing to prove your charge to his satisfaction you shall forfeit all claim upon me, and that you shall pay one hundred pounds to the British Red Cross Society and make an ample apology in a leading article in the "Railway News."

I am writing to various London editors, enclosing a copy of this letter for publication in their columns.

I suggest that the bankers of the New Transport Company or any other London bankers, be appointed stake-holders. Yours faithfully,

per pro A. W. GATTIE,
SIDNEY CULVERWELL,
Assistant Secretary, New Transport Co., Ltd.

OBITUARY.

KILLED IN ACTION.—The following deaths in action or of wounds are reported:—

Lieut. E. R. Wilmshurst (R.F.), 21 years of age, who has died abroad of wounds, was a son of Mr. T. P. Wilmshurst, borough electrical engineer of Derby. His parents were at his bedside when he died. His two brothers are also officers and have been wounded.

Sec.-Lieut. D. C. Francis (York and Lancaster Regt.), who has been killed in action, studied engineering at Owen's College, Manchester, and was an associate member of the Institution of Civil Engineers.

Sub-Lieut. E. A. Gordon Harvie, R.N.V.R., 29 years of age, who was killed on Nov. 13, was trained as an electrical engineer at the Central Technical College, South Kensington.

Pte. H. Brittain (Duke of Cornwall's Light Infantry), who has been killed, was a Birmingham Corporation tramways employé.

PERSONAL.

Mr. G. E. Mason, president and managing director of the Lancashire Dynamo & Motor Co., of Canada, left for England on Nov. 7 to take up a position with the parent company at Manchester, and Mr. S. A. Gaskell will take charge of the business in Canada.

Mr. Alan Williams, M.I.E.E., has been appointed temporary Lieutenant R.N.V.R., for special electrical engineering duties.

WAR CASUALTIES.—The following casualties amongst employees of the County of London Electric Supply Co. are reported: Sergt. H. Clarke (21st London), Rfmn. W. E. Dossett (L.R.B.), Pte. J. Lindfield (Duke of Cornwall's L.I.), L. Corp. E. Goodyear (3rd Middx.), Rfmn. T. E. Maylam (5th E. Surrey), Rfmn. S. Perry (12th London), and Pte. J. Pulham (E. Surrey), wounded. L.-Corp. G. F. Ayling (Duke of Cornwall's L.I.), wounded and prisoner of war. Corp. W. Goldsmith (Duke of Cornwall's L.I.), gassed. Rfmn. A. Deeth (21st London), wounded and missing. L. Corp. A. Rose (5th Berks), missing.

Military Appointments.—The following appointments and promotions have been made :—

Royal Engineers (Wireless Section): H. F. Gill (of the County of London Electric Supply Co.'s secretarial department) to be Second Lieut. (Mr. Gill has been awarded the Military Cross). J. J. Lightfoot (County of London Electric Supply Co.'s secretarial department) to be Second Lieut.

Tyne Electrical Engineers: Staff-Sergt. G. T. B. Scullard and Staff-Sergt. F. Thompson to be Second Lieuts. (on probation); Second Lieutenant (temp. Lieut.) H. S. Ripley is seconded for duty with R.F.C.

Royal Ordnance Corps: N. A. Dunk (County of London Electric Supply Co.'s secretaral department) to be Lieutenant.

London Electrical Engineers: J. Clarke and Petty Officer R. H. Sperling (from R.N. Reserve, A.A. Corps.) to be Second Lieutenants (on probation).

City of Edinburgh (Fortress) Engineers (Electric Lights Co.): Q.-M.S. W. F. Anderson (from R. Scots) to be Second Lieutenant (on probation).

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of shift engineer, to take charge of the running of boiler-house at Summer lane generating station, Birmingham. Salary £150, plus £10 extra per annum during the war. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Wednesday, Dec. 13.

An electrical and mechanical engineer is wanted (temporarily) by the University of Bristol. Applications to the Registrar. *See advertisement.*

An advertiser wants lady assistants for an electrical test room.

A London electric supply company advertises for an assistant engineer to take charge of a watch at one of its stations.

Reigate Corporation require a shift engineer at their generating station. Applications to the Borough Electrical Engineer by Dec. 12.

Mr. F. Fairley has been appointed senior assistant engineer in the Melbourne municipal electricity department.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—The 91st illustrated Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Prof. Arthur Keith, M.D., F.R.C.S., LL.D., F.R.S., his title being "The Human Machine which all Must Work." The subjects are as follows:—"Living Engines," Dec. 28; "Living Levers," Dec. 30; "Living Pumps," Jan. 2; "Living Bellows," Jan. 4; "Living Workshops," Jan. 6; "Living Central Exchanges and Wires," Jan. 9. The lecture hour is three o'clock. Among the lecture arrangements before Easter are the following:—Prof. W. E. Dalby, two lectures on "The Structure of Metals"; Prof. F. G. Donnan, three lectures on "The Mechanism of Chemical Change"; and Prof. J. A. Fleming, two lectures on "Modern Improvements in Telegraphy and Telephony": (1) Telegraphy, (2) Telephony.—The Friday evening meetings will commence on Jan. 19, when Prof. Sir James Dewar will deliver a discourse on "Soap Bubbles of Long Duration." Succeeding discourses will probably be given by Prof. Gilbert Murray, Charles C. Carpenter, Daniel Jones, Rev. H. Hensley Henson, H. Wickham Steed, Charles F. Cross, Sir Almroth Wright, Sir J. Stirling Maxwell, Edward Clodd and others.

Royal Society.—Among the Papers read yesterday before the Royal Society was one by Messrs. J. J. Guest and F. C. Lea on "Torsional Hysteresis of Mild Steel."

Royal Society of Arts.—The juvenile lectures this session will be delivered by Mr. Alan A. Campbell Swinton, F.R.S., on "Electricity and its Applications." The lectures, which will be fully illustrated with experiments, will be given on Wednesdays, Jan. 3 and 10, at 3 p.m.

Diesel Users' Association.—At the November meeting of the Diesel Engine Users' Association the president (Mr. Geoffrey Porter) announced that the committee's report on "Air Compressor Explosions and Troubles," with their recommendations on the subject, had been finally revised, and that it would be printed and circulated to the members and subscribers.

Mr. George B. Vickers read a Paper on "Piston and Small-end Lubrication in Diesel Engines," and we hope to give an abstract of this Paper in an early issue. In the discussion which followed, Mr. W. Fennell gave some information concerning inquiries he had made in regard to the possible use of deflocculated graphite, and special graphite preparations for the lubrication of Diesel engine cylinders. He also referred to the increased sulphur contents of certain fuel oils which were now being used, and it was found that these reacted on the lubricating oil, causing a sticky deposit, which destroyed the lubricating properties of the oil. An ideal lubricating oil would leave no deposit when burnt away. He expressed the opinion that the most successful Diesel engine of the future would have a crosshead. In his reply to the discussion, Mr. Vickers agreed that sulphur would certainly have a bad effect on most compounded oils, but that it would have no effect on a pure mineral oil. If there was any sign of acid action in a lubricating oil, it was not suitable for use on the engine.

ARRANGEMENTS FOR THE WEEK.

MONDAY, Dec. 11th.

Western Local Section, Institution of Electrical Engineers.

5 p.m. At South Wales Institute of Engineers, Park-place, Cardiff. "Kelvin" Lecture on "Some Aspects of Lord Kelvin's Life and Work," by Dr. A. Russell.

Royal Society of Arts.

5 p.m. At John-street, Adelphi, W.C. Howard Lecture on "Coal and its Economic Utilisation," by Prof. G. S. S. Brame. (Lecture III.)

TUESDAY, Dec. 12th.

Scottish Local Section, Institution of Electrical Engineers.

7.30 p.m. At 207, Bath-street, Glasgow. Paper on "The Parallel Operation of Electrical Power Stations," by Mr. J. S. Peck.

Manchester Local Section, Institution of Electrical Engineers.

7.30 p.m. At the Engineers' Club, Manchester. Illustrated lecture on "Some Aspects of Industrial Research, with Special Reference to American Research Activities," by Mr. A. P. M. Fleming.

Association of Supervising Electricians.

7.15 p.m. At St. Bride's Institute, Ludgate-circus, E.C. Paper on "Electric Meters," by Mr. J. Rennie.

WEDNESDAY, Dec. 13th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, W.C. Paper on "The Development of Imperial Resources," by Mr. H. Wilson Fox.

Association of Engineers-in-Charge.

8 p.m. At St. Bride's Institute, Ludgate-circus, E.C. Paper on "Solid Fuels," by Mr. S. G. Martlew.

Liverpool Engineering Society.

At Royal Institution, Colquitt-street, Liverpool. Paper on "Works Costing Systems," by Mr. H. Shephard.

THURSDAY, Dec. 14th.

Institution of Electrical Engineers.

8 p.m. At the Institution, Victoria Embankment, W.C. Paper on "Colonial Telegraphs and Telephones," by Mr. R. W. Weightman.

Greenock Electrical Society.

7.45 p.m. At Masonic Rooms, 22, West Stewart-place, Greenock. Paper on "The Art of Wiring," by Mr. James Nichol.

FRIDAY, Dec. 15th.

Illuminating Engineering Society.

5 p.m. At Royal Society of Arts, John-street, Adelphi, W.C. Peper on "War Economies in Lighting," by Mr. L. Gaster.

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, S.W. Paper on "Variable-Speed Gears for Motor Road-Vehicles," by Mr. R. E. Phillips.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At Bolbec Hall, Newcastle-upon-Tyne. General Meeting.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week.

Officer for the Week.—Platoon Commander Parker.

Next for Duty.—Platoon Commander C. H. C. Bond.

Promotion.—Orderly Room Corporal Hardcastle to be Sergeant (dated Dec. 1).

Monday, Dec. 11.—Technical for Platoon No. 9, at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.25 to 8; Lecture on Telephones, 7.30.

Tuesday, Dec. 12.—School of Arms, 6 to 7; Lecture, 7.15, "The Service of Protection," Company Commander Hynam.

Wednesday, Dec. 13.—Instructional Class, 6.15; Platoon Drill, Platoon No. 1.

Thursday, Dec. 14.—Platoon Drill, Platoon Nos. 5 and 6; Ambulance Class by M.O., 6.

Friday, Dec. 15.—Technical for Platoon No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.25 to 8.25; Lecture on Telephones, 7.30.

Saturday, Dec. 16.—N.C.O.'s Class, 2.30, Company Commander Hynam.

Sunday, Dec. 17.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday ration to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

THE RESTORATION OF SERVICE AFTER A NECESSARY INTERRUPTION.*

BY F. E. RICKETTS.

Generally speaking, alternating-current generators cannot be injured by overloading for a few minutes, and since the sudden interruption of a circuit carrying heavy currents tends to produce abnormal voltages it is advisable during abnormal conditions to keep all the switches closed except for disconnecting a section of the system that has become permanently disabled.

Since the amount of service affected by the opening of a switch is in proportion to the nearness of the switch to the generator, the importance of keeping the switches closed increases as we approach the generators; consequently the generator switches should be arranged so that they will never open due to any overload. But for the chance of trouble within the generators themselves, the switches controlling them would be better made non-automatic; however, with such an arrangement, in case a short circuit or a ground should occur within the generator, the service would be seriously disturbed, and there would also be a possibility of the generator being seriously damaged if not destroyed.

An ideal scheme for the protection of generators is illustrated in Fig. 1. The generator is three-phase, but in describing the scheme we need only consider a single phase. At each extremity of phase *A* there is a current transformer, *A*1 being near the oil switch and transformer *A*2 being near the neutral, so that any current passing completely through phase *A* will produce in the secondaries of the two transformers, currents that are exactly equal and in phase, the transformers having equal ratios and connected so that their secondaries will work in series with their instantaneous voltages in the same direction. Then if a relay such as *A*3 is connected with its actuating coil between the two wires connecting the transformers, and its contact circuits connected both to the trip coil of the switch in the armature circuit and the trip coil of the switch in the field circuit, the terminals of the actuating coil of the relay will always be at the same potential as long as there is no leakage of current in the winding of phase *A*, regardless of the load on the generator or whether it is operating as a generator or motor. Therefore, as long as there is no trouble in the generator no current will flow through the coil of the relay and there will be no tendency to trip the switch, but just as soon as current starts to leak from phase *A* to one of the other phases or to ground, there will be a difference in the value of the current flowing through the two transformers, which difference will be represented by a current in the secondary of one transformer, but not in the other; therefore this unbalance in the secondaries will have to flow through the actuating coil of the relay which will cause its contacts to close, thereby opening both the armature circuit and the field circuit, and thus not only preventing current from feeding into the damaged generator, but also preventing the damage that would have been caused by current generated by this generator had the field circuit remained closed.

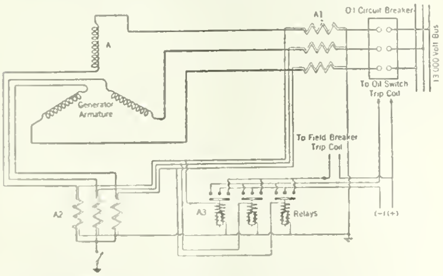

FIG. 1.—CONNECTIONS FOR RELAYS ON GENERATORS.

Now let us consider what would happen if we simultaneously interrupt the field circuits of all the generators for a short interval of time; say, one or two seconds. When the field circuits of the generators are opened, the voltage of the system will very quickly drop to near zero, and when the short circuit is severe, the heavy armature current will tend to demagnetise the generators, even before the field circuits are opened. The drop in voltage will be much more rapid than could be accomplished by reducing the voltage applied to the field circuits while the field circuits remained closed since then, as the magnetism of the fields decrease there would be induced in the closed field circuit a voltage that would oppose the decrease in field current. In the original Paper oscillograms are given which show the time required for the armature voltage to die out when the generator field is opened and when the exciter field is opened. If the exciter voltage were lowered by inserting resistance in the exciter field, the time would be still longer. By the time the fields close the arc will have ceased, and as the current builds up in the fields the armature voltage will rise gradually from zero to normal, with total absence of voltage surges and an armature current not exceeding 200 per cent. normal. As the armature voltage rises to normal, the service on the entire system will be restored. However, to accomplish the best results, special arrangements of relays should be provided, and when there are synchronous motors on the system, special features should be incorporated in their design.

To assist in the detail description of this system Fig. 2 is shown. A motor *M* is connected through a train of gears to a dial switch *A* in such a way that when the motor is in operation the dial makes one complete revolution in one minute which is the time required for one cycle of operation of the system. The motor is started by any one of the relays, 1, 2 or 3 which are connected to current transformers in the armature leads of at least one generator that is in operation on the system to be protected. These relays are connected to transformers in the generator leads rather than in any other part of the system for the reason that they will then always be subjected to the same current during a short-circuit regardless of the number of generators in service, whereas, if they were placed in the outgoing circuits they would, during a short-circuit, be subjected to a current that would be in proportion to the number of generators in service at the time. The action of the relays to start the motor is delayed by a definite time-limit relay 4 for two seconds in order to give certain of the selective relays on the system time to operate or cut out a minor circuit that may be short circuited, but this time must be less than that required to operate the relays controlling the major part of the system. Very soon after the time-limit relay has caused relay *R*1 to pick up and start the motor, segment *B* which is carried by the rotating dial will touch a contact which will apply current to relay *R*1 during one complete revolution of the dial independent of the time-limit relay. This prevents the motor from stopping after it has once started until it has completed one cycle. Immediately after *R*1 is locked a button on the dial touches a contact that closes relay *R*2, which trips out all the field switches, and about two seconds later another button on the dial touches a contact that closes relay *R*3 which closes all the field switches. The voltage regulator will boost the exciter voltage to a maximum, while the fields are opened so that when the fields are closed the field current will build up to a maximum which is very desirable, as the time required for the generators to pull in step varies inversely as the strength of the field currents. However, when the generators pull in step the voltage may rise so rapidly that the regulator will not be able to control it, therefore, to prevent the voltage from rising too rapidly and overshooting, the relays, *R*4, *R*5 and *R*6 are controlled by the segments near the centre of the dial so that during the first one-third cycle of operation, one-half the resistance in series with the voltage-regulating coil of the

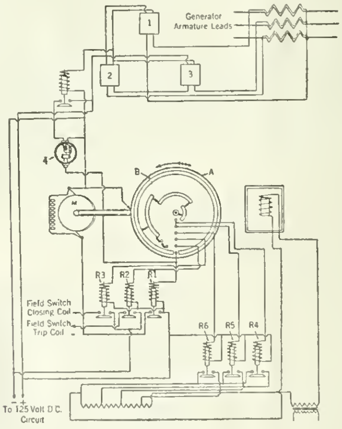

FIG. 2.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

regulator will be short circuited and the resistance will be cut in circuit in steps as the dial rotates, all of the resistance being in circuit at the end of the cycle.

Therefore, since the regulator operates to maintain a constant current in the voltage coil, the voltage will be maintained in proportion to the resistance in the circuit of the voltage coil; that is, the voltage will be restored to normal gradually, which is of great importance in pulling the motors on the system into synchronism.

During the operation of the device, the induction motors will slow down and come back to normal speed, but the relays controlling them should be set for a rather high current, say 400 per cent. load to prevent them from tripping before the motors are up to speed. This high setting will not be dangerous as the motors will stand a heavy overload for a few seconds without excessive heating, and in case a motor burns out sufficient current will flow to trip the relay.

Synchronous converters present a more difficult problem since they lose a great part of their torque when they get out of phase, and their polarity on the direct-current side depends upon the polarity of the brushes when they come into synchronism.

This reversing may be overcome by exciting the fields from an external direct-current source. In most cases 25 per cent. full value of field current will ensure the polarity being correct. Fig. 3 illustrates one method that has been successfully used. A converter, 1, is connected to the 'bus bars through automatic circuit breakers and has its neutral grounded. There is also a storage battery, 2, connected to take the load during short interruptions on the alternating-current system. When the fields of the generators open and the voltage decreases, current will flow from the battery into the converter until the breakers open. Then, since the voltage of the rotary is not sufficient to hold up the relay $R1$, the plunger of this relay will drop, opening its own circuit and closing that of relay $R2$ which connects the negative 'bus to a point between the field coils and the rheostat, so that current will flow from the ground through the transformers to the armature and thence through the field coils and rheostat in multiple to the negative 'bus, the voltage impressed on the field coils being half normal and in the direction to give the proper polarity at the brushes. Therefore, when the converter comes up to speed it will be ready for service.

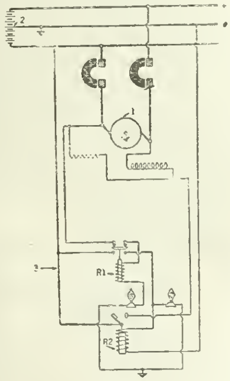


Fig. 3.

When no battery is used on the 'bus, a small battery capable of furnishing the field current should be connected between the neutral and wire marked 3 which would then not be connected to the negative 'bus.

With synchronous motors it becomes necessary to reduce the load to a point where the motor will pull in step. One method of accomplishing this is shown in Fig. 4 which illustrates the connections for reducing the load on a motor-generator until the motor can pull in. A single armature lead is shown, as the connections to the others are similar. In this armature lead is a current transformer which furnishes current to two relays, one of which A is connected to trip the main switch controlling the motor, is set for 400 per cent. load and should have an inverse time characteristic such that it will trip in about one-third of a second at the maximum current the motor will feed into a short circuit; then it will not trip under heavy load or when a short circuit occurs on the system, but will act very quickly when trouble occurs in the motor. This protection could also be accomplished by the scheme recommended for generator protection (Fig. 1), but the arrangement shown in Fig. 4 has the advantage of protecting the motor should it get out of step and for any reason be unable to regain synchronism. There is also in the circuit of the current transformer a relay B which is so designed that it will pick up at a current corresponding to 200 per cent. load of the motor, and after it has once picked up, it will not drop till the load on the motor is normal. Responsive to the relay B is a switch in the field circuit of the generator, which has connected in parallel with it a resistance E that, when in circuit, will limit the load on the generator to a point where the motor will pull into synchronism. Therefore, as the voltage on the system builds up after an interruption, before the current in the motor is great enough to operate relay A, relay B will pick up and trip the field switch, which will cut in the resistance E and thereby limit the load on the motor to a point where the motor can pull in without operating relay A. It will also be noted that there is a relay F which picks up in response to the voltage across resistance E, and opens the circuit of the trip coil of the field switch and closes the circuit of the closing coil, so that when the motor pulls into synchronism and the current decreases to normal the field circuit breaker will be closed and the voltage on the generator will be restored to normal; also the voltage across relay F will drop to zero and it will reset itself.

The design of synchronous motors affects to a great extent their ability to pull back into synchronism, the greatest item being the resistance of the damper winding. When a heavy current flows in the armature of a synchronous motor while it is out of phase, the fields are subjected to a considerable stress by induction and it is therefore advisable, though not necessary, to insert reactors in the armature leads. This reactance should bring the total of the circuit to about 20 or 25 per cent., and can be provided in the winding of the motor in new machines.

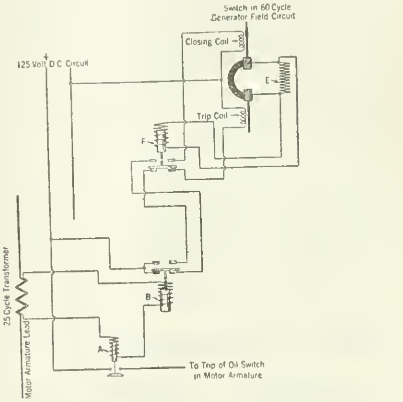


Fig. 4.

Generators.	Resistance.	Capacity.
5,000 k.v.a.	0·5 ohm.	150 amp.
3,000 „	1 „	75 „
1,000 kw.	2 „	50 „

Voltmeter charts taken at a generating station protected by this system are given in the original Paper.

The system has proved of great value in clearing short circuits in the main 'bus structure, such as are sometimes caused by the failure of an oil switch or the accidental starting of an arc between 'bus bars. A further advantage is gained in starting a system after a general shut down, which can be done by closing all the alternating-current switches while the fields are open, and then, when the fields close, all the generators will synchronise and bring the entire system up to normal, as the voltage will build up gradually and therefore not damage any machines that may be left in service. When there are several generating stations operating in parallel there is no difficulty in getting the field breakers of all generators open at the same time, since the short circuit strikes all the stations simultaneously. If some of the breakers open a little before the others or if some of them do not open at all there is no bad effect.

In addition to interruptions that affect the entire system there is another class which affects only a minor part of the system, for example alternating-current distribution feeders that are not tied in with other feeders after they leave the station. More than 50 per cent. of the short circuits on these feeders are of a temporary nature, and therefore clear themselves as soon as the feeder trips out; but by the time the operator can close the switch again the motors have shut down. This in effect gives an interruption of several minutes as the customer will be slow in starting up. Since an arc breaks within a fraction of a second after the voltage is cut off we may, by closing the switch quickly, prevent the motors from shutting down.

Fig. 5 illustrates a system that has operated very satisfactorily to clear temporary short circuits on distribution feeders, when the short circuits are of such a nature that they will not re-establish themselves after the arc is once broken.

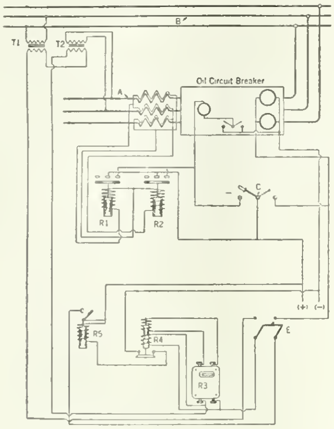
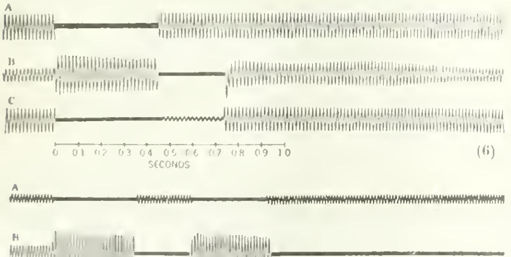


FIG. 5.

A feeder *A* is connected through an electrically-controlled oil switch to a station 'bus *B*. The switch *C* is for operating the switch manually, and relays *R*1 and *R*2 are for tripping the switch in response to current in the feeder, and serve the purpose of the usual overload relays. Transformers *T*1 and *T*2 are connected one on either side of the oil switch, and in such a way that when the oil switch is closed their voltages will oppose each other, and therefore there will be no voltage impressed on relays *R*3 and *R*4. Then, when an arc occurs on the feeder, either of the relays *R*1 or *R*2 may trip the switch but as soon as the current is interrupted by the oil switch the voltage on the two transformers *T*1 and *T*2 will become unbalanced, which will cause current to flow through relays *R*3 and *R*4; *R*4 will pick up instantly, but *R*3 being a time-limit relay will start to move but will not close its contacts for a predetermined time. When relay *R*4 closes its contacts, current will flow through relay *R*5, which will close its contact, and thereby close the oil switch. If the short circuit is still on the feeder when it is made alive, relays *R*1 and *R*2 will trip the switch again and *R*4 and *R*5 will close the switch as soon as the potential across the switch is unbalanced. This opening and closing of the feeder switch will continue until the relay *R*3 closes its contacts, thereby short circuiting the upper coil of relay *R*4, which will prevent this relay from further operation until the voltage across *R*3 has been reduced to zero for sufficient time for it to return to its starting position. This is done after the trouble on the feeder has been cleared by opening switch *E* and closing the oil switch by means of switch *C*; then the system can be put in operation again by closing switch *E*. If the arc breaks the first time the oil switch opens, *R*3 will return to its starting position making the apparatus self-setting.



FIGS. 6, 7 AND 8.

In order to illustrate the accuracy with which this system operates, and its effect on the service, oscillograph records were taken on a 6,600-volt system protected by this method. The arc was started by throwing a one-inch (2·54 cm.) spark gap, short circuited by a fuse wire, across the circuits.

In Fig. 6, *A* shows the 'bus voltage, *B* the current in one leg of a 200-h.p. induction motor carrying full load, and *C* the voltage on the feeder. To make the test most severe, the short was made near the switch and the load on the motor was provided by a direct-connected generator supplying current to a resistance, so that the fly-wheel effect would be very small. It will be noted that the time of operation was the same in each case and that the load was not very great after the operation. Fig. 7 was taken under the same conditions as Fig. 6, except that the spark gap was made so the arc would not break. This shows how the number of operations was limited.

Fig. 8 shows the operation of the system with a later type oil switch; *A* is the voltage across the switch and therefore shows the time the switch was open, *B* is a timing curve taken from a circuit of 62½ cycles, and *C* shows the current in the short circuit. It will be noticed that the switch opened much quicker and closed slower than the old type switch used in the other tests; the total time of operation, however, was about the same.

The tests shown above have been repeated many times and in no case has the time required for similar operations varied more than 0·02 second.

A WEHNELT CATHODE-RAY TUBE MAGNETOMETER.*

BY CHAS. T. KNIPP, M.A., PH.D., AND L. A. WELO, M.S.

In a recent Paper† the authors described an apparatus for determining the horizontal intensity (*H*) of the earth magnetic field, depending on the measurement of the magnetic and electrostatic deflections of a beam of cathode rays and on the assumption of the ratio of the charge to the mass of the electron. It has since been suggested by the authors that it might be well to deduce *H* by comparing the deflection produced by the earth's magnetic field with the deflection produced by a known calculated field, thus avoiding the assumption of the ratio e/m. It was for the purpose of carrying out this suggestion, and also in the hope of obtaining a more compact and convenient instrument, that the work now to be described was undertaken.

The discharge tube is a glass jar about 40 cm. in height and of 12 cm. diameter, clamped at the bottom to a brass plate, which is in turn fastened to the widened part of a brass pipe about 5 cm. in diameter. The last fastening is adjustable, so that the axis of the discharge tube can be made to coincide exactly with that of the pipe, which turns in holes cut in a wooden frame. The pipe thus serves as a bearing, permitting the discharge tube to be turned about a vertical axis. The rotation about the vertical axis is a necessary feature of the instrument, for the earth's magnetic field cannot very well be eliminated for a zero reading of the deflections, but they must be observed for various orientations of the tube.

The tube is exhausted through a glass stem inside of the brass pipe. One end of the stem is waxed into a hole at the bottom of the jar, and the other is fitted by a long and well-ground joint to another glass stem which connects to a Gaede capsule pump, to a bulb containing the drier P_2O_5, and to the charcoal liquid air bulb for further improving the vacuum.

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* Abstract of a Paper in the "Philosophical Magazine," No. 190, 1916.

† Knipp and Welo, "Terrestrial Magnetism and Atmospheric Electricity," "Phil. Mag.," Vol. XX., 1915, pp. 53-68.

The cathode shown at C, Fig. 1, is of a form previously described by the authors,* but has in this case been somewhat simplified and made more compact. The object of using the Wehnelt cathode rather than the cold aluminium cathode is to secure electrons having a low velocity, with consequent measurable deflections for the relatively weak earth field, and at the same time get a definite beam of sufficient range without the use of diaphragms, as was found possible when the spot of lime (Bank of England wax) does not exceed 0·02 cm. in diameter. The direction that the beam takes is uncertain, and two adjustments of the cathode are necessary, one in the plane of the drawing and one perpendicular to it.

The anode is an aluminium ring of nearly the internal diameter of the jar, lying at its bottom, and connected by a wire to mercury at the bottom of the glass stem below the joint J_1. The mercury is in contact with a sealed-in platinum wire, which is connected to the positive terminal of a high potential battery. Since the cathode and the wire leading to the anode from the inside of the exhaust tube are very close together, a mica screen is inserted at M to prevent a direct discharge, which might take place if the vacuum were at a favourable stage, with possible injury to the battery.

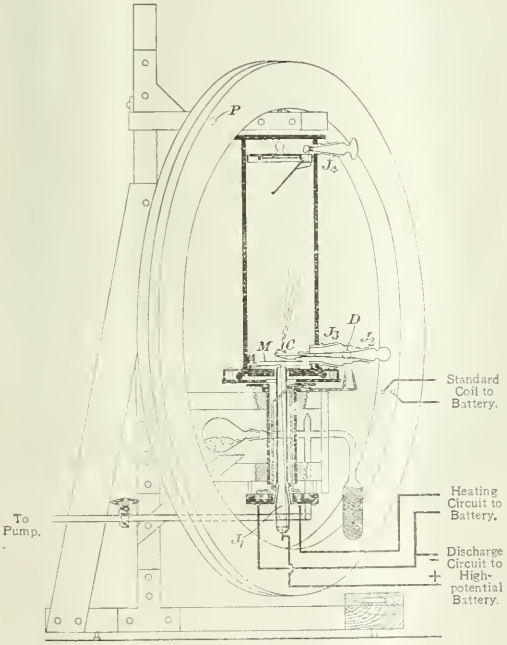
P
J_4
D
J_3
J_2
M
C
Standard Coil to Battery.
Heating Circuit to Battery.
To Pump.
J_1
Discharge Circuit to High-potential Battery.
−
+

FIG. 1.—DIAGRAM OF THE INSTRUMENT.

The deflections of the beam of particles are recorded on a photographic plate held near the top of the tube in a simple form of plateholder and shutter. The holder, which rests on a brass ring waxed to the inside of the tube, is a disc of aluminium with a small segment cut away. On the under side of this disc a shallow box is built. One end of the box is slightly undercut on the inside, so that the photographic plate can be wedged in, and a wedge-shaped clamp actuated by a spring in the wall at the other end secures the plate in position, not only from falling out, but presses it up against the disc, so that its position is never in doubt. The cover is a thin aluminium plate hinged at a side, bent over at the edges to prevent light from entering edgewise, and is backed by a spring, so that it will stay closed. The lid is opened by the winch shown at J_4, which winds a string hooked to the handle on the lid. The discharge tube is closed at the top by a piece of plate glass, sealed on with half-and-half (beeswax and resin) wax.

The platinum strip on which the lime is placed is heated electrically. To do away with troublesome winding of the wires as the tube is turned a hard rubber plate containing two rings of mercury was arranged immediately beneath the brass pipe bearing. The rings are connected to the terminals of a battery by binding posts leading up under the rings through the rubber. From the rings, wires lead up the inside of the brass pipe, but outside the exhaust stem, through the brass pipe above the wooden frame, and thence to sealed-in platinum terminals set in tubes perpendicular to the plane of the drawing and indicated by the dotted circle at D. Wires on the inside of the cathode mounting lead to the cathode itself. One terminal of the heating circuit leads to the negative end of the high-potential battery, while the positive end of the high-potential battery is connected to the sealed-in platinum wire below J_1, as has already been stated.

The coil of six turns, wound so close that the current may be considered a circular one, is wound on a built-up and accurately turned wooden core. It is pivoted on the horizontal support, shown above the discharge tube, so that it hangs vertically, but is prevented from turning about a vertical axis by an adjustable clamp (not shown) on the support. A pointer on the coil which moves over a graduated circle on the support gives the orientation. A pointer on the brass supporting pipe and a graduated circle on the wooden frame gives, it might be added, the orientation of the tube itself. When it is desired to remove the cover from the discharge tube the coil is lifted off and the support swung back about the pivot P.

When making a determination the pump is generally run for over an hour, the charcoal bulb being gently heated during the while to drive off gas absorbed at ordinary temperatures. When the bulb has cooled it is immersed in liquid air. The heating circuit may soon be closed, the resistance adjusted until the platinum glows with a red heat, and 1,000 volts now applied between the cathode and anode. It is well to leave the glowing cathode thus for, say, five minutes. If the heating current is then slowly increased a diffused spot will show on the plateholder lid, which is covered with willemite. On further heating, the diffused spot becomes either a well-defined spot or a sharp line in a plane containing the platinum strip. After the cathode has been adjusted so that the spot is east of the centre of the plateholder by an amount equal to the estimated deflection (and in the plane of the coil), and the orientation of the tube noted, the plateholder is opened and an exposure made for 5 to 15 seconds, depending on the intensity of the beam. The switch of the coil circuit is then closed, so that the beam is deflected still more, and the exposure at the new spot made. Then the plateholder is closed, the tube turned to 180 deg., the plateholder again opened and the process repeated. We thus get four spots or lines on the plate, which should be arranged along a straight line. Half of the distance between the two inner spots is the deflection due to the earth's field alone, while half the distance between the outer two is the deflection with the earth's field increased by the standard one.

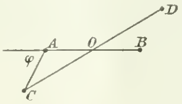

FIG. 2.

The Declination.—It is unnecessary to determine the declination by another instrument in order to set the coil in a plane perpendicular to the meridian. The instrument itself is, indeed, a sufficiently accurate declinometer for the purpose of setting the coil.

A test photographic plate is first taken with the coil in any position, which is noted on the graduated circle, and four spots obtained. Fig. 2 represents the general case. OA is the deflection due to the earth's field alone, and OC that due to both fields. But OC is the resultant of OA and the component AC of the coil field making an angle, φ, with BA produced. On this test plate, then, the line BA is drawn and produced; draw the line AC and measure the angle φ. The coil must be turned through the angle φ in order that it be perpendicular to the magnetic meridian.

In the subsequent section of the Paper the authors work out formulæ enabling the intensity of the field from the standard coil to be accurately computed and relating this intensity, and the deflections recorded on the photographic plate with H. Account is taken of the fact that the field of the standard coil is not uniform along the path of the rays, and an analytical solution of the problem is found.

Seven determinations of H were made, with a relative probable error in the fourth significant place. However, this does not fairly indicate the performance of the instrument, owing to the presence of electrical circuits in neighbouring rooms and the changing distribution of iron in the building.

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*Loc. cit.

ON THE MANUFACTURE AND TESTING OF PRISMATIC COMPASSES.*

BY F. E. SMITH.

The primary object of this Paper is to assist makers of prismatic compasses in the manufacture of these instruments and in testing their reliability.

As the object of a prismatic compass is to determine direction, any defect in material or error in workmanship which affects the determination of direction should be tested for. It is also an essential condition that these tests should not be merely of a qualitative nature, but should indicate the magnitude of the error accruing from faulty material or bad workmanship.

The possible errors may be briefly summarised thus:—

1. Error due to want of parallelism of axis of magnet with the 180 deg. to 360 deg. direction as indicated on the dial.
2. Error due to eccentricity of dial and point of suspension.
3. Error due to centre of suspension not being in plane containing slit and line.
4. Error due to want of uniformity of the engraved divisions on the dial.
5. Error due to sighting line being out of the vertical when the compass is supported on a horizontal surface.
6. Error due to prismatic effect of the glasses (window and cover).
7. Error due to magnetic material in the case, screws, &c.
8. Error due to faulty setting of prism in the prism box.
9. Error due to excessive friction between pivot and jewel.

POSSIBLE ERRORS NOS. 1, 2 AND 3.

First with regard to the errors 1, 2 and 3. It is not *essential* to have the axis of the magnet directly under the 180 deg. to 360 deg. line.

If, however, the axis of the magnet is not *parallel* to the 180 deg. to 360 deg. diameter the error of the bearings (in degrees) will be constant and equal to the angle between the magnet's axis and the diameter in question.

Next suppose that the centre of the dial as represented by the engraved divisions does not lie on the axis of support.

When the vertical plane containing line and slit is parallel to, but does not contain, the 180 deg. to 360 deg. diameter of the dial, but the centre of the dial is on the axis of support, the error is constant and always of the same sign.

In general the bearing errors 1, 2 and 3 are present to a very small extent in every compass.

On inspection of a large number of prismatic compasses I find that the axis of the magnet is frequently inclined to the 180 deg. to 360 deg. line, errors as large as 3 deg. being due to this cause alone. The eccentricity of the dial and point of support is very small in compasses of some makers and very large and variable in others. The error due to this cause in most of the compasses examined was about a half degree.

It appears that errors 1 and 2 would be considerably reduced if the following process of construction were adopted:—

(*a*) The magnet pieces to be stamped and of regular shape, the three circular holes C D C′ being on the axis of the magnet. These holes to be tapped. There is, therefore, perfect symmetry about the line *a b*. When these steel pieces are hardened and properly magnetised (see later section of Paper) the magnetic axis coincides with the geometrical axis *a b*.

(*b*) The mother of pearl disc to have three holes drilled in it corresponding with the three holes in the magnet, and when the disc is engraved it should be placed over three studs protruding through the holes. The line of these three studs on the engraving machine to be the 180 deg. to 360 deg. diameter of the dial.

(*c*) The jewelled centre piece and two small screws secure the magnet to the dial, and if perfection of workmanship be assumed the magnetic axis will be parallel with the 180 deg. to 360 deg. diameter and there will be no eccentricity between the dial and centre of support. The mother of pearl is sufficiently transparent to enable one to see if the points of the magnet lie in the diameter referred to.

There is a chance of eccentricity in the jewelled centre piece, and in assembling, care should be taken to avoid this.

Errors of bearing are measured at the National Physical Laboratory in a special hut built of non-magnetic material and in which the direction of the earth's magnetic field can at any moment be determined within less than a tenth of a degree. In one portion of this hut a declinometer with a mirror is set up, and the position of a line of light on a transparent scale gives the magnetic declination. On special supports in the hut prismatic compasses can be tested. Readings of the compasses are taken when the plane containing the slit and line lies in the meridian, and other readings are made when this plane is at right angles to the meridian. In all, four readings corresponding to the directions magnetic N., S., E., and W. are taken, with a probable error due to the arrangements of not greater than a tenth of a degree. With liquid compasses readings are made every 45 deg.

In the past the great difficulty has been the fluctuation of the magnetic field in any ordinary workshop or test-room. In one case a manufacturer assured me that the daily change in the direction of the magnetic field in his test-room was normally 3 deg.; this variation was largely due to some neighbouring electrical machinery.

Fortunately the difficulty is readily overcome, and provided that the maker has one good standard compass he can easily and cheaply find all bearing errors for himself. Suppose a good prismatic compass to be mounted on a small table and let it fit into a ring of wood or brass—or better let there be a centering device—so that other compasses may be substituted for it with a certainty of occupying the same position. Turn the compass until the reading is approximately 360 deg. and note the time of swing as well as the reading of the dial. Let the time of swing be T_1 seconds. In the figure a simple brass pedestal screwed to a rigid support is shown supporting the compass. Under the base of this pedestal it is possible to introduce a long bar magnet the poles of which are n s. The height of the pedestal above the table need not be more than 15 cm. After the period T_1 and the reading ot the dial have been taken the long bar magnet is introduced into position (n pole pointing north), so that the centre of the magnet is practically under the centre of the compass and its axis approximately in the magnetic meridian. To ensure the latter condition being satisfied the direction of the magnet is changed until the reading of the compass is the same as before. Again, take the period of the compass. Let it be T_2 seconds. Then the new magnetic field intensity is greater than the old magnetic field intensity in the proportion T_1^2 to T_2^2. Thus if the first time of swing was 6·0 seconds and the second 2·0 seconds, the second magnetic field is nine times as intense as the original field. With the arrangement sketched (the compass being 15 cm. above the level of the table) I have obtained a magnetic field 10 times as intense as the earth's horizontal field by using a bar magnet 25 cm. × 2 cm. × 1 cm. I suggest that makers increase the intensity of the field at least 10 times; preferably more.

The bar magnet is now *rigidly secured* to the observation table and the case of the standard compass turned until the reading of the dial corresponds exactly to the reading "true north," as deduced from the certificate for the compass.

On a wall at as great a distance as possible a bright vertical line is set up in such a position that the sighting line bisects it. For convenience the bright line should be only slightly broader (apparently) than the sighting line. The vertical plane passing through this line and the centre of the observation table may now be taken as the magnetic meridian for the purpose of testing compasses, and no appreciable error will result.

The arrangement described costs but a few shillings to install and is absolutely reliable. It will be seen that the testing of compasses does not involve the use of a non-magnetic hut if a reliable standard compass is available. The latter need not be specially made; a good prismatic compass with negligible friction error is suitable. It should be standardised at some such laboratory as the National Physical Laboratory—where a non-magnetic hut is essential—and re-standardised from time to time in case of change. The arrangement described must not be used to take the normal period of the magnet system, nor the error due to friction between pivot and jewel.

POSSIBLE ERROR NO. 4.

With regard to the divisions on the dial, most engraving machines are so accurate that the error is generally too small to be considered. I have no knowledge of a prismatic compass being rejected owing to errors due to the dividing of the dial, but in hand-painted cards for ships' compasses the error may be considerable.

POSSIBLE ERROR NO. 5.

The want of verticality of the sighting line may produce appreciable error. It is not uncommon for the error due to the line to be as great as half a degree.

When testing a compass for the magnitude of this error the instrument is placed on a carefully levelled horizontal table and turned until the lower end of the line apparently bisects the white space between two lower blackened squares on a vertical board situated 228 cm. from it. The upper part of the line when viewed now appears to bisect the white space between two blackened squares on the upper part of the board, and the number corresponding to these squares gives the possible error due to the inclination of the line. From the centre of the white space (reading 0) a silk plumb-line drops through the centre of the lower white space. The horizontal displacement of the white spaces between successive pairs of black spots is 1 mm. (corresponding to a tenth of a degree).

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[*] Abstract of a Paper read before the Optical Society.

Width of Line and Slit.—The sighting lines in some compasses are unduly thin, the apparent width when viewed through the slit being at times as small as 5′. In the majority of instances the apparent width is 15′, and this width is one to be recommended. It is customary to regard a compass as unserviceable if the actual width of the slits is less than a fifth of a millimeter.

POSSIBLE ERROR NO. 6.

The prismatic effect of the glasses of the window and cover is very rarely serious and the error introduced is generally of the order of 0·1 deg. Most pieces of glass having flat surfaces (unless specially worked) are slightly prismatic, and some makers test the glasses before marking the line on the window. The glass is turned so that any displacement of a ray of light is in a vertical plane; if so used in the window no prismatic error is introduced.

POSSIBLE ERROR NO. 7.

The magnetic effect of the case and metal fittings is important. Some cases are cast, others stamped, while others are spun. If a case is slightly but uniformly magnetic there is no error due to it, but if particles of iron or steel are present, thus destroying symmetry, an error varying with the position of the magnet is introduced. Most brass screws are magnetic; some of them are appreciably so, and their introduction into a case may produce errors as large as 6 deg. As most brass intended for the manufacture of screws has a considerable content of iron (I am told that it is added to make the machining easier) great care should be exercised in choosing purchased screws.

Errors due to part of the case or screws being of magnetisable metal cannot be quantitatively determined without the aid of a special instrument.

If the compass needle were supported on an absolutely frictionless pivot then the magnet would always point due magnetic north, conditionally that no magnetic material was near it. The rotation of the case, if non-magnetic, would not affect such a needle. While such a test is impossible owing to the friction between the pivot and jewel, it is easy to design an instrument for testing a compass case on this plan.

Such an arrangement has for its object the replacement of the magnet of a prismatic compass by a magnet of the same length and practically the same moment but whose motion is not controlled by solid friction.

To test the case of a compass and to measure in degrees the error which is likely to be produced by magnetic material in the case, the cover glass and dial must be removed. The case, with the window vertical or inclined, is then raised to the correct height. The point passes into the thimble *T*, and the prism box is raised and pushed over as when making observations. The case is then *very slowly* rotated. By means of the mirror the image of a bright filament is thrown on a scale divided into degrees, and by observing the motion of the image the error due to the case can be directly read off.

POSSIBLE ERROR NO. 8.

Not unfrequently errors of bearing are produced through faulty setting of the prism in the prism box. It is necessary that the vertical plane containing the slit and line should be normal to the reflecting surface of the prism. When this is not so the graduations on the dial appear to be non-radial. I have examined compasses in which the difference between readings amounts to half a degree.

POSSIBLE ERROR NO. 9—FRICTION BETWEEN PIVOT AND JEWEL.

The commonest defect of all is excessive friction between pivot and jewel. This produces an uncertainty in the readings, which invariably increases with prolonged use of the compass.

When the magnet is moving away from its position of equilibrium there are four distinct forces acting on the moving system, all of which tend to stop its motion. These forces are:

1. Magnetic force due to action of earth's magnetic field on the magnet.

2. Fluid frictional force due to retarding action of the medium in which the system swings. In the case of an ordinary prismatic compass the medium is air. In liquid compasses the medium is a mixture of spirits and water, or of glycerine and water.

3. Electromagnetic retarding force due to the production of electrical eddy currents in the metal case.

4. Solid frictional force due to the friction between pivot and jewel.

Forces (2) and (3) depend on the velocity of the moving system. When the velocity is great these fores are of considerable magnitude. For small velocities they are negligible. The meaning of great and small velocities will presently be seen.

Force No. 1 is proportional to the displacement of the moving system, but force No. 4 is independent of the velocity and of the displacement.

Forces Nos. 1, 2 and 3 are beneficial to the action of a compass Force No. 4 is not.

The important thing to observe in the manufacture of a compass is to make force No. 1 large, *i.e.*, the magnet should be strong, and to make the ratio of force 1 to force 4 as great as possible. In the case of the ordinary prismatic compass forces 2 and 3 are considerable, but it would be of advantage if they were greater still. The greater they are the sooner will the system come to rest, and this without any sacrifice of accuracy.

The rapid reduction or "damping" of the oscillations caused by air friction and electromagnetic action is very considerable. In the instance of compass (*a*) an oscillation of 5 deg. amplitude (10 deg. of swing) would, after one minute (the period was 4·5 seconds), be reduced to 4·3 deg. by solid friction only, but the air friction and electromagnetic damping reduce the amplitude to a fifth of a degree in loss than half a minute. And these forces produce no uncertainty in the readings. If the compass case had been of copper the electromagnetic damping would have been much greater. By properly shaping the moving system it is possible also to increase the fluid friction.

In liquid compasses this damping may be made "aperiodic," so that the system when displaced from its position of equilibrium will not oscillate, but will return in a single movement to its position of rest.

In a few rejected compasses the frictional error has been greater than 10 deg. In the majority of instances, whenever a frictional error exceeds half a degree the value obtained varies considerably with change in the relative position of pivot and jewel. In certain positions the frictional error is often very excessive. This is no doubt due to a want of symmetry of the point and jewel about the axis. In such cases it is practically impossible to repeat the readings, but it is not difficult to confirm the fact that the friction is excessive.

Having explained the cause of the uncertainty the remedy must be sought. This, briefly, consists in improving the pivot the jewel in increasing the intensity of magnetisation of the magnet, and in reducing the ratio of the moment of inertia of the moving system to the moment of the magnet.

I have examined under the microscope a large number of hard steel pivots in compasses from various makers. Many of the conical points showed flat reflecting surfaces, and in a few instances the pivots were clearly too soft. The general shape of the point was usually correct. The pivots should be of hard steel, but in general not quite dead hard.

With regard to jewels, agates are usually employed but garnets are better. Agates vary considerably in hardness, and care should be taken to choose hard stones. The polish is important.

In all instances it may safely be asserted that any error due to friction between pivot and jewel will increase with the use of a compass. Good pivots and good jewels are therefore of fundamental importance. The very best type of pivot is a short, hard steel pin forced into a larger brass pin and ground up in the lathe. A dead hard point can then be used. In liquid compasses the points should be of iridium.

The Magnet and Dial.—It will be observed that in the list of errors (p. 312) no mention is made of the strength of the magnet or of the time of swing. Both of these are, however, measured in testing a compass.

On the whole I am inclined to think that with mother of pearl dials the magnets are preferably not less than 1 mm. thick. In such a case the total moment of inertia for a dial (0·5 mm. thick) and magnet is about 5 gm. cm. units.

The magnetic moment of such a magnet, if made of good steel, may, after ageing, exceed 50 C.G.S. units, and the time of a complete swing of the dial system will not exceed five seconds. When testing compasses at the National Physical Laboratory the moment of a magnet 4·5 cm. long is regarded as too small if it is less than 18 C.G.S. units, and a system is regarded as too sluggish if the period exceeds 7·0 seconds. It is clear that for such a weak magnet the moment of inertia must be correspondingly small for the compass to be satisfactory.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Elementary Mathematics for Engineers," by E. H. Sprague, A.M.Inst.C.E. (London: Scott, Greenwood & Son.) Pp. viii.+236. 4s. net.

"Spon's Electrical Pocket Book," by W. H. Molesworth. (London: E. & F. N. Spon.) Pp. vii.+488. 6s. net.

THE GRADING OF STARTING RESISTANCES FOR SERIES MOTORS AND FOR SERIES-PARALLEL CONTROL.

BY F. T. CHAPMAN, D.SC.

In several recent articles on this subject it is assumed that the maximum and minimum starting currents can be fixed at the outset, and the number of steps, n, in the rheostat chosen to suit them.* But in general the values chosen at first will not agree with any integral value of n, and they must be adjusted by a lengthy process of trial and error.

In practical work the value of n is often fixed by the type of controller to be used in a particular case, or the choice is between two or three values at the most.

The value of the maximum current (I_1) employed during the starting period will be limited by (a) the capacity of the circuit to which the motor is connected and the possible effects on neighbouring circuits; (b) the setting of the fuses or circuit-breakers which protect the motor; (c) the possibility of mechanical injury to the motor, or to gear connected with it, by unduly large accelerating forces; and (d) slipping of the driving wheels in the case of traction motors. On the other hand, I_1 must be large enough to allow a sufficient mean acceleration during the starting period. The value of I_1 is thus fixed fairly definitely by conditions altogether apart from the starter.

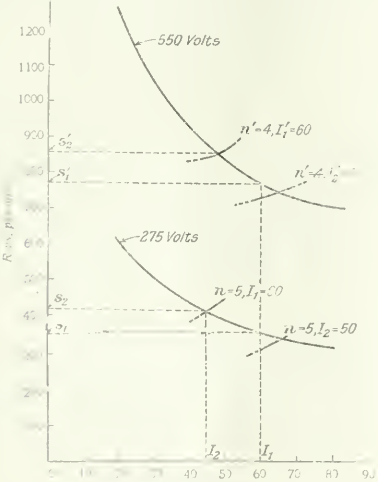

FIG. 1. SPEED-CURRENT CURVES.

I_1 and n being fixed, the minimum current I_2 and the values of the resistance steps are to be determined. Methods of making these calculations have been published already,† but the following method, though based on the same fundamental principles, presents some novelty.

In all cases it is necessary to employ either the speed current curve (Fig. 1), the tractive-effort curve, or the saturation curve of the motor considered. The first is most usually available, especially in railway work, and the method given here is based upon it.

For any series motor we can write

$E = Ir + ks$,

where E = applied E.M.F.,

I = current in motor,

r = total resistance of motor circuit, including rheostat, if any,

k = a coefficient depending on the winding constants of the armature and on the field flux; its value is constant so long as I is constant.

s = speed of motor. This may be in revolutions per minute, or the train speed in miles per hour may be used instead.

For a given value of I the relation between r and s is a straight line, such as AB in Fig. 2. The normal speed s_1, corresponding, on the speed-current curve, to a current of I_1, is obtained when $r = r_m$, the resistance of the motor alone, and if the speed is zero when the external resistance is r_1 and the current is I_1, then $r_1 + r_m = E/I_1$. In Fig. 2 the co-ordinates of the points A and B are (r_m, s_1) and $(r_1 + r_m, 0)$ respectively, and the line AB refers to a current, I_1. For any other current, I_2, we can draw the line CD, the co-ordinates of C and D being (r_m, s_2) and $(r_2 + r_m, 0)$ respectively; s_2 is the speed corresponding to I_2 on the speed-current curve and $r_2 + r_m = E/I_2$.

In starting the motor the ideal process is to switch it into the circuit with the resistance r_1 in series. The speed then rises to u_1, while the current falls to the desired minimum value I_2. This condition is represented by point E in Fig. 2. A suitable fraction of this resistance is now cut out so that the current again rises to I_1 without any change in speed (the effects of self-induction being neglected), and this is the condition at point F; the speed now rises by an increment, u_2 to G, and so on. The process of starting the motor is represented by the zig-zag line $BEFGH$ . . . of Fig. 2, commencing on the first contact of the starter at B and ending on the nth contact at A.

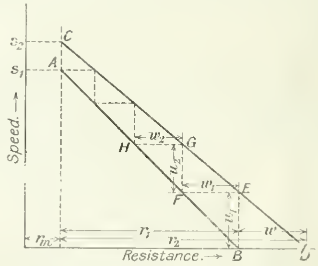

FIG. 2.

If w_1, w_2, &c., be the resistances cut out on the successive contacts, and $w = r_2 - r_1$ (w is not a part of the actual resistance), we see from Fig. 2 that

$$\frac{r_2}{s_2} = \frac{w}{u_1} = \frac{w_1}{u_2} = \frac{w_2}{u_3} = \dots = \frac{w_{n-2}}{u_{n-1}} \quad . \quad . \quad . \quad . \quad (1)$$

and

$$\frac{s_1}{r_1} = \frac{u_1}{w_1} = \frac{u_2}{w_2} = \dots \dots = \frac{u_{n-1}}{w_{n-1}} \quad . \quad . \quad . \quad . \quad (2)$$

Multiplying together the corresponding terms of these two series of equations we obtain

$$\frac{r_2}{r_1} \cdot \frac{s_1}{s_2} = \frac{w}{w_1} = \frac{w_1}{w_2} = \frac{w_2}{w_3} = \dots = \frac{w_{n-2}}{w_{n-1}} \quad . \quad . \quad . \quad . \quad (3)$$

If we write $r_2/r_1 = R$, and $s_2/s_1 = S$, we see from (3) that

$w_1 = w \cdot \frac{S}{R}$, $w_2 = w_1 \cdot \frac{S}{R} = w \cdot \left(\frac{S}{R}\right)^2$, and so on to $w_{n-1} = w\left(\frac{S}{R}\right)^{n-1}$.

But $\qquad w + w_1 + w_2 + \dots + w_{n-1} = r_2 = r_1 . R$,

and $\qquad w = r_2 - r_1 = r_1(R - 1)$.

$$\therefore \quad r_1(R-1)\left\{1 + \frac{S}{R} + \left(\frac{S}{R}\right)^2 + \dots + \left(\frac{S}{R}\right)^{n-1}\right\} = r_1 R,$$

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* See, for instance, F. Castiglioni, "Calculation of Starting Resistances for Railway Motors," "Electric Railway Journal," 44, pp. 1382-1385, Dec. 26, 1914; A. M. Buck, "Proportioning of Railway Motor Resistances," "Electric Railway Journal," 45, pp. 330-332, Feb. 13, 1915; C. C. Garrard, "Apparatus for Starting and Controlling Electrical Running Machinery," THE ELECTRICIAN, 76, pp. 772-774, March 3, 1916.

† E. Eros, "Eine analytische und graphische Methode zur Berechnung von Anfahr- und Bremswiderständen für electrische Eisenbahnen," "Elektrotechnische Zeitschrift," 16, pp. 277-282, April 20, 1899; H. Parodi, "Calcul des Résistances de Démarrage d'une Locomotive à courant continu," "La Lumière Electrique," 25, pp. 641-646, May 23, 1914.

whence

$$(R-1)\frac{1-\left(\frac{S}{R}\right)^n}{1-\frac{S}{R}}=R$$

and

$$R=\frac{1-\left(\frac{S}{R}\right)^n}{\frac{S}{R}-\left(\frac{S}{R}\right)^n} \quad \ldots \ldots \ldots \quad (4)$$

The value of S/R never exceeds unity, and by assigning to it a suitable series of values, corresponding values of R can be calculated. We then find S from the equation $S=R\ (S/R)$. For each value of n we can express by a curve the relation between S and R which must hold in order that the line *BEFGH* . . . *A* may be complete in exactly $n-1$ steps, as required by a starter with n contacts or "notches." Table I.

Table I.

$n=3$		$n=4$		$n=5$		$n=6$		$n=7$		$n=8$	
S	R	S	R	S	R	S	R	S	R	S	R
1·50	1·50	1·33	1·33	1·25	1·25	1·20	1·200	1·167	1·167	1·143	1·143
1·40	1·63	1·25	1·44	1·20	1·31	1·17	1·235	1·150	1·185	1·120	1·168
1·35	1·71	1·20	1·54	1·15	1·40	1·15	1·260	1·120	1·225	1·100	1·195
1·30	1·81	1·15	1·67	1·10	1·54	1·10	1·365	1·090	1·288	1·070	1·260
1·25	1·95	1·10	1·85	1·07	1·70	1·07	1·475	1·050	1·420	1·040	1·375

and Fig. 3 give data for a set of such curves* for $n=3$ to $n=8$. They can be used in calculations on any motor, series, shunt or compound, when the speed current curve is given, as follows :—

Fix the maximum current I_1 from the speed curve read off the corresponding speed s_1, and calculate r_1, the external resistance required to reduce the current to I_1 at standstill.

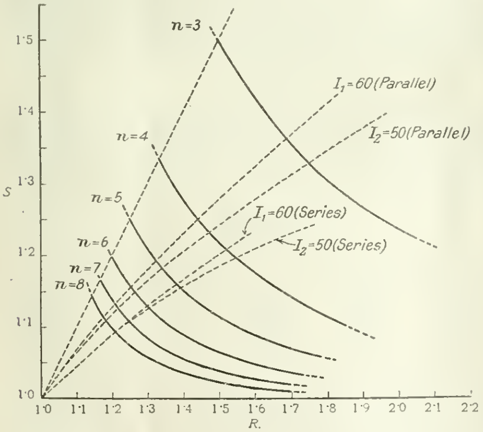

FIG. 3.

For some smaller current, I, the speed and resistance will be s and r respectively, and if this current were employed as the minimum during the starting period we should have $S=s/s_1$ and $R=r/r_1$. By considering several values of I in succession we should obtain a series of values for S and R, which would give a curve like those shown dotted in Fig. 3. Each curve is characteristic of the motor in question for the particular value of I_1 chosen, and, by its intersection with the full-line curves, it gives the values of S and R which satisfy the conditions imposed by the use of the corresponding numbers of contacts, and from them the necessary values of I_2 and r_2 can be determined. In practice the full-line curves of Fig. 3 would be drawn once for all, and the motor curve would be drawn on transparent paper laid over them.

An example will help to make this clear. A 275-volt motor is to be started with a five-contact starter, the maximum current (I_1) is to be 60 amperes, the total resistance of the motor and leads (r_m) is 0·60 ohm, the speed-current curve is given in Fig. 1 marked "275 volts." The calculation is given in tabular form in Table II., where the first and third columns are obtained from the speed-current curve and the remaining columns are calculated as shown.

Table II.

I	$r=(E/I)-r_m$	s	$S=s/s_1$	$R=r/r_1$
60(I_1)	3·98(r_1)	358(s_1)	1·0	1·0
55	4·40	375	1·048	1·105
50	4·90	395	1·103	1·230
45	5·51	414	1·156	1·384
40	6·27	440	1·230	1·575

The figures for R and S in the last two columns give the dotted curve marked "$I_1=60$ (series)" in Fig. 3, which cuts the curve "$n=5$" where $S=1·157$; the normal speed at minimum current must be $S\times s_1=1·157\times358=414$ revs. per min., and from Fig. 1 we see that this means a minimum current of 45 amperes with $r_2=(275/45)-0·60=5·51$ ohms. A diagram like Fig. 2 can now be drawn, and the values of the resistance steps w_1, w_2, &c., determined.

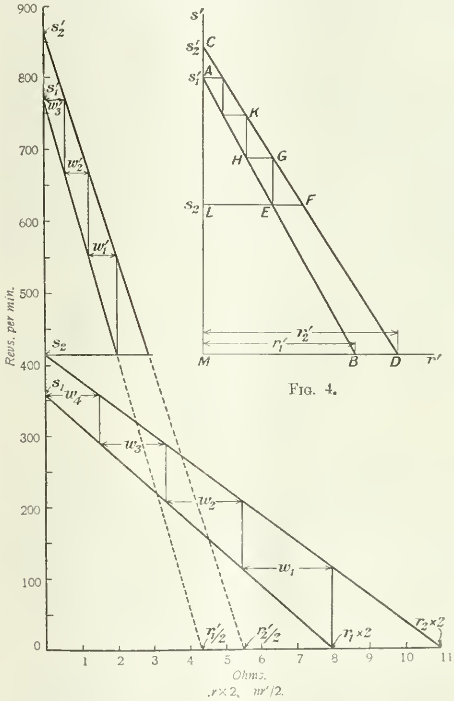

FIG. 4.

FIG. 5.—DIAGRAM SHOWING METHOD OF COMPUTING RESISTANCE STEPS FOR SERIES-PARALLEL CONTROL OF TWO SERIES MOTORS.

No. of series notches=5. No. of parallel notches=4. Max. current throughout=60 amps. Min. current on series notches=45 amps. Min. current on parallel notches =47·6 amps. (For speed curves see Fig. 1.)

Another method of procedure is to convert the $n=5$ curve of Fig. 3 into terms of s and I and superpose it on the speed curve, thus determining I_2 immediately as the intersection between the two curves. Table III. gives the calculation required; r_1 and s_1 are determined as above. The figures in the first two columns are taken directly from Table I. The curve marked "$n=5$, $I_1=60$" in Fig. 1 is obtained from the figures in the last two columns, and the intersection with the speed curve indicates that the necessary value of the minimum current is 45 amperes.

The method of Table II. is most convenient where several values of n are to be compared, while that of Table III. is preferable when n is fixed.

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* Similar curves were given by Parodi, *loc. cit.*

Table III.

S	R	$r=R\times 3{\cdot}98$	$s=S\times 358$	$I=E/(r+r_m)$
1·25	1·25	4·97	447·5	49·4
1·20	1·31	5·22	430·0	47·2
1·15	1·40	5·57	412·0	44·5

SERIES-PARALLEL CONTROL.

In a simple series-parallel control system the motors are brought up to a speed, s_2, corresponding on the half-voltage speed curve to the minimum current on the series notches, and are then switched into parallel with a suitable resistance in circuit to keep the current per motor down to some maximum value, I_1'. If we consider each motor separately, we can draw speed-resistance lines for full voltage, as AB and CD in Fig. 4, in exactly the same manner as for half voltage in Fig. 2 (r_m has been omitted in Figs. 4 and 5), and we now have $R'=r_2'/r_1'$ and $S'=s_2'/s_1'$. Draw the line LEF at a height equal to the speed s_2 at the end of the series period. The resistance to be switched in series per motor, to keep the current down to I_1' on the first parallel notch, is given by the length LE, and the operation of bringing the motors up to full speed is indicated by the line $EGHK$ . . . A. The line CD corresponds to a minimum current which is to be determined; this current is generally different from the minimum during the series period.

If we denote by R the ratio LF/LE, and by S the ratio CL/AL, it is obvious that the relations between R and S and the number of parallel notches are the same as those given in Table I. and Fig. 3.

Referring to Fig. 4 we see that

$$CL/CM=LF/MD \text{ and } AL/AM=LE/MB.$$

Dividing the first equation by the second and rearranging we obtain

$$\frac{CL/AL}{CM/AM}=\frac{LF/LE}{MD/MB},$$

i.e.,

$$R/R'=S/S';$$

but we see from Fig. 4 that $S=(s_2'-s_2)/(s_1'-s_2)$, and, knowing S, we find R from $R=S\,.\,R'/S'$.

The speed curve on full voltage being known and the maximum current fixed (say I_1'), s_1' and r_1' can be found; for any other current, I', we can determine s' and r', and hence the corresponding values of $S=(s'-s_2)/(s'_1-s_2)$ and of R. An R-S curve can then be constructed and superposed on Fig. 3 as before, and the minimum current and the resistance steps determined.

As an illustration we will take the same motor as in the previous example, which will now be run up to full speed on a voltage of 550. The speed curve for this voltage is given in Fig. 1. The speed at minimum current on half voltage was 414 revs. per min. The maximum current per motor on the parallel notches will be taken as 60 amperes, so that $r_1'=550/60-0{\cdot}60=8{\cdot}56$ ohms, $s_1'=770$ revs. per min. and $s_1'-s_2=770-414=356$ revs. per min. Four parallel notches will be used. The calculations are given in Table IV.

Table IV.

I'	$r'=\frac{E}{I'}-r_m$	$R'=\frac{r'}{r_1'}$	s'	$S'=s'/s_1'$	$s'-s_2$	$S=\frac{s'-s_2}{s_1'-s_2}$	$R=S.\frac{R'}{S'}$
60(I_1')	8·56(r_1')	1·00	770(s_1')	1·0	356	1·0	1·0
55	9·4	1·098	806	1·047	391	1·10	1·153
50	10·4	1·215	840	1·091	425	1·197	1·333
45	11·6	1·355	877	1·139	462	1·301	1·548
40	13·15	1·535	920	1·195	505	1·422	1·826

The figures of the last two columns give us the curve marked "$I_1=60$, parallel," in Fig. 3. The intersection with the $n=4$ curve occurs at $S=1{\cdot}252$. Hence, $s_2'-s_2=356\times 1{\cdot}252=446$, and $s_2'=446+414=860$ revs. per min. From Fig. 1 we see that the minimum current I_2' will be 47·6 amperes, and $r_2'=550/47{\cdot}6-0{\cdot}60=10{\cdot}95$ ohms.

Alternatively, we may proceed by converting the $n=4$ curve to a speed-current curve for the parallel notches. Since $S=(s'-s_2)/(s_1'-s_2)$ and $S'=s'/s_1'$, we may write

$$S'=S(s_1'-s_2)/s_1'+s_2/s_1'.$$

In the case under consideration this becomes

$$S'=0{\cdot}461S+0{\cdot}539.$$

Table V. gives the calculations required. The figures in the last two columns give the curve marked "$n'=4$, $I_1=60$" in Fig. 1, and the intersection shows the necessary minimum current to be 47·6 amperes, as above.

Table V.

S	R	S'	R'	$r'=R'r_1'$	$I'=\frac{E}{r'+r_m}$	$s'=S's_1'$
1·33	1·33	1·152	1·152	9·86	52·6	888
1·30	1·37	1·138	1·200	10·27	50·6	876
1·25	1·44	1·115	1·285	10·91	47·8	858
1·20	1·54	1·092	1·400	11·98	43·7	841

It is important to remember that the resistances determined by the calculations above are all "per motor," so that they must be doubled for two motors in series, or halved for two in parallel, in order to obtain the actual controller resistances.

In Fig. 6 the speed-resistance curves are given for two such motors as we have considered, the abscissæ in the diagram being *total* controller resistances. The values of successive steps for the series notches are w_1, w_2 . . . , and for the parallel notches w_1', w_2', &c.

In order to reduce the number of tappings in the rheostat and the number of fingers in the controller, it is usual to employ some of them for both series and parallel notches, and it becomes necessary to depart a little from the values of the resistances found by the above methods. The way in which this compromise is best arranged must depend on the circumstances of individual cases, and general rules cannot be given.

APPENDIX.

In some cases it may be more convenient to fix I_2 and n instead of I_1 and n; the procedure is then altered slightly. Thus, suppose that in the above illustration the minimum current were fixed at 50 amperes, with $n=5$ the calculation would proceed as in Table VI.

Table VI.

I	$r=\frac{E}{I}-r_m$	s	$S=s_2/s$	$R=r_2/r$
50(I_2)	4·90(r_2)	396(s_2)	1·000	1·00
60	3·98	358	1·103	1·231
70	3·33	336	1·180	1·471
80	2·83	320	1·237	1·731

The last two columns give the curve marked "$I_2=50$, series," in Fig. 3, whence $R=1{\cdot}385$, $S=1{\cdot}155$, $s_1=396/1{\cdot}155=343$, $I_1=66{\cdot}4$, $r_1=3{\cdot}54$.

For the parallel notches the course of the calculation is given in Table VII., which leads to the curve marked "$I_2=50$, parallel," in Fig. 3, whence (for $n=4$) $S=1{\cdot}232$, $s_1'=439/1{\cdot}232+396=753$, $I_1'=65{\cdot}6$ and $r_1'=7{\cdot}78$ ohms.

Table VII.

I'	$r'=\frac{E}{I'}-r_m$	$R'=\frac{r_2'}{r'}$	s'	$S'=\frac{s_2'}{s'}$	$s'-s_2$	$S=\frac{s_2'-s_2}{s'-s_2}$	$R=S\frac{R'}{S'}$
50(I_2')	10·40(r_2')	1·000	835(s_2')	1·000	439	1·000	1·000
60	8·56	1·215	770	1·084	374	1·174	1·315
70	7·26	1·432	737	1·133	341	1·287	1·627
80	6·27	1·659	710	1·175	314	1·398	1·973

Table VIII.

S	R	$r=r_2/R$	$s=s_2/S$	$I=E/(r+r_m)$
1·25	1·25	3·92	317	60·8
1·20	1·31	3·74	330	63·4
1·175	1·35	3·63	337	65·0
1·15	1·40	3·50	344	67·0

Table IX.

S	R	S'	R'	$r'=r_2'/R'$	$I'=E/(r'+r_n)$	$s'=s_2'/S'$
1·33	1·33	1·150	1·150	9·05	57·0	726
1·30	1·37	1·138	1·200	8·66	59·4	734
1·25	1·44	1·118	1·288	8·08	63·4	747
1·20	1·54	1·096	1·407	7·39	68·9	761

The calculations for the alternative method are given in Tables VIII. and IX., and the last two columns in the two tables give the curves marked " $n=5$, $I_2=50$," and " $n_1'=4$, $I_2=50$," respectively in Fig. 1.

In deriving column 3 in Table IX. the relation

$$S'=\frac{S(s_2'/s_2)}{(S-1)+s_2'/s_2}$$

has been employed.

SCIENTIFIC AND TECHNICAL RESEARCH.

At the Institution of Civil Engineers on Friday last a deputation from the Joint Board of Scientific Societies waited upon the Marquis of Crewe, Lord President of the Privy Council and President of the Committee of the Privy Council for Scientific and Industrial Research, to ask for increased State aid for scientific and industrial research. There were also present:—

Committee of Privy Council.—The Right Hon. A. H. D. Acland, the Right Hon. J. A. Pease, M.P., and Sir John Struthers, K.C.B. (representing the Right Hon. H. J. Tennant, M.P.), with Dr. H. F. Heath, C.B. (secretary).

Advisory Council.—Sir William M'Cormick (Chairman), the Right Hon. Lord Rayleigh, F.R.S., Sir G. T. Beilby, F.R.S., Mr. W. Duddell, F.R.S., Prof. J. A. M'Clelland, F.R.S., the Hon. Sir C. A. Parsons, K.C.B., F.R.S., Prof. J. F. Thorpe, F.R.S., and Mr. R. Threlfall, F.R.S.

Sir J. J. THOMSON, President of the Royal Society, who with Sir Maurice Fitzmaurice and Prof. H. B. Baker, spoke for the deputation, said the conjoint Board of Scientific Societies had been formed to promote co-operation between those engaged in pure science and those occupied in the industrial applications of science. The object of the deputation was to urge the importance of increased grants for scientific and industrial research. They were grateful for the appointment and for the grants the Government had already made for scientific research, and he was afraid that in coming to his Lordship so soon after those grants had been made that it would make him agree with a former Master of Trinity College, who said the proper interpretation of a certain well-known proverb was not "he who gives quickly gives double," but "he who gives quickly will be asked to subscribe again." The deputation were urged on from the utilitarian point of view that any money granted to the aid of research would be an excellent financial investment. An illustration of the importance of research in pure science from the utilitarian point of view was given very clearly in the application of X-rays for surgical purposes. The saving to the country by that invention, not merely in the saving of suffering and grief, but the material saving in the restoration of those who could render valuable services to the country was almost incalculable. The method of X-rays in surgery did not arise from investigation taken with the object of improving the method of locating gunshot wounds, but from investigations taken to find out the nature of electricity, a purpose remote from the humanistic interest. The experiments would have appeared to anybody to be a collection of laboratory tricks, and if it had been left to any ordinary board to find money for those experiments he was afraid that in the early stages they would have had a very small chance of receiving any such assistance. He spoke feelingly, because he had been occupied the greater part of his life in experiments on that subject. Practical men had suggested that he had better employ his time working at something more practical. If the research had been started at the other end, no doubt a much improved method of locating bullet wounds would have been reached, but it was almost impossible to imagine that the X-rays—the applied product of the abstract investigation—would have been reached. Research in applied science might lead to reforms, but research in pure science led to revolutions, and revolutions—political or industrial—were exceedingly profitable, if you happened to be on the winning side. Assistance to this pure research could not be given by granting sums of money to individuals, as research of that kind was too uncertain; years might be spent on pioneer researches, and at the end, to all appearance, no further advance might have been made since they were begun. The position would be almost intolerable to a man with a conscience receiving money for research, and he would be tempted to work on a plane where he could rely on getting year by year a return commensurate to the time spent upon it. He thought research of that kind would always be carried on in the universities, because having no certainty of yielding immediate results it must be done by people who were paid for doing something else. The State could ensure that those people could devote a proper amount of time to the research work by seeing that their income from their professorship was not so small that they had to occupy their free time in examining work, and so on, to enable them to live. The State could also do much to assist by putting the laboratories of the universities into an efficient state. More expensive and elaborate apparatus was now required. The majority of the universities would not bear investigation from the financial point of view. The finances of the National Physical Laboratory, which had done good work in pure science, were not in a satisfactory state. Representations had been made to the Privy Council on that point, so he would only say the grant to the National Physical Laboratory did not permit of adequate salaries being given to the trained assistants, and many of them had expressed their intention of leaving, and talking up posts in private establishments where their salaries would be double what they now received. The expenses of research in pure science were trivial compared with those on industrial applications of science, but pure science was the seed of applied science, and to neglect pure science would be on a par with spending a large amount on the manuring and ploughing of land and then omitting to sow any seed.

Sir MAURICE FITZMAURICE (President of the Institution of Civil Engineers) said when he took up White Paper CD 805 he did not proceed far with reading it when he found he was in touch with something different from what he had expected. It was not the dry bones of a scheme which might take years to put flesh on, but a real scheme with real life, that was to vitalise our industries and revive industries that had left us. He received the scheme with great enthusiasm, and he felt that such a scheme was essential to the industries of the country. As he said when speaking at that institution some time ago, he thought that scheme, if properly worked, might have more far-reaching effects than had been conceived by those who started it. When he was asked to take the chairmanship of the Standing Committee on Engineering he did so with the greatest pleasure, because he felt that with hard work one might possibly give a little help in furthering that great scheme, and he was sure his colleagues on that committee were filled with the same views. He did not think he had ever presided over a more enthusiastic committee. They had done a certain amount of work, but he thought they had had a little set back—they had run down a little and wanted a tonic—and they felt and hoped they were going to receive it that day. However, one could not live on tonics and they wanted as soon as possible to get into a strong healthy working state. The heads of industries and men of science had been working harder during the last 18 months than they had even worked before, and the time which had been given to the work of committees was extraordinary. In addition, many heads of industries had, at the request of the Standing Committee on Engineering, had meetings in their own particular trades to try and arrange for joint research with the help of the Advisory Council. The objects of the scheme were well known, and he wished to confine his remarks to the best way of attaining those objects. One of the principal things they wanted was money. He had heard recently different views about money. One was that as the war took up such an enormous amount of money a million or two here and there did not matter; the other view was that as the war had taken so much money we must save every halfpenny we could. The true fact was that all money wanted for the war or was essential for national interests must be found, but not wasted. He hoped the money wanted for that scheme might be found, and that the researches might be put in hand and be looked upon in a generous and broad-minded way. Two other points were the human element and the question of time. The former consisted principally in obtaining the confidence of those who wanted to help and those who wanted help themselves. If that was not obtained a scheme of that kind would be a failure, and a failure of that kind not only did not obtain confidence, but destroyed confidence and it would be difficult to get back on to the right lines. The time element was bound up with the human element. In the White Paper which they had read it was stated that the work must be started and carried out at once, and that substantial progress must be made before the end of the war; otherwise we would be clogged by the restrictions which must occur at the end of the war. Time, of course, was often said to have a healing effect and to knock off the rough edges, but the passing of time without healing raised doubts and destroyed confidence. Instead of rounding off the rough edges of controversy it took off the keen edge of enthusiasm. He hoped they would hear that day something which would revive their enthusiasm, and start them working with their best efforts on the scheme. He had stated that they had had a little set back. It was not too late to retrieve the position. The money question was not the only one. He wanted his Lordship to try and see that the application of the funds for that great scheme were dealt with in a human way. In dealing with that scheme they were dealing with men of science and business men who when looking at schemes and reports went straight to the kernel of vital questions. All they looked to were the main points of the scheme. There were two ways of looking at research proposals—one was to try and see every reason why any proposal should receive favourable consideration; the other way was to try and find out reasons why it should be deferred. One was the way by which things got done and the other was the way which led to disaster. He would like to appeal as Chairman of that Institution and as President of the Standing Committee on Engineering that in this scheme there should be an attempt to throw red tape to the winds. He had come there full of hope, and to assure his Lordship that if they were given a reasonable chance they were ready to devote all their energies to making this great scheme the great success which they thought it ought to be.

Prof. H. BRERETON BAKER, D.Sc. (Imperial College of Science, South Kensington), said he had been asked to speak on behalf of chemistry. There could be no two opinions about the importance of research to the chemical industry. Those who were not too young would remember in the eighties there was a great trade depression in the country, and Lord Beaconsfield, who was then Prime Minister, when expected to say something comforting to his audience at the Mansion House dinner, said there had been a rise of a farthing in the price of sulphuric acid. The people in the audience knew nothing about it, and they laughed. Lord Beaconsfield never explained or apologised, and left it at that, but sure enough sulphuric acid had shown itself then, as it always had been, the barometer of commercial success or failure, because it was one of the chief commercial products, and it underlay almost every trade in the country. Those heavy chemicals were used in so many trades that they showed whether trade was going to be good or bad. All but about 1 per cent. of the sulphuric acid used in this country was made by a process invented by a quack doctor at the end of the eighteenth century, although it had been modified. Could we say we had got to the best process even in the manufacture of sulphuric acid, or that the use of the compound bleaching powder now used was the best way of applying the bleaching action of chlorine? There were hundreds of smaller problems to be investigated. The waste by-products of the manufacture of dyes in Germany were made into useful and valuable drugs, which were not sold at £100 a ton, but something like, perhaps, 6s. an ounce. All these things indicated that we wanted more and more research in chemistry in this country. Two kinds of research were wanted—the *ad hoc* research undertaken with a definite idea of improving some particular big scale process or utilisation of some by-product, and, as the President of the Royal Society had said, problems which had no direct industrial aim. A great authority a year or two ago stated that no great discovery had ever been made except by accident. That was a paradox. An instance of the value of such discoveries was the discovery of the induced current by Faraday. A friend asked him, "What is the use of this?" and Faraday asked, "What is the use of a new-born baby?" But that seemingly inconsiderable discovery was the basis of all electrical developments which had come since. It was only since the war that there had been a coming together of the academic and manufacturing chemists in this country. The academic chemists had, wrongly, no doubt, looked upon the manufacturing chemists as rather intolerant of new ideas, and had thought they wanted to make their profits at once. The manufacturing chemist, perhaps, had taken just as mistaken a view with regard to the academic chemist, and thought he was a pure visionary concerned with the way atoms or molecules united, and that he had no bearing on the great manufacturing processes. That was now disappearing. The one was getting to take a more correct view of the other. If more research work were done, with collaboration between the manufacturer and the university and college laboratories it would be of enormous advantage to the whole of that particular industry.

Lord CREWE, replying to the deputation, said we had to look ahead, and prepare for the new conditions which would arise both in this country and the whole of the civilised world after the war. In taking the question of research into consideration and in endeavouring to forecast what might be done in future years, they were showing their full confidence in the ultimate result of the war. The Committee of the Privy Council for Scientific Research had the advantage of what was nominally the advice but really the co-operation of those who did practically all the work—namely, the so-called Advisory Council, which was composed of men of the first eminence in science and industry. It became evident as the industrial side of research became more prominent, and as the work of the Advisory Council developed that it could not remain an annexe of the Board of Education, and the Government decided to institute a new department presided over by the President of the Council, although a close connection must exist between the new department and the Board of Education. The funds would be of three kinds—money provided by Parliament, funds which it was hoped would be received in increasing amounts in the future from different parts of the Empire for the promotion of special researches of interest to them, and private benefactions. As to the provision of money from public funds the Government had been impressed by the need of coming further to the help of research. Consideration had been given to the question what should be done—to mention a single point—to assist the great staple industries of the country in developing systematic research on a large scale. It was clear that in the case of large and wealthy industries where either individuals or limited companies might look to profit on a very large scale as the direct result of research, the country would not be likely to be willing to pay the whole amount devoted to research. The Advisory Council had, therefore, already devoted much time to conversations with leaders of different great industries in the hope of bringing about a scheme of co-operation between those leaders and themselves. The matter of scientific research applied to industry was, it was considered, one of the cases in which an exception might be made to the usual plan of procedure by annual estimates. When co-operation of the most varied kind and on entirely different scales had to be instituted between a Government department and a number of different industries, an attempt to estimate the actual amount required for a given year would be hopeless. Therefore, the Chancellor of the Exchequer was prepared to advise the Government to devote a very large sum, estimated to meet the needs for this co-operation for the next five years, on a scale which ought to enable them to spend certainly four and possibly five times as much on the object of co-operation between the department and the firms as had been spent for the whole purpose of research by vote hitherto. What they desired to see was the creation or adaptation of trade associations on a large scale, which might be able to assess the contribution which the industry was able to make towards systematic research. Some associations would, he hoped, be specially formed for the purpose. In other cases where the great commercial associations for particular industries already existed a branch of the association might easily be appointed especially devoted to this subject, but forming part of the whole of the government of the industry. He hoped that as a rule the trading associations would be on the largest possible scale. In some cases, such as the engineering trade, where there was a great variety of applications, it might be found advisable to form a series of distinct associations for research purposes. On the other hand, an individual great engineering firm having various activities of its own might belong to several associations, and make its contribution in respect of the particular class of research which might be proceeded with at a given time. These associations should, so far as possible, be placed under small but carefully selected committees of direction, including some leaders of the particular business, some men of science, and some representatives of the skilled workers in different trades. The Chancellor of the Exchequer had decided that no objection should be offered by their surveyors of taxes to the allowance as working expenses for income-tax purposes of contributions by traders to industrial associations which might be formed for the sole purpose of scientific research for the benefit of the various trades. Allowances would be equally applicable as regarded traders' contributions specifically earmarked to the sole purpose of the research section of the adapted existing association. The allowances were subject to the conditions that the association or research section must be under partial State control and the trader's contribution must be an out-and-out payment made from his trade profits and giving him no proprietary interest in the property of the association. This concession also carried with it a certain proportion of relief from excess profits tax. Speaking as President of the Board of Education on the subject of technical instruction, he said that the present regulations under which technical schools received public money, apart from university institutions, were not up to date. They were going to discuss with the local authorities and governors of schools new draft regulations which it was hoped would simplify administration and stiffen instruction. The Government had decided that special increases should be made in the estimates of the Board of Education to assist local authorities. A further point of special importance was to make improved arrangements for the training of technical teachers and for scholarships to carry on to the universities selected industrial students. In addition to the block grant to cover five years, there would be an annual vote in the estimates for various purposes. A sum would be set apart to meet cases in which the individual research worker needed a grant to enable him to get on, and provision would be made to help professional societies who stood in need from time to time of assistance to carry on research work. He understood that the Advisory Council and the Coal Committee had agreed upon the beginning of a series of researches which were designed to establish a scientific basis for systematic economy in the use of fuel. The intention was to begin with an economic survey of the coal measures in the United Kingdom, to examine and experiment on the behaviour of different strata of coal under various furnace tests, and the suitability of different kinds of coal to different processes—cooking, and so on.

A vote of thanks was accorded to Lord Crewe for receiving the deputation and to the Government for the steps they had taken in regard to the movement. Sir J. J. Thomson, in proposing the vote of thanks, said the conjoint board would do everything in its power to aid in making the proposed scheme successful.

The deputation consisted of the following: Sir Joseph Thomson, O.M., Prof. H. Jackson, Dr. Dugald Clerk, Sir Robert Hadfield, Mr. A.D. Hall, Sir Alfred Keogh, K.C.B., Sir Ray Lankester, Prof. A. Schuster, Sir John Snell, Lord Sydenham, Mr. R. Threlfall, Sir Alfred B. Kempe, Sir H. Trueman Wood, Sir Philip Magnus, M.P., Prof. A. Keith, Prof. C. G. Seligman, Mr. E. B. Knobel, Dr. W. H. Maw, Dr. Frederick Taylor, Sir W. Watson Cheyne, Sir J. Bland Sutton, Mr. H. Wilson Fox, Prof. E. J. Garwood, Mr. Alexander Ross, Sir William Garforth, Sir Philip Watts, K.C.B., Sir William Beardmore, Sir Hugh Bell, Sir Boverton Redwood, Prof. W. A. Herdman, Prof. J. Perry, Sir David Ferrier, Prof. A. Fowler, Prof. R. A. Gregory, Sir George Greenhill, Prof. Alexander Hill, Dr. A. Harden, Dr. F. Gowland Hopkins, Prof. A. K. Huntington, Prof. M. J. M. Hill, Principal Hatton, Major H. G. Lyons, Major P. A. MacMahon, Sir William Mather, Lord Moulton, Sir Cooper Perry, Sir Ronald Ross, Prof. Thane, Sir Jethro Teall, Prof. W. P. Wynne, Prof. J. O. Arnold, Mr. Charles Bathurst, M.P., Prof. W. Bateson, Prof. W. A. Bone, Prof. H. B. Baker, Sir Alfred Dale, Prof. W. E. Dalby, Sir Frank Dyson, Sir Archibald Denny, Mr. Douglas Freshfield, Dr. W. Garnett, Dr. Alexander Scott, Dr. A. Strahan, Prof. W. G. Fearnsides, Sir David Prain, Mr. C. V. Boys, Prof. O. W. Richardson, Prof. W. M. Bayliss, Prof. W. D. Halliburton, Dr. P. Chalmers Mitchell, Sir James Burnett, Capt. Bell-White, Dr. R. H. Burrown, Surgeon-General Sir David Bruce, Mr. John Cadman, Col. A. W. Crossley, Mr. Horace Darwin, Prof. W. B. Dunstan, Prof. W. Eccles, Dr. R. T. Glazebrook, Sir Alfred Pearce Gould, Principal Hadow, Sir H. Oram, Prof. G. T. Morgan, Prof. F. W. Oliver, Sir Isambard Owen, Sir William Osler, Dr. A. Russell, Prof. R. A. Sampson, Col. A. Smithells, Dr. A. E. Shipley, Prof. E. Barclay Smith, Prof. W. J. Simpson, Mr. Edgar Taylor, Prof. Graham Wallas, Prof. Ernest Wilson, Sir John Wolfe-Barry, Mr. Edmund White, Prof. W. H. Bragg, Prof. E. G. Coker, Sir William Collins, Sir Arthur Evans, Prof. J. A. Fleming, Dr. J. H. Gardiner, Hon. R. C. Parsons, Mr. G. E. C. Healey, Dr. E. Heron-Allen, Sir A. Pedler, Dr. F. W. Keeble, Mr. C. H. Bedford, Prof. H. C. H. Carpenter, Sir William Tilden, Prof. W. J. Pope, Prof. A. Dendy, Dr. J. S. Haldane, Dr. Charles Carpenter, Prof. J. B. Farmer, Mr. A. E. Broadberry, Dr. A. Harker, Dr. R. M. Walmsley, Mr. W. F. Reid and Mr W. R. Cooper. There were also present representatives of the Institution of Gas Engineers and of the British Cyanides Co. (Ltd.).

We have received the following announcement from the Secretary of the Department of Scientific and Industrial Research:—

The Government have decided to establish a separate Department of Scientific and Industrial Research for Great Britain and Ireland under the Lord President of the Council, with the President of the Board of

Education as vice-president. They have also decided, subject to the consent of Parliament, to place a large sum of money at the disposal of the new department to be used as a fund for the conduct of research for the benefit of the national industries on a co-operative basis.

The Board of Inland Revenue have decided, with the approval of the Chancellor of the Exchequer, that no objection shall be offered by their Surveyors of Taxes to the allowance, as a working expense for income tax purposes, of contributions by traders to industrial associations which may be formed for the sole purpose of scientific research for the benefit of the various trades; and the allowance would be equally applicable as regards traders' contributions specifically ear-marked to the sole purpose of the research section of an adapted existing association.

In both cases the allowance would be subject to certain conditions—*e.g.*, the association or the research section to be under Government supervision, and the trader's contribution to be an out and out payment, made from his trade profits and giving him no proprietary interest in the property of the association, &c.

In order to enable the department to hold the new fund and any other money or property for research purposes, a Royal Charter has been granted to the official members of the Committee of the Privy Council for Scientific and Industrial Research under the title of the "Imperial Trust for the Encouragement of Scientific and Industrial Research." The Trust is empowered "to accept, hold and dispose of money or other personal property in furtherance of the objects for which it has been established, including sums voted by Parliament to that end." The Trust can take and hold land and can "accept any trusts, whether subject to special conditions or not, in furtherance of the said objects."

A substantial gift has already been made to the Trust by two members of the Institution of Mechanical Engineers for the conduct of a research in mechanical engineering to be approved by the Department, in the hope that this example will be followed by other members of the institution.

Mr. H. Frank Heath, C.B., has been appointed permanent secretary of the new department, to whom all correspondence should be addressed, until December 31st next at the offices of the Board of Education, Whitehall. On and after January 1, 1917, all correspondence should be addressed to the Secretary, Department of Scientific and Industrial Research, Great George-street, Westminster, S.W.

The "London Gazette" of December 1st contains an announcement that a Royal Charter was passed on November 23rd, creating under the title of "The Imperial Trust for the Encouragement of Scientific and Industrial Research," the official members for the time being of the Committee of the Privy Council for Scientific and Industrial Research, a body corporate for the purposes of the said committee.

LIGHTING A CHURCH OF THE BASILICA TYPE.*

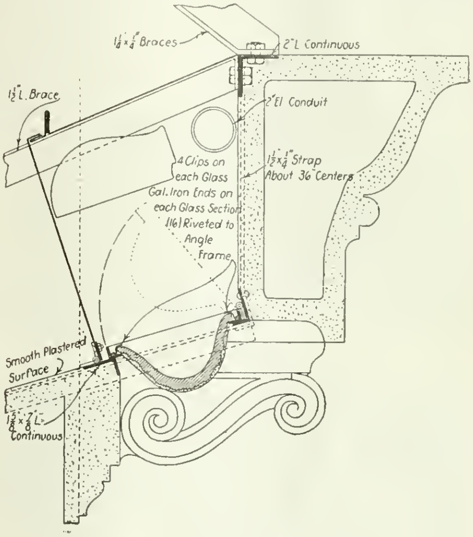
A new system which has been designed for lighting basilica churches is well exemplified by the installation in St. Adalbert's Church, at Seventeenth and Paulina-streets, Chicago. Other churches are now being lighted by the same method.

The system of illumination comprises a combination of direct and indirect lighting, and has the advantages of freedom from glare, low intrinsic brilliancy, good diffusion, absence of intense shadows, and a uniform intensity of illumination. It also shows advantages from the standpoints of depreciation and operating economy, since the units are easily accessible and easily cleaned, and renewals of burnt-out lamps can be made without difficulty. The power consumption is also said to be less than that applying to other churches with equally intense illumination.

The principal part of the lighting for the auditorium issues from the under side of an interior cornice. This cornice, which is about half-way up on the side walls, is of reinforced plaster and is hollow, with a slot running the whole length or the under side. Directly over the slot is a metal light box and closing in the slot are sections of Alba glass, semi-circular in section and curved in a special cylindrical mould to fit the profile of the cornice. This glass is smooth on the inside and rough on the exterior with reed and ribbon decoration. It forms a decorative part of the cornice. The light box contains a wiring trough and supports the lamp sockets. The lamps are 60-watt tungsten lamps, placed 16 inches apart and about 8 inches above the glass with their axes at right angles to the line of the cornice. The lamps have individual, parabolic, mirrored glass reflectors, and the whole equipment is protected from dust by the metal light box. In St. Adalbert's Church there are 105 of these lamps on each side.

The indirect lighting has the purely decorative function of displaying the relief work in the ceiling which would otherwise be invisible at night and offer too much contrast in illumination between the upper and lower parts of the nave. The indirect lamps are 100-watt lamps in parabolic, mirrored reflectors placed 21 ft. apart on top of the cornice. It is important that these reflectors be placed below the line of vision and in such a position that none of the light is reflected back upon the adjacent wall. It is possible in this manner to illuminate the ceiling perfectly without showing the slightest indication of the light source.

The accessibility of the equipment for renewals and cleaning is one of the most important features contributing to its success and the maintenance of a high efficiency. The rear of the cornice is made of hinged panels opening directly into the long chamber under the side roof. This makes it extremely easy for the attendant to reach all of the lamps and reflectors and the diffusing glass from behind the cornice. The Alba glass is mounted in hinged sectional frames arranged to fold over on a table and allow of cleaning the under side conveniently. This feature is most essential, for without such means it would be necessary to mount ladders some 35 ft. in length from below, a proceeding so dangerous and troublesome for the average caretaker as to practically preclude the operation.



SECTION OF CORNICE SHOWING HINGED PANELS AND LIGHT BOX.

In St. Adalbert's Church the lighting is entirely controlled from a cabinet in one end of the church near the sanctuary. Arrangements have been made to control the entire lighting by dimmers in case it is decided to install this apparatus, but up to the present time this has not been done. With all lamps lighted the intensity of illumination in St. Adalbert's Church is about one foot-candle and is uniform within 6 per cent. over the entire floor. Additional local lighting is provided in the sanctuary, organ loft, vestibule and corridors.

OPERATING CHARACTERISTICS OF LEAD ACCUMULATORS.*

BY J. H. TRACY.

Desiring to call the attention of battery users (and particularly of vehicle battery users) to the effect of recent improvements in lead storage battery construction, the author refers first to their discharge. He points out that it may be at any amperage safely permissible in reference to the metallic conduction provided for in the design, there being no fear of damaging the plates themselves by discharge rates as heavy as can be yielded by the electrolytic action possible under the conditions of diffusion of electrolyte obtaining. Cells to discharge in 10 minutes are instanced, and the writer is of opinion that if there were a demand for them, cells to discharge in three minutes could be made.

Reference is then made to the recuperative effect in batteries designed for comparatively slow discharge. Instances and a chart of tests are given showing that even at very high discharge rates, if periods of rest are given, such a battery may put out its full low-rate capacity, the essential diffusion of electrolyte taking place during the intervals between working, and permitting terminal voltages high enough for good service. A discharge chart of a submarine cell is reproduced in the adjoining figure, and shows that a cell whose useful discharge at 3,000 amperes is not more than one hour will give a further 3,000 ampere hours at good voltages at various diminishing current rates, suitable for a series of speeds less than the full.

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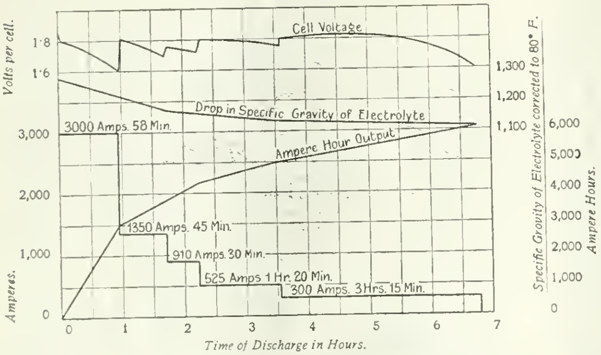
* Abstract of an article in the "Electrical Review and Western Electrician."

* Abstract of a Paper in the "Electric Journal."

In reference to charging such batteries, it is advocated that no high-current limit need be set beyond a temperature limit of 110°F.; it is added that the cells must not gas freely, and that the cells may be recharged after any desired portion of the discharge has been taken. A good rule for determining commencing charging rate is that it should not be at a greater number of amperes than the ampere hours out of the battery. Two charts are given showing that under this rule the charge rate would be very nearly that which results from charging a battery at a suitable constant potential.



In order to reduce the initial current to that which may safely be carried by the wiring of cars when this system of charging is used, a resistance may be employed, or the garage may be wired and supplied at two slightly differing voltages.

A system of charging is described in which a reversible ampere-hour meter is used, and which may have a trip device incorporated with it to cut off the charging current as soon as the charge has been supplied, a hand-controlled full charge being given periodically to compensate for local action and gassing losses.

SCIENCE AND INDUSTRY, WITH SPECIAL REFERENCE TO THE WORK OF THE NATIONAL PHYSICAL LABORATORY.*

BY R. T. GLAZEBROOK, C.B., F.R.S.

The subject is a wide one, even when limited by the special reference.

The Advisory Committee of the Privy Council was appointed to consider, among other objects, proposals "for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades." The earlier clauses of its first Report deal with previous Government action in the present century. The National Physical Laboratory was established in 1900, with the assistance of a grant from the Treasury, under the control of the Royal Society, and opened in 1902 by His Majesty the King, then Prince of Wales. It is remarked "The Laboratory has done and is doing most valuable work for our industries and for the Government, and it might have done much more had it been endowed with anything like the annual subvention of nearly £100,000 which the American Bureau of Standards receives for development and maintenance from the United States Government. But we think experience has shown that no single institution, however great or distinguished, can expect to do more than a part of all that our vast industries require."

Had the Laboratory since 1902 been really placed in a position to do the work indicated by His Majesty the task of the Committee at the present day would be much lighter, and the advances already made still more considerable. "The object of the scheme is to bring scientific knowledge to bear practically upon our everyday industrial and commercial life."

In this process, as we shall see, three distinct stages may be observed. We need :—

1. The work of the man of science in his research laboratory.
2. The investigations which go on in an industrial research laboratory, developing new processes or introducing new products.
3. The works laboratory proper controlling the quality of raw materials, finished products and processes.

We must have scientific knowledge, and, to be successful, knowledge must be pursued for its own sake. Each of the modern practical applications of science had its foundations in purely scientific work, and to quote Prof. Gregory, in his recent book, discovery or the spirit and service of science, was not the result of deliberate intention to make something of service to humanity. The discovery of the laws of electromagnetic induction is due to Faraday, and is described in his first three series of "Experimental Researches," published in 1831-33. Oersted, Ampere and Arago had investigated some of the phenomena connected with the magnetic force produced by an electric current, and to Faraday it appeared clear that conversely it should be possible to produce electricity from magnetism, as he put it. It is difficult to picture the world to-day without electric power, and yet the whole development of electrical machinery, as we know it, rests on the laws described in these brief scientific papers. Each advance of knowledge brings its benefits to mankind, and in a general way Faraday may have hoped to be a benefactor to his race by widening the sphere of knowledge, but it was the desire to know the truth which led him on and to which we owe such tremendous consequences.

We must have the student of pure research, the genius who goes on his way discovering new truths, irrespective of consequences, laying bare more and more of Nature's secrets and unravelling her mysteries.

As regards the National Physical Laboratory, it is necessary to maintain the standard of the output, to secure that the proper grade of material is supplied to the works, to check the instruments in use, and to test the product in its various stages of manufacture. The days are gone when successful manufacture could be carried on entirely by rule of thumb, trusting to the skill of some trained workman for the success of each delicate operation, when the hereditary instinct passed down from father to son was sufficient to produce each year practically the same results. New processes come, which appear likely to improve production or to reduce its cost; the works laboratory serves to test these. New products are suggested, which may or may not have the advantages claimed for them; this can be investigated in the works laboratory, and all these investigations and tests must go on in the works themselves under the eyes of men familiar with the process of manufacture in its every stage. The works laboratory must extend, and others are more competent than I to outline the direction of extension and to guide its growth.

Now between these two—the man of science researching in his University or college, and the works chemist toiling in his shop—there is a gap. Some means are needed to make the discoveries of science available to the manufacturer to secure to him the advantages which come from the growth of knowledge to keep him in the forefront of his trade. This is the function of a laboratory of industrial research, and among such laboratories the National Physical Laboratory should hold a prominent place. The National Physical Laboratory has another function to fulfil, it is a great standardising and testing institution. This means a large, elaborately equipped and heavily staffed laboratory engaged largely on work which for many years will be unremunerative, and which for a considerable time after its foundation will obtain no results which can be applied by the manufacturer.

This work clearly needs a special house, it cannot be done in the laboratory of a technical institute. The main work in such a laboratory as that of a technical institute must be educational. It is not the work of pupils, while still at college, to solve the conundrums of the manufacturer. The research laboratory is necessary if progress is to be made. Abbé realised somewhere about 1876 that British optical instruments had reached the highest possible development unless a radical change could be produced in the optical properties of glass, and the researches of Schott and himself, aided by subsidies from the Bavarian Government, lasted a number of years before the first catalogue of Jena glass was produced. Synthetic indigo was discovered by von Baeyer about the year 1880; it was not until some 20 years later that it was put commercially on the market, and in that time it is reported that no less than £1,000,000 was spent by the Badische Anilin-Soda-Fabrik before this desired end was reached.

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* Abstract of an address delivered to the Birmingham and Midland Institute.

Dr. Rosenhain has mentioned as an instance the case of a series of alloys which is being studied by an investigator interested mainly in theoretical metallurgy; he works with pure metals or metals as nearly pure as he can get them, and finds that one alloy of his series has some specially noteworthy properties. He may call the attention of a manufacturer to these and suggest that the alloy might have valuable industrial application. Much, however, remains to be done before this can be realised; the pure materials of the investigator are not available in quantity. To what extent is the presence of impurity detrimental, what are the impurities which must be removed, what are the steps required to do this on the requisite scale, to what extent do the difficulties involved in this render the whole method commercially impossible by adding seriously to the cost? Is there any difference between the material made in quantity and that produced by the laboratory furnace, where rapid cooling or heating may be readily employed, although impossible in the full scale work, and so on? For the industrial research laboratory, the plant, &c., must be so planned that it is possible to carry out the necessary operations on a scale comparable with that required in works, and, moreover, the man who carries through the investigation must be not only acquainted with the latest scientific advances in his subject, but must know what is possible in works, and must mould his solution of the problem to harmonise with these possibilities. The undertaking is often more complex than that of the pure scientist. It is one which needs a special laboratory, a special equipment. The National Physical Laboratory has acquired the confidence of the technical industrial world, and problems are brought before the staff with the knowledge that they will be handled in a confidential manner by men trained to deal with them. The whole staff are engaged in applying science to industry; equipment is provided for this purpose only.

One other aspect of the matter remains to be considered, though very briefly. If we are to have a National Industrial Research Laboratory, who is to pay for it, who is to support it? The obvious answer is the nation, but this in some quarters at once raises a difficulty. It is claimed that the results of any successful research bring profits in the first instance to some particular class, and that class ought to pay. For example, the discovery of some new and valuable alloy would profit, in the first instance, the manufacturer of the alloy and the persons employing it in their special trade. Each case must be considered on its merits.

But the needs of the nation at the present time are too serious, the danger of delay too pressing, and the State may well devote large sums to industrial research without minute enquiry as to whether the research is going to benefit Messrs. A.B. specially and what share, therefore, of the expense Messrs. A.B. must be asked to guarantee. In America the Bureau of Standards, in Germany the Reichsanstalt and the Material-Prüfungs-Amt work thus for the national good, and this should be the task of our English Industrial Research Laboratory.

The National Physical Laboratory was founded in 1899. My appointment as its first director dates from Jan. 1, 1900, but its home at Bushy House, Teddington, was not ready for it until 1902. It is controlled by the President and Council of the Royal Society, but that control is exercised through a General Board and Executive Committee containing representatives appointed by six of the great technical societies; at least half of the unofficial members of the Executive Committee must be selected from the representatives of these technical societies. The Royal Society receives from the Government the sum of £7,000 annually towards the cost of the Laboratory.

In the year before the war the actual expenditure was nearly £41,000, and practically the whole of the difference between these sums had to be raised as payment for work done; towards this an amount of about £5,000 was received from the Government for researches in aeronautics. The Government also pays for tests and investigations carried out for their various departments.

The financial responsibility for the Laboratory rests on the Royal Society. The fact is that the whole financial position needs overhauling. Before the war the German institutions in Berlin, which covered approximately the same ground as the Laboratory, had an income of about £70,000, while that of the Bureau of Standards of America was well over £100,000. In both these cases the Government are responsible for the whole expenditure, and take the receipts from fees. The Laboratory owes much to private donors.

To-day the Laboratory comprises eight large buildings. It is organised in four main departments, each with its superintendent. These are:—

1. Physics: Superintendent, The Director.
2. Engineering: Superintendent, Dr. T. E. Stanton, F.R.S., M.Inst.C.E.
3. Metallurgy: Superintendent, Dr. W. Rosenhain, F.R.S.
4. The William Froude National Tank: Superintendent, Mr. G. S. Baker, M.Inst.N.A.

The Physics department is divided into six divisions, each under a Principal or Senior Assistant, and there is a large staff of Scientific Assistants, divided into Senior Assistants, Assistants and Junior Assistants. The primary work of these is scientific research, though each is expected to take his share of the testing and examination of instruments, which forms a large part of the work of the Laboratory. Beyond these there is a staff of observers whose main duty is the routine test work, though opportunities are given to these to help as far as possible in the researches. The routine test work is concerned chiefly with instruments; ordinary commercial, chemical and strength tests of materials are not undertaken by the Laboratory except for Government Departments, or as matters of special investigation.

And here let us note the importance of keeping the test work a live thing by the aid of research. Instruments are tested to see, among other objects, if they come up to standard, but the standard of to-day is too low some years hence; the tests must be so regulated as to tend to a gradual improvement in the product. Let me give an example of this. Ordinarily, we test a large quantity of a certain article, and the average failures are under 1 per cent. some seven or eight in a thousand. Recently, in consequence of pressure, articles were passed into service without tests, and after a time the tests were introduced; on the earliest batches examined after the change the failures were 18 per cent., they were 25 times as great as previously. The number of instruments tested in the year covered by the last report—to March 31, 1916—was over 75,000. This does not include gauges for the Ministry of Munitions which in the past 15 months have numbered nearly 250,000.

I trust I have convinced you—probably you did not need convincing—that such laboratories as the National Physical Laboratory are necessary.

There must be more than one; in many cases an industry can be best served by a laboratory near its principal centre. Large firms, again, may each prefer to have their own trade secrets—this must be so to some extent—and trade jealousies may interfere with full co-operation, but a private laboratory on a really sufficient scale is expensive; too often it becomes little more than what I have called a works laboratory for testing the products of the factory, and for the smaller firms, at least, the only way to secure the full advantage of scientific advance is by co-operation—co-operation in the laboratory, co-operation, with specialisation in production, in the works themselves.

Lord Crewe, the President of the Privy Council Committee on Industrial Research, announced on Friday, Dec. 1, that a large sum is to be at the disposal of the Committee during the next five years, and oultined the scheme for its expenditure. The Lord President spoke in generous terms of the work of the Laboratory in the past, and he indicated a sphere of wider usefulness under less difficult conditions in the future. Let me picture to you what I trust that sphere may be.

In many cases, no doubt, the researches contemplated must go in special laboratories arranged and equipped for the purpose—laboratories closely connected with the industry it is desired to help, situated at the great manufacturing centres; but there are many other researches of wide interest and great importance for which a central laboratory is the proper house, a laboratory fitted and equipped in an ample manner, with a trained and competent staff animated, like those, my colleagues, who have built up the National Physical Laboratory, with a love for science and yet withal with a keen appreciation of the practical side of the question discussed and a real desire to help our country by the application of science to industry.

"Safety First" on the Rand. The "Safety First" Committee of the Rand Mutual Board has issued a useful *résumé* of work since its inception in 1912. Since 1909 the accident rate on the Rand has steadily fallen. 1914, the first full year of the Committee's activities, was a record low year, and in 1915 even better results were obtained. In June, 1916, there were no fatal accidents on the surface, accidents due to explosives are materially diminishing; but minor accidents require attention, and the education of the native element needs unremitting effort. Notices urging safety measures and asking for suggestions are posted in each mine, and the managers and workmen are giving their cordial support to the movement.

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THE DESIGN OF DYNAMO ELECTRIC MACHINERY.

The more one studies the methods of many of our most successful engineers and designers the more one realises that, notwithstanding our ever-increasing knowledge of engineering theory, engineering design is still largely a matter of judicious guessing. This applies to all branches of engineering and more particularly to electrical engineering. In spite of imperfect knowledge of the properties of the materials of engineering, and of stresses and strains, the many different types of structures designed and executed by civil and mechanical engineers serve to indicate the influence of the factor of safety in engineering design. The design of dynamo-electrical machinery is complicated by the fact that there is as yet no factor of safety which bears the same relation to the electrical constants as the ordinary factor of safety of the civil and mechanical engineer bears to mechanical stress.

Maybe it is this absence of factor of safety in electrical engineering that accounts for the attempt to frame satisfactory rules and theories covering the design and performance of all classes of electrical machinery. Many of these theories are the work of men who are either unfamiliar with the short-cut methods of the designer or not conversant with the conditions under which the designer follows his employment. The result is that very often the man in the works has neither the ability nor the time to study a highly technical Paper or treatise. In view of this the authors of such Papers and treatises would do well to prepare a concise and, preferably, non-mathematical statement of their work. We do not underrate the value of the highly technical work, nor do we know of better methods than those followed by the designer. But we do regret that there is no language common to the technical man and the busy designer.

In addition to the mechanical strength problems which, as we have said, are covered by an adequate factor of safety, electrical design is complicated by a host of other problems, some of which are magnetic, some are purely electrical and some are thermal. Of these, the last-named are probably the most important. The reason for this is that many of the magnetic and electrical problems connected with design have been solved partly by improvement in the materials of construction and partly by indirect methods.

As an example of improved materials may be mentioned the special steels used for the magnetic circuits of dynamo machinery. The interpole and compensating winding are examples of the indirect method. Although many are of the opinion that it is possible to design satisfactory commutating machinery without interpoles, the tendency is to use such interpoles on all continuous-current machines, and it is not unlikely that the brush rocker, which, in our opinion, is one of the weakest features of a machine, will be entirely eliminated. As regards dielectrics, the choice of materials in a given case is limited. Notwithstanding their limited number all the materials available are known to fall far short of the ideal.

With the improvement of materials and on account of a more certain knowledge of the properties of the electric and magnetic circuits, the design of electrical machinery at the present time is largely a thermal problem and, as yet, the laws of heat transmission are imperfectly understood. The study of these laws in the past has had a marked effect on design, and in the future it is likely to have an even more marked effect. For this reason we welcome two informative Papers that were read last week before the American Institute of Electrical Engineers. One of these, by Mr. B. G. LAMME, was entitled "Temperature Distributions in Electrical Machinery," and dealt with certain fundamental principles governing heat distribution and temperature in electrical apparatus. The other, by Mr. F. D. NEWBURY, on "Rational Temperature Guarantees for Large A. C. Generators," was an argument in favour of the standardisation of temperature guarantees when the guarantee is based on internal temperatures as measured by thermocouples. Mr. LAMME concluded that no hard and fast rules can be made to cover the facts, except in a very general way, and that commercial temperature measurements should be considered as approximate, this being permissible because there is no sharply defined line between good and bad.

This brings us back to the influence of guessing on design. In this connection we regard Prof. MILES WALKER's suggestions on the subject as sound. Prof. WALKER, in his book on "Specification and Design of Dynamo-Electric Machinery," states that "A busy designer would never get through his work if he stopped to calculate everything. He guesses a great deal, or makes rapid mental estimates of quantities he has not time to calculate. Now, he is never justified in so guessing unless he knows the limit of his possible error with fair accuracy, and knows that with the error he will still have a machine which will comply with its specifications. Knowledge of these two things can only come from many calculations made and many machines tested. The way to acquire the art of correct guessing is to employ fairly simple rules for calculation that are based on sound principles. An empirical rule, however often applied, does not help the mind to form rapid mental estimates, because it does not take into account all the factors that determine the result."

Like many designs, there is little in this article that is original. Like the methods of many designers the article is based largely on what other people are doing. To many the design of a dynamo-electric machine is like the design of a piece of cloth. In the latter case even firms of repute endeavour, and not without success, to obtain samples of the ranges that have been produced by their competitors, and their design is limited to the production of identical ranges in inferior material. But there can be no question that such methods of design in any trade will in the long run be detrimental not only to the trade but to the trader.

REVIEWS.

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The Localisation of Faults in Electric Light and Power Mains.

By F. CHARLES RAPHAEL. Third Edition. (London: "The Electrician" Printing and Publishing Co.) Pp. vii. + 210. 8s. 6d. net.

This book has become one of the standard works on the subject and the author was well advised to issue a new edition brought up to date. The last edition was published in 1903, and any book on electrical subjects soon gets out of date. The volume has been practically rewritten and several fresh chapters added. Many electrical books have misleading titles, but any purchaser of this book knows exactly what he is getting.

The author, in the introductory chapter, points out how the class of fault is changing. Burn-outs are more common owing to the fact that cables are worked nearer their full load than they used to be and that there are far more high-tension cables in use. With the present high cost of copper and labour the tendency will be to avoid laying new cables and to put up with a greater volt drop on the existing cables. The author proceeds to discuss practical methods of laying and jointing cables and deals with gas explosions in street boxes. In the definitions of terms used in testing, attention is drawn to the lack of uniformity of symbols throughout the world. The principle of the Wheatstone bridge is fully described and different types of galvanometers discussed. The chapter concludes with good descriptions of the chief makes of portable insulation testing sets. The author should have drawn attention to the fact that with many of these testing sets the cable is not always subjected to the full pressure marked on the case. Anyone holding the terminals of a set marked to give 500 volts will soon be aware of this fact.

In Chapter II., in dealing with the insulation testing of low-pressure networks during working, a daily test is recommended. There is a great difference of opinion as to the value of so doing, and mains engineers should settle this point. The ordinary earth-recording ammeter is criticised; its chief fault is that it does not indicate clearly a fault on the neutral wire. Various types of leakage indicators are described suitable for direct-current and alternating-current circuits.

Several methods of insulation testing of high-pressure mains during working are described in Chapter III., but, as the author remarks, the fault is usually not detected until it is a dead earth. The new chapter at the end of the book on duplicate feeders and automatic systems of mains protection is the one that will be carefully studied by engineers and their mains assistants. It deals with the Merz-Price, Ferranti-Field, Merz-Hunter, Ferranti-Waters, and Callender-Waters systems. In the latter part of Chapter X. there are described some systems in use in Germany.

Faults on traction feeders are specially dealt with in Chapter IX. which is new. Some excellent ideas are given which should prove of great use to those responsible for this special class of network. The rest of the book is taken up with the description of different systems of testing. The Murray loop-testing set illustrated on page 57 is a splendid idea and seems to be due to the author. The fact that the distance to the fault can be read off on a scale will commend itself to every mains engineer. What is wanted is an accurate localiser that is simple, not a delicate laboratory one with elaborate calculations to work out. The author is to be commended for giving the details of actual tests carried out; these show the reader what sort of readings to expect and exactly how to work out the result.

It is a pity that one or two examples of capacity tests on cables were not included, as if this test is really satisfactory it would often be used. A burn-out with neither earth nor short circuit to help one is very difficult to locate. If the capacity test is doubtful the fault must be broken down, and how to do this is described on page 120. The search coil and telephone method is fully described and the author seems to recommend it for certain classes of faults. On page 112 is described a good method of measuring the resistance of a cable, and on page 155 a method is described of testing distributors whilst alive, which seems very practical.

The author should have impressed on his reader the importance of the methodical keeping of data regarding everything dealing with a distribution system. Having this data handy when fault-testing is of the greatest assistance. It would also have helped to increase the value of the book if a chapter on the planning out of a distribution system, with special regard to fault localising, had been added. Before a fault can be located the piece of cable which is defective must be found and this often takes up more time than it should. It is, however, unfair to criticise the author for not making the book longer, as he informs us in the preface that most of the work was carried out under trying circumstances. No matter how perfectly cables may be made and laid, faults will occur, and books like this be worth many times their cost price. W. A. TOPPIN.

Catalysis and its Industrial Applications. By E. JOBLING, A.R.C.Sc. (London: J. & A. Churchill.) Pp. viii.+120. 2s. 6d. net.

Some few years ago the ordinary text books on chemistry dealt with the subject of catalysis in but a few lines and with some half-dozen classic examples of the phenomena. To-day the position is far different. Catalysis is, as it were, a new chapter in chemistry, and one of the greatest importance. What actually occurs may still be open to question, but, nevertheless, catalytic methods are among the most powerful at the disposal of the chemist at the present day. We therefore welcome the present small volume on the subject.

In the first chapter the author deals with the general methods by which catalytic changes are most readily brought about, and defines catalysis, which is not altogether an easy thing to do. Then a reference is made to the delicate nature of many catalysts, and the pronounced effect of small proportions of "poisons" in gases. Taking the subject in the broadest sense, there appear to be chemical catalysists, physical catalysists, and a third class, combining the characteristics of both the foregoing. In all probability it is doubtful whether any such clear distinction can be drawn.

In the following chapters the author deals successively with various important manufacturing processes, such as the manufacture of sulphuric acid, the fixation of atmospheric nitrogen, hydrogenation and similar commercial processes. At the present time the chapter on nitric acid will probably be read with the greatest interest. A sketch is given of the process due to Haber (misspelt Heber twice on p. 10), and the Ostwald process, both of which have become of supreme importance under war conditions in Germany. In the chapter on surface action, the author deals with surface combustion and illustrates the Bonecourt boiler, but we notice that the latest modification of the refractory material is not given. It is interesting to note that the author, in dealing with the contact process for sulphuric acid, states that many of the difficulties which delayed the progress of the process were due to the inadequacy of contemporary engineering chemistry. This, we fear, is true of more than this particular process, and if success is to be made of processes working at high pressures, such as 200 atmospheres, there is no question that chemical engineering in this country must rise to the occasion.

We do not doubt that the present little volume will be welcomed by all those who wish to keep in touch with the development of modern methods.

THE DESIGN OF DIRECT-CURRENT RAILWAY ACCELERATING RESISTORS.*

BY L. J. HIBBARD.

The design of a direct current railway accelerating resistor involves three distinct problems:

1. The determination of the total amount of resistance required in the circuit when the controller is on the first notch.

2. The determination of the number of steps and their ohmic values, into which the resistance must be divided to give uniform acceleration.

3. The determination of the current-carrying capacity of the various steps which is necessary to prevent the overheating of the resistor element.

AMOUNT OF RESISTANCE REQUIRED IN CIRCUIT AT START.

The total resistance required in the circuit at start, and the amount of resistance that is cut out at any given instant, depends upon the permissible rate of acceleration. For car equipment this rate lies between 1 and 2 miles per hour per second. To accelerate a car at the rate of 1·5 miles per hour per second it is necessary to exert approximately 150 lb. tractive effort per ton weight of car.

Assuming an acceleration of 1·5 miles per hour per second, and given the car weight in tons, it is possible to determine the total tractive effort which must be exerted by the motors. Dividing this total tractive effort by the number of motors on the car gives the tractive effort which must be exerted by each motor. Knowing the gear ratio and wheel diameter the value of the current which will produce the above tractive effort can be obtained from the torque curve of the motor. Then, by means of the line voltage, the total resistance can be determined. The value of the resistance obtained by this method must be reduced by a factor which varies from 0·7 to 0·8—*i.e.*, the resistance must be multiplied by approximately 0·75 to give the value of resistance which is actually placed in the circuit. The necessity for using this factor is due in general to two causes: First, the inductance of the motors, and second the regulation of the transmission system. By following the method outlined and by using a constant of 0·75, the amount of resistance which is required in the circuit at start can be determined, and then by subtracting the motor resistance from the total the external resistance which is required is obtained.

NUMBER OF STEPS.

To accelerate the motors at a constant rate it is necessary to keep a certain average value of current flowing through them during the acceleration period. When external resistance is used to accelerate a motor equipment the resistance must be cut out in steps of such a value that the current will vary between two limits, such that the average value will produce the desired rate of acceleration.

On the average railway equipment the variation in tractive effort should not be greater than 25 or 30 per cent. If these values are exceeded the mechanical parts will be subjected to severe strains, and the passengers will be jolted unduly.

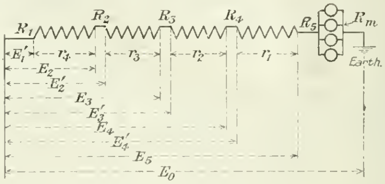

FIG. 1.—RESISTOR CONNECTIONS.

E_0 —Line voltage.
E_1 =Counter E.M.F. at instant contact is made at R_1.
E'_1 = ,, ,, ,, ,, broken at R_1.
E_2 = ,, ,, ,, ,, made at R_2.
E'_2 = ,, ,, ,, ,, broken at R_2.
E_3 = ,, ,, ,, ,, made at R_3.
E'_3 = ,, ,, ,, ,, broken at R_3
E_4 = ,, ,, ,, ,, made at R_4.
E'_4 = ,, ,, ,, ,, broken at R_4.
E_5 = ,, ,, ,, ,, made at R_5.

The number of steps and their ohmic values can be calculated from the following formulæ:—*

$$P = \frac{\log\left[1 - \frac{R_T}{R_m}(1 - CK)\right]}{\text{Log } CK} - 1 \text{ (straight rheostatic notching)}$$

$$r_1 = CKR_m$$
$$r_2 = CKr_1 = C^2K^2R_m$$
$$r_3 = CKr_2 = C^2K^2r_1 = C^3K^3R_m$$
$$r_n = CKr_{n-1} = C^2K^2r_{n-2} = \ldots C^{n-1}K^{n-1}R_m..$$

Where r_n = First step of resistance cut-out.
r_{n-1} = Second step of resistance cut-out.
r_{n-2} = Third step of resistance cut-out.
And r_1 = Last step of resistance cut out.
R_m = Resistance of motors and wiring.
P = Number of steps.
R_T = Total resistance in circuit at start.
CK = A constant whose value depends upon:—

1. Motor characteristics.
2. Variations in torque on each notch. (In ordinary railway service the value of CK will be approximately 1·465, *see* Fig. 2.)

CAPACITY.

To determine the current-carrying capacity of each step it is necessary to know

(*a*) The maximum time spent on each notch.

(*b*) $I_{\text{max.}}$ and $I_{\text{min.}}$ from which it is possible to determine the value of

$$\sqrt{(I^2_{\text{max.}} + I^2_{\text{min.}})} \div 2.$$

(*c*) The time required to complete one cycle of the speed-time curve. If the time required to complete this cycle varies, the minimum value should be chosen.

Knowing these values, it is possible to determine the root mean square value of the current flowing through each step of the resistor. The resistor element that is used should be able to carry this value of current continuously without overheating. Also this resistor element should have sufficient thermal capacity to withstand the peak loads without dangerous heating. The capacities obtained by this method are safe only on the assumption that the acceleration is automatic. If the equipments are accelerated by hand the above capacities should be increased, the amount of increase depending upon the type of service and upon the class of motormen.

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* From the Electric Journal.

* For derivation of these formulæ *see* end of article.

As an example, take an equipment as follows: –

Number of motors	4
Horse-power of motors	140
Hourly rating	200 amperes
Continuous rating	125 amperes
Resistance of the four motors in parallel	0·045 ohm.
Average line voltage	530 volts
Gear ratio	21:56
Wheel diameter	33 in.
Desired rate of acceleration	1·5 m.p.h.p.s.
Pounds tractive effort per ton weight of car	150 lb.
Car weight	35·8 tons
Type of acceleration	Hand

To find the total resistance required in the circuit :—

Total tractive effort required = 35·8 × 150 = 53,691 lb.

Tractive effort per motor = 5,369 ÷ 4 = 1,342·5 lb.

Torque per motor = 1,342·5 × 21 ÷ 56 × 33 ÷ 24 = 692 lb. at 1 ft. radius.

Current required per motor (from Fig. 3) = 155 amperes.

Type of notching = straight rheostatic.

Average amount of current = 4 × 155 = 620 amperes.

Maximum amount of current = 620 × 1·08 = 670 amperes.

Minimum amount of current = 620 × 0·92 = 570 amperes.

Inductance and line regulation factor = 0·75.

Resistance required in circuit = 530 ÷ 670 = 0·79 ohm.

Total resistance actually placed in circuit = 0·79 × 0·75 = 0·595 ohm.

To find the number of steps :—

$CK = 1{\cdot}465$ when the variation in tractive effort = approximately 25 per cent. (*see* Fig. 2).

Then

$$P=\frac{\left[1-\frac{0{\cdot}595}{0{\cdot}045}(1-1{\cdot}465)\right]}{\text{Log }1{\cdot}465}-1=4{\cdot}15.$$

Therefore, from the result in last formula, four steps are used.

To find the ohmic value of each step :—

$r_1 = 1{\cdot}465 \times 0{\cdot}045$ .... 0·0659 ohm.

$r_2 = (1{\cdot}465)^2 \times 0{\cdot}045$ .... = 0·0966 ,,

$r_3 = (1{\cdot}465)^3 \times 0{\cdot}045$ .... = 0·1415 ,,

$r_4 = (1{\cdot}465)^4 \times 0{\cdot}045$ .... = 0·2075 ,,

0·5115 ,,

Resistance of four motors in parallel........ – 0·0450 ,,

R_T for four steps .... = 0·5565 ,,

If five steps are used :—

$r_5 = (1{\cdot}465)^5 \times 0{\cdot}045$ .... = 0·3033 ,,

R_T for five steps .... = 0·8598 ,,

The continuous capacity of resistor which should be selected depends on the length of time it is normally in service. The first grid to be cut out can, therefore, have a lower continuous capacity than the last one. For average operating conditions, experience indicates that in a four-step resistor satisfactory operation will be secured with the steps having capacities of 30, 45, 60 and 75 per cent. respectively of the total continuous rating of the motors. In the above example the total continuous motor rating is 4 × 125, or 500 amperes. The continuous rating of the resistors should therefore be

For $r_4 = 0{\cdot}30 \times 500 = 150$ amperes.
For $r_3 = 0{\cdot}45 \times 500 = 225$,,
For $r_2 = 0{\cdot}60 \times 500 = 300$,,
For $r_1 = 0{\cdot}75 \times 500 = 375$,,

On this curve

$$C = E_{\text{min.}}/E_{\text{max.}} = 106{\cdot}5/114 = 0{\cdot}935,$$
$$K = I_{\text{max.}}/I_{\text{min.}} = 167{\cdot}5/142{\cdot}5 = 1{\cdot}175,$$
$$CK = 0{\cdot}935 \times 1{\cdot}175 = 1{\cdot}1.$$

Assuming an inductance factor of 0·75, the value of CK by substitution into formula will be $1{\cdot}1 \div 0{\cdot}75 = 1{\cdot}465$. Also assuming the variation in tractive effort equal to 25 per cent. Then for railway motors the tractive effort equals a constant times torque equal approximately a constant $\times I^{1{\cdot}6}$, or if

$$\frac{(\text{Tractive effort})_1}{(\text{Tractive effort})_2}=\frac{I_1^{1{\cdot}6}}{I_2^{1{\cdot}6}}=1{\cdot}25,$$

Therefore $I_1/I_2 = 1{\cdot}1715 = I_{\text{min.}}/I_{\text{max.}}$

PROOF OF FORMULÆ.

(Straight rheostatic notching.)

To derive a formula for the number of steps, let

$I_{\text{min.}}$ = minimum value of current allowable during acceleration.
$E_{\text{min.}}$ = counter E.M.F. of motor at full speed with $I_{\text{min.}}$ flowing.
$I_{\text{max.}}$ = maximum value of current allowable during acceleration.
$E_{\text{max.}}$ = counter E.M.F. of motor at full speed with $I_{\text{max.}}$ flowing.

$$I_{\text{min.}}/I_{\text{max.}} = 1/K = K',$$
$$E_{\text{max.}}/E_{\text{min.}} = 1/C = C',$$
$$C'K' = Z' = 1/Z = 1/CK.$$

P = Number of steps.
R_T = Total resistance in circuit when the controller is on the first notch.
R_m = Resistance of motors and wiring.

From Fig. 1 it is seen that counter E.M.F.s E_2 and E'_1 are generated at the same speed. Also to satisfy the conditions of acceleration assumed

$$E_2/E'_1 = E_{\text{max.}}/E_{\text{min.}} = C' \text{ or } E_2 = C'E'_1.$$

Similarly $E_3/E'_2 = E_4/E'_3 = E_5/E'_4 = C'.$

Let R_1 = the total resistance required in circuit at start to allow $I_{\text{max.}}$ to flow (Fig. 1).

Then $R_1 = E_0/I_{\text{max}} = (E_0 - E'_1)/I_{\text{min.}}$

From which $I_{\text{min.}}/I_{\text{max.}} = K' = (E_0 - E'_1)/E_0$ and $E'_1 = E_0(1-K')$ (1)

$$R_2 = (E_0 - E_2)/I_{\text{max.}} = (E_0 - E'_2)/I_{\text{min.}}$$

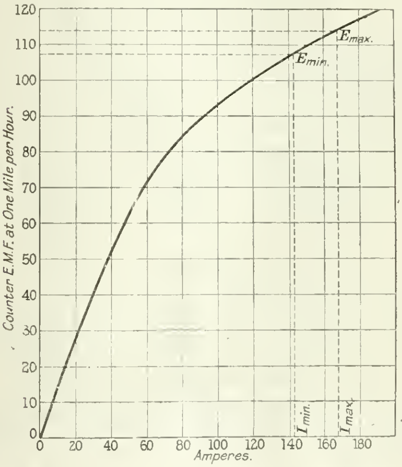

FIG. 2.—VARIATION OF COUNTER E.M.F. AND CURRENT.

From which

$I_{\text{min.}}/I_{\text{max.}} = K' = (E_0 - E'_2)/(E_0 - E_2)$ and $E'_2 = E_0(1-K') + K'E_2$ (2)

But from Fig. 2 $E_2 = C'E'_1 = C'E_0(1-K').$

Then $E'_2 = E_0(1-K') + C'K'E_0(1-K').$

Likewise

$$E'_3 = E_0(1-K') + K'E_3 \text{ and } E_3 = C'E'_2 = C'E_0(1-K') + (C'^2)K'E_0(1-K')$$

or $E'_3 = E_0(1-K') + C'K'E_0(1-K') + (C')^2(K')^2E_0(1-K')$. (3)

Similarly

$$E'_4 = E_0(1-K') + C'K'E_0(1-K') + (C')^2(K')^2E_0(1-K') + (C')^3(K')^3E_0(1-K') \quad . \; . \; . \; . \; . \; . \quad (4)$$

$$E'_5 = E_0(1-K') + C'K'E_0(1-K') + (C')^2(K')^2E_0(1-K') + (C')^3(K')^3E_0(1-K') + (C')^4(K')^4E_0(1-K') \quad . \; . \; . \; . \; . \quad (5$$

Referring to Fig. 1

$$r_1 = R_1 - R_5 = [(E_0 - E'_4)/I_{\text{min}} - (E_0 - E'_5)/I_{\text{min.}}] = (E'_5 - E'_4) \div I_{\text{min.}} \quad . \; . \; . \; . \; . \; . \; . \quad (6)$$

or $r_1 = (C')^4(K')^4E_0(1-K') \div I_{\text{min.}}$

Likewise

$$r_2 = R_3 - R_4 = (E'_4 - E'_3) \div I_{\text{min.}} = (C')^3(K')^3E_0(1-K') \div I_{\text{min.}} \quad . \quad (7)$$

Thus : $r_1/r_2 = C'K' = 1/CK = 1/Z$, or $r_2 = Zr_1.$

Similarly $r_3 = Zr_2$; $r_4 = Zr_3$; . . . $r_n = Zr_{n-1}$.

Therefore in the same way

$$r_1 = ZR_m \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (8)$$
$$r_2 = Zr_1 = Z^2R_m \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (9)$$
$$r_3 = Zr_2 = Z^2r_1 = Z^3R_m \quad . \; . \; . \; . \; . \; . \; . \; . \quad (10)$$
$$r_n = Zr_{n-1} = Z^2r_{n-2} = Z^{n-1}R_m \quad . \; . \; . \; . \; . \; . \quad (11)$$

In general, if R equals total resistance in circuit (equals R_1, (Fig. 1): $R_T=R_m+r_1+r_2+r_3 \ldots r_{n-}+1=R_m+ZR_m+Z^2R_m+Z^3R_m + \ldots Z^{n-1}R_m$,

or $$R_T / R_m=1+Z+Z^2+Z^3+ \ldots Z^{n-1}$$

and $$R_T / R_m=(1-Z^n)/1-Z^*$$

$$Z_n=1-\{R_T(1-Z)\div R_m\}$$

$$\text{Log } Z^n=\log\,[1-\{R_T(1-Z)\div R_m\}\,]$$

Therefore $$n=\text{Log }[1-\{R_T(1-Z)\div R_m\}\,]\div\text{Log } Z.$$

But $n=P+1$ where P=number of steps.

Therefore $$P=\frac{\log\,[1-\{R_T(1-CK)\div R_m\}]}{\text{Log } CK}-1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

SERIES PARALLEL CONTROL.

The formula as given by equation (12) is correct for straight rheostatic control. It is not absolutely correct for series parallel operation, due to the fact that the ratio R_T/R_m changes slightly when the motors are changed from series to parallel connection. However, if this is neglected, and if the transition point is considered as an acceleration step, the number of steps in series and parallel will be equal.

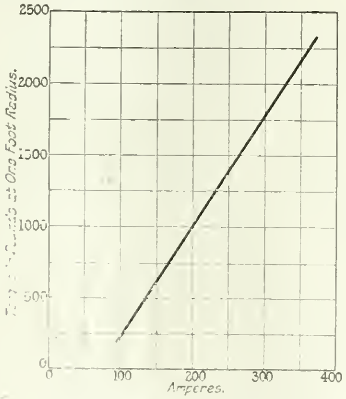

FIG. 3.—VARIATION OF TORQUE WITH CURRENT.

If, however, this variation is taken into consideration, and if the transition point is not used as an acceleration step, the following formula for the number of steps required for series parallel operation may be derived.

Let P_s = Number of notches required in series connection.
P_p = Number of notches required in parallel connection.
$R_m/4$ = Motor resistance in parallel connection.
Rg_p = External resistance in parallel connection.
R_m = Motor resistance in series connection.
R_T = Total resistance on first notch of series connection.

The equation for the number of steps required for the series connection is identical with equation (12).

For the parallel connection

$Rg_p=0{\cdot}5E_0/2I_{\min}=E_0/4I_{\min}=KE_0/4I_{\max}=KR_TI_{\max}/4I_{\max}=KR_T/4$ and $R_{Tp}=Rg_p+(R_m)/4=(KR_T+R_m)/4$ = total resistance in parallel connection.

Then $$P_p=\frac{\text{Log}[1-\{(KR_T+R_m)/R_m\}(1-CK)]}{\text{Log } CK}-1 \quad . \quad . \quad . \quad . \quad (13)$$

and $P_0=P_p+P_s$

$$=\frac{\text{Log}\left[1-\frac{KR_T+R_m}{R_m}(1-CK)\right]\left[1-\frac{R_T}{R_m}(1-CK)\right]}{\text{Log } CK}-2 \quad . \quad (14)$$

Thus by substituting the necessary values into equations (8), (9), (10), (11), (12), 13) and (14) it is possible to determine the number and ohmic value of the steps required.

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* $(1+Z+Z^2+Z \ldots Z^{n-1})$ is a geometric series and will reduce to the form $\left(\frac{1-Z^n}{1-Z}\right)$.

CORRESPONDENCE.

ULTRA-VIOLET LIGHT AND THE EYES.

TO THE EDITORS OF THE ELECTRICIAN.

Your article on this subject last week is of importance, not only in connection with electric lighting, but on account of the continual advertising of spectacles to protect the eyes against ultra-violet light. No one doubts that an excess of such light, such as is given by the quartz mercury vapour lamp, is deleterious; but the proportion of ultra-violet light given out by ordinary electric lamps is, as you truly remark, less than in daylight, and it is exceedingly difficult to believe that such a proportion can be harmful. The fact that the maximum sensitiveness of the eye is for a wave-length not far from $0{\cdot}54\mu$, corresponding almost exactly with the dominant wave-length of solar radiation, shows how perfectly natural selection has brought about an adaptation of the eye to its normal conditions; and it is inherently improbable that a similar adjustment should not have taken place as regards resistance to injury by the normal proportion of ultra-violet radiation.

May not phenomena such as snow blindness be more reasonably accounted for by the fact that the retina is accustomed only to being illuminated over its lower portion from the sky, and that it may be very intolerant to brilliant illumination from below?

Such irritation as is felt from metallic filament lamps is most certainly due, as you claim, to high intrinsic brilliancy, and the remedy lies in proper diffusion.

Westminster, Dec. 5. CHARLES V. DRYSDALE.

SHOULD REVIEWS OF BOOKS BE SIGNED?

TO THE EDITORS OF THE ELECTRICIAN.

Without reference at all to the points in dispute between Dr. Gisbert Kapp and the reviewer of his book, permit me to suggest that it might be a good plan if all outside contributions—whether reviews or otherwise—were on the understanding that the writer's name may be added if thought fit by the Editor.

Westminster, Nov. 30. CHARLES BRIGHT.

[We fear that this suggestion would scarcely meet the case, for a reviewer may be quite willing to sign a review under certain circumstances and not under others. The circumstances are not always known to the Editor.—EDS. *E.*]

"SUMMATION-WATT" CAPACITY OF FIELD RHEOSTATS.

TO THE EDITORS OF THE ELECTRICIAN.

I heartily agree with the last paragraph of Mr. Boothman's letter in your current issue, in which he quotes words used by Mr. Carter, that "the use of a formula without care and intelligence is certain to lead, sooner or later, to disaster." My contention all along has been in accordance with this principle.

I note that for a 10-ampere 20-volt machine the figures given by Mr. Boothman work out right; I quite agree with this, but would point out that such a machine is rather an extreme case. I had in mind, however, a potentiometer resistance used, for example, in conjunction with rotary converters.

I think if Mr. Boothman were to check my figures for such a rheostat he will agree that they are correct.

Birmingham, Dec. 2. CHARLES C. GARRARD.

[This correspondence is now closed.—EDS. *E.*]

Regulation of Electric Arc Lamps.—A recent patent taken out by J. Brockie and Johnson & Phillips (Ltd.) relates to the use of a small compressed air motor in order to operate the carbon holders. Means are provided to regulate electrically the supply of air to the motor and control the movements of the latter according to the requirements of the arc.

THE PLIOTRON OSCILLATOR FOR EXTREME FREQUENCIES.*

BY WILLIAM C. WHITE.

It has been common practice during the last few years to utilise hot cathode vacuum tubes of the relay type, such as the pliotron, for the production of a few watts of alternating-current energy of audible, or radio frequency.

A type of pliotron has been developed in the Research Laboratory at Schenectady having an output of high frequency current sufficient for transmission purposes in practical radio telegraphy and telephony.

The Pliotron.

The type of pliotron referred to has the usual three elements; filament, grid and plate, all enclosed in an evacuated globe. The tungsten filament is about 10 in. long and is W-shaped, the four spans lying in the same plane. The grid surrounds the filament and consists of a mesh of very small tungsten wires lying in two planes, one on each side of, and parallel to, the plane of the filament. This is made by winding the tungsten wire for the grid on a rectangular frame. The planes of the grid wires are each about ⅛ in distant from the plane of the filament.

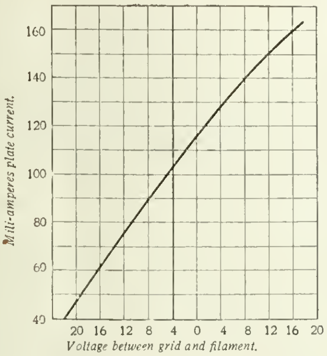

Fig. 1.—Control Characteristics of Pliotron.

The plate consists of two rectangular sheets of thin tungsten about 1¾ by 2½ in., and these sheets are spaced parallel to each other about ½ in. apart; these are held in the bulb so as to be parallel to the planes of the grid and filament and, therefore, each one is spaced about ¼ in. from the filament.

These pliotron tubes are evacuated to a high degree and the metal of the grid and the plate is freed from gas.

In operation the filament is made incandescent as in a lamp, and if then a positive potential, with respect to the filament, is applied to the anode a current will flow between the two, due to the passage of electrons from the filament to the plate.

Providing the filament is emitting sufficient electrons, the number of electrons reaching the plate per unit of time (and thus the current between filament and plate) depends upon the potential gradient, and, therefore, this current increases with the plate voltage.

Now the electrons in their passage must pass through the mesh of the grid. Any change in potential of the grid with respect to the filament changes the electric force distribution between filament and plate, and therefore, the electron current. If the grid is made positive with respect to the filament the electrons are accelerated and the current increases; if negative, their acceleration is retarded and the current decreases.

There exists an almost linear relation between grid potential and plate current through a wide range, as shown in the characteristic curve, Fig. 1. The plate current will follow faithfully, and without lag or phase difference, and variation in the potential of the grid.

The Pliotron Oscillator.

Suppose an arrangement as shown in Fig. 2. Then F represents the filament, G the grid, P the plate of a pliotron and D is the source of direct current in the plate circuit. A transformer, one coil of which is in the plate circuit, is represented by T and A is an alternator supplying an alternating potential to the grid G.

During one half of the cycle of the alternator potential the grid is positive with respect to the filament and during the other half it is negative. Since the plate current is controlled by the grid potential the former will also vary, following the sine wave of the alternator, periodically varying between a minimum and a maximum, but never reversing in direction. However, from E, the secondary of the transformer, a real alternating current may be obtained.

The energy of this alternating current obtained at E is drawn from the direct current source D and is of exactly the same character as that supplied by the alternator A, but of much greater energy because very little energy is required to vary the potential of the grid G. Suppose one watt is supplied at A and ten watts of the same character alternating current is obtained at E, it should then be perfectly possible to utilise one watt of the ten then obtained at E to supply the grid, in place of using the alternator and thus make the system self exciting. Such an arrangement as just described constitutes a pliotron oscillator system.

The frequency of the alternating current which a self-exciting system of this type generates will, of course, depend on the electrical constants of the circuits.

Production of Currents of Very Low Frequency.

For the production of very low frequencies it is necessary to have very large inductances and capacities. For instance, an inductance of 101 henries and 25 microfarads has a natural period of one second.

The connections for the production of very low frequencies from the pliotron are shown in Fig. 3.

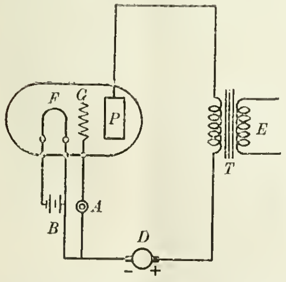

Fig. 2—Connections to Illustrate the principle of the Pliotron Oscillator.

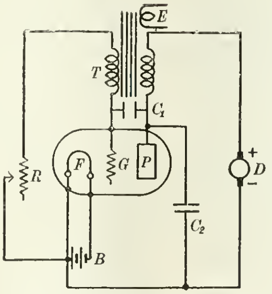

Fig. 3.—Connections for Very Low Frequency Pliotron Oscillator.

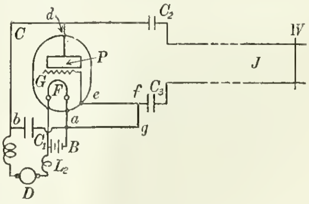

Fig. 4.—Connections for Very High Frequency Pliotron Oscillator.

Here the elements of the pliotron are represented as before, and T is a transformer acting as an inductance and also is used for transferring energy back into the grid circuit. The condenser C_1 forms an electrostatic coupling between the circuits and aids the electromagnetic coupling in supplying energy back into the grid circuit for excitation. The condenser C_2 is a capacity added to increase the period of the oscillations, and R is a resistance which is placed in circuit for some tests described in a later paragraph. As in the previous figure the pliotron filament is made incandescent from a battery B and the energy to produce the alternating current is derived from a direct-current generator D. Alternating-current energy may be withdrawn from the system by a third coil E on the transformer T.

It has been possible by such an arrangement to produce an alternating-current of a frequency as low as one half cycle per second.

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* Abstract of an Article in the "General Electric Review" (U.S.A.).

For measurements at this frequency zero centre direct-current instruments are used, the swing of the pointers being slow enough for readings at the peak of the wave to be obtained, and the phase relations between the various currents and voltages noted.

By means of small magnetic needles as indicators the magnetic flux actions in the transformer may be studied.

If, while this pliotron oscillating system is operating, resistance is introduced at the point R in Fig. 3, the amplitude of the oscillations will be decreased, and if sufficient resistance is added enough energy cannot be supplied to the grid circuit both to excite the system and supply the losses in this resistance, and therefore the oscillations will die down and finally cease. The value of this resistance can be readily adjusted so that five to ten seconds, or even longer, will be required for the oscillations to decrease slowly in amplitude and finally die out.

By proper values of inductance and capacity, the system may be given a frequency of just one cycle per second and then a relay in one of the circuits will tick off seconds, thus forming a real electrical clock.

It is possible that some electrochemical reactions may best be brought about by a current of very low frequency.

The Production of Very High Frequencies.

For the production of very high frequencies it is necessary to reduce the inductance and capacity of the circuits to a minimum; in fact, the natural capacity between the elements inside the pliotron bulb is more than sufficient to supply electrostatic coupling between the plate and grid circuits. Also, the conductors of the circuits must be carefully laid out so as to be of a minimum inductance, yet of correct realtive value.

For the determination of frequencies above ten million cycles per second direct measurement of the length of the electrical waves set up is the best method to employ. Electric wave impulses travel at a velocity of approximately 186,000 miles per second, or 3×10^8 metres per second.

Now, in any wave motion through a medium, the velocity of propagation is equal to the product of the frequency and the wave length or distance from crest to crest. Therefore, for a frequency of fifty million cycles per second, the wave length will be 6 metres, or about 19·6 feet.

If a very high frequency current is made to pass along a straight parallel pair of wires of a length which is a multiple of the wave length of the high frequency current employed stationary electrical waves will result. This means that at intervals along the wires half a wave length apart there will be points at which the voltage between wires will be a maximum, while at intermediate points half way between the voltage from wire to wire will be zero.

The actual arrangement of apparatus used to produce these high frequencies is shown in Fig. 4.

Here the pliotron elements, filament heating battery, and direct current energy source are represented as in previous figure. The inductances L_1, L_2 and the capacity C_1 are used to prevent the very high frequency currents from passing through the direct-current source D. The oscillating inductance in the plate circuit consists solely of the connecting wire b, c, d, between filament and plate, and in the grid circuit of e, f, g, a, between filament and grid. Each of these wires is only a few inches long.

The voltage for charging the parallel wires is obtained by connecting them to grid and plate, but through very small capacities, C_2 and C_3, which reduce the effect of the capacity of the wires on the oscillating system and also insulate the wires from the supply sources B or D as far as direct current is concerned.

As previously mentioned, it is necessary that the parallel wires J have a length which is a multiple of the wave length set up by the oscillator. This is accomplished by sliding the short circuiting bridge H along the wires until this condition is obtained.

By means of a special bridge slider that does not make metallic contact with the wires but draws current from them through a small capacity used in connection with a sensitive hot wire milliammeter, the voltage distribution along the wire may be found and the wave shape plotted in the form of a sine curve. The frequency may thus be accurately determined and the presence of any current of a harmonic frequency detected.

It will be found that a maximum of voltage occurs at a point a quarter of a wave length from the short circuiting bridge, thus showing the right angle phase relation between current and voltage in a resonant circuit.

A current flows through the short circuiting bridge located at a minimum of potential and maximum of current, which can be shown by bringing up close to it one side of a rectangular loop of wire, the loop having in circuit a small tungsten lamp with short filament of small diameter wire.

If, with a lamp burning in such a manner, one of the wires is touched with the hand at a point where there is a maximum of potential, the lamp will go out, whereas if touched at a potential minimum there will be no effect. If one of the wires is touched at some intermediate point the lamp will dim more or less, depending on the distance of the point touched from a potential maximum or minimum.

The pliotron method of producing continuous high frequency currents of considerable energy should prove a valuable tool in the solution of many electrical and physical problems.

THE RELATION OF DIELECTRIC LOSSES IN CONDENSERS TO THE CONDITIONS OF CHARGE AND CONDUCTION.*

BY F. TANK.

In a lengthy Paper the author describes various methods of measuring directly the losses in condensers exposed to an alternating electric field, and studies their quantitative relation with the conditions of charge and the conductivity of the dielectric.

Among the phenomena characteristic of charged condensers, the existence of an "after-charge" current, following the normal charging current, deserves attention. As regards the effect of conduction through the dielectric, it is to be noted that there is no constant current corresponding with a constant electric field, and that the current diminishes with time.

The two phenomena are so far distinct that, in general, the first only exhibits itself in the case of solid dielectrics, and the second in the case of liquid dielectrics; it is, however, possible that the two effects may overlap to some extent. The first effect is explicable according to the Schweidler-Wagner theory of dielectric "after-action," the second is based on ionic conduction. This after-action exhibits proportionality with the intensity of field and also "reversibility"; the calculation of these losses with alternating currents on a theoretical basis is therefore possible. The conduction effects, on the other hand, are not reversible; in an alternating field they merely give rise to a purely heating loss.

These considerations are confirmed by our knowledge of the course of the phenomena during a small interval of time. While during a small interval a constant conductivity is observable in the case of liquid dielectrics, we find with solid dielectrics that the shorter the period of time the greater the momentary after-charge current appears to be, without any recognisable limit being apparent. This is in substantial accordance with the relation

$$i = EC_0\beta t^{-n} \quad 0<n<1.$$

This leads to a loss in alternating fields which may exceed that due to stationary conduction by more than a hundred times. Since this loss increases with the frequency (being approximately proportional thereto), it follows that at high frequencies condensers using solid dielectrics exhibit losses far greater than those with liquid dielectrics, even though at a low frequency the reverse may be the case.

A comparison of theoretical data with the results of actual experiment shows that the losses in solid dielectrics must be ascribed almost entirely to this after-effect in the dielectric. Apart from the relatively small losses that arise from a certain degree of conduction being present, there is no evidence of losses arising simply through the alternation of the field; such as, for example, the absorption of electric oscillations in the dielectric, analogous with those which occur in connection with dispersion phenomena in many liquids. These effects occur at such exceedingly high frequencies as to be comparable with intramolecular processes, and are not met with in practice with ordinary alternating currents.

It appears, therefore, that the losses encountered are of quite a different character, and when described in terms of "dielectric after-effect" or "viscous hysteresis" these expressions should not be allied with any special conception in molecular physics.

THE RAW MATERIALS OF THE ELECTRICAL INDUSTRY.

In a recent address, Mr. Guy E. Tripp, of the American Westinghouse Electric and Manufacturing Company, dealt with the question of promises of delivery of the raw materials of the electrical industry.

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* Abstract of an article in "Annalen der Physik," Vol. XLVIII.

A general idea of the "material" handicap on deliveries is shown by the following list of some of the more important raw materials and the time required to get them :—

Aluminium, sheet Aluminium, meter discs Aluminium, meter covers	6 months
Asbestos cloth	16 to 20 weeks
Brass rod Brass tubing Brass sheet	5 to 6 months
Copper rods Copper sheets Copper tubing	5 to 6 months
Copper wire, bare	5 to 6 months
Cotton-covered magnet	5 months
Silk-covered magnet	5 months
Rubber-covered wire and cords	5 months
Drills, high speed ... Indef.	5 to 6 months
Drills, standard carbon	4 to 5 months
Drills, special	4 to 6 months
Emery wheels	5 to 7 months
German silver sheet German silver wire, bare German silver wire, ins.	5 to 6 months
Lamp cord	5 months
Linen, 0·012 in.	60 to 90 days
Porcelain, on wet process high-tension pieces	8 to 12 weeks
Porcelain, on dry process high-tension pieces	8 to 12 weeks
Porcelain, some large and difficult pieces	8 to 12 weeks
Steel drop forgings	120 days
Steel shafts, spec. No. 1476	4 to 16 weeks
Steel shafts, spec. No. 1478	4 to 16 weeks
Steel, bare	10 months
Steel plates	10 months
Steel sheet—Bess. & O. H.	120 days
Steel, cold-rolled strip	6 months
Steel, tool	4 to 6 months
Steel castings	8 weeks
Tapes, asbestos	60 to 90 days
Tapes, bias friction	30 days
Tapes, grey webbing	120 days
Tapes, linen, 0·007 in.	120 days
Tapes, surgical, 0·020 in.	120 days
Tapes, taffeta	120 days
Tools, small	12 to 20 weeks

ARMOUR-CLAD SWITCHGEAR.

In his recent address, as chairman, to the Newcastle Local Section of the Institution of Electrical Engineers, Mr. H. W. Clothier said that owing to the pressure of the times he had found it difficult to settle down to the preparation of an orthodox address up to the Institution's standard. He paid a tribute to those men who had answered the calls from the Army and Navy, but he said that way in which the majority of those engage in the manufacturing Industry had to fight at present was to multiply their output and to develop with the future in mind.

As the perfection of output was now so freely acknowledged to be of national interest, he thought he need make no excuse for selecting as a subject one for which credit was due to engineers in this country, viz., "The Development of Armour-clad Switchgear of the 'Draw-out' Type." The fundamental basis for the design were :—(1) The oil break switch ; (2) the ironclad enclosure of conductors ; (3) the "Draw-out" principle.

Each of these features was of early British origin. For instance, he illustrated an oil switch designed by Partridge and used on cable mains in 1892, another by Ferranti used on power station switchboards in 1894-5 and the use of ironclad pillars for generators by Rayworth a year or so earlier. The "draw-out" principle, or the easy detachment of complete working parts was also initiated in the Ferranti slate-cell gear. Ten years afterwards, acting upon the advice of the engineers of the North-east coast power companies, these main features were assembled on the gear called the "Ironclad" type, which included the enclosure of bus-bars run in solid with compound (developed about the same time by Highfield), and the covering of each conductor or limb with armour.

Owing to the subsequent introduction of other metals than iron for the casing, for instance steel for switches and aluminium alloys for use in proximity to conductors carrying very heavy currents, he preferred now to call this gear "Armour-clad." He demonstrated the progress that had been made in the last decade by showing designs prepared in this country by several manufacturers, including Westinghouse, Siemens, Holmes, Switchgear & Cowans, Erskine Heap, Electrical Apparatus, and Reyrolle, and referred also to B.T.-H. designs. All these had one common purpose, viz., to meet the characteristically British demand for apparatus solid and substantial in its construction. Perhaps they were more expensive than some other forms but they had the humane feature of affording the maximum protection to life. As there was a similarity of purpose, so there was a similarity in design, and though standardisation might be too ideal to consider at the moment, he thought it was not an impossibility, particularly for three-phase 440 to 3,000 volt use.

It had been said in a recently published book that Ironclad "Draw-out" gear was "suitable for mining and sub-stations, but with control-board requirements of a central station the arrangement no longer possesses the advantage of simplicity." He did not agree with this statement. In cases where a control-board was requisite, the design of the control-board presented no more difficulties with armour-clad gear than with any other form of gear ; in fact, in some instances the control-board had been considerably simplified on account of the use of armour-clad gear.

Dealing with larger switchgear he thought the near future would decide in favour of the use of armoured principles for all sizes of plant and power stations. He illustrated examples of large power station switchgear and said that the chief problem was the necessary strength of the enclosure of actual circuit breaking parts to withstand the heaviest stresses likely to occur on breaking short-circuit currents. He saw no limitation to the use of armour-clad gear for any size of plant or for any voltage, and there were no difficulties which experience to date had brought to light, that were not equally applicable to other forms of switchgear construction.

PARLIAMENTARY INTELLIGENCE.

Marconi and Telefunken Companies.

In reply to a question in the House of Commons last week, the Postmaster General (Mr. J. A. PEASE) stated that the Government were satisfied that there had been no connection between the Marconi and Telefunken Companies since the war began. The Marconi and Telefunken systems, like other wireless systems, were capable of communicating with each other, and it was the object of the International Radiotelegraph Convention, to which this country was a party, to regularise and promote general intercommunication between ships and coast stations equipped with the various systems. The agreement between the Marconi and Telefunken Companies which existed before the outbreak of war had no bearing on that point. Every precaution had been taken to ensure the loyalty of the operators employed on board British ships. The Government could not, of course, investigate the antecedents or sentiments of operators on board neutral ships, but all practical measures had been adopted to obviate danger in that direction. In that connection the assistance of the Marconi Company had been valuable. Operators on British ships were British subjects.

Armorduct Mfg. Co. (Ltd.)—In the House of Commons on Friday, Mr. Protyman, replying to questions asked by Mr. Nield, said that the supervisor of the Armorduct Mfg. Co. (Ltd.) was at present in communication with several British firms with the view of obtaining offers for the business, and pending the result of the negotiations he was unable to say what consideration would be given to the offer made by Mr. Small. The difficulty in offering the business for sale by auction was that it was necessary that the purchaser should continue the business satisfactorily. The difference between the Armorduct Mfg. Co. and the Isleworth Rubber Co. was that the Armorduct Co. was manufacturing articles required by the War Office and Ministry of Munitions in the national interest, and the supply of which might have been diminished by closing the company's business, and the Isleworth Co. was not manufacturing at all.

Mr. BUTCHER (York, U.) asked that care should be taken that the business should be sold to a British-born subject, and Mr. PRETYMAN said that consideration would be borne in mind. The business would be dealt with under the usual regulations, which provided that any portion of the profits of the undertaking which would accrue to enemies would be vested in the Public Trustee.

LEGAL INTELLIGENCE.

British Power Traction, &c., Co. (Ltd.) v. Hodgson.

On Monday Mr. Justice Peterson heard a summons by which plaintiffs sought to enforce a finding of the Master that defendant was liable for a sum of £7,000 odd.

Mr. HUGHES, K.C. (for plaintiffs) said that by a judgment of Nov. 6 it was decided that the liability was incurred by fraud or fraudulent breach of trust, and was, therefore, not liquidated by plaintiff's bankruptcy, but directed that the order should not be drawn up as there was a pending summons to extend the time for applying to vary the Master's certificate. Defendant had decided not to proceed with that summons, and, therefore, he asked that an order should go in accordance with his lordship's judgment that defendant should pay into Court a sum of £7,652. 11s. 4d., with interest at 4 per cent. from June 25, 1909 (the date of the Master's certificate), and also costs of the summons.

Mr. Tomlin, K.C., for defendants, said that plaintiff company was in liquidation, the action was really by creditors, and the defendant had issued a summons in the winding-up to set aside the judgment. Defendant had also intended to appeal against his Lordship's judgment on the present summons, and he asked for indulgence. It was a matter that had been in suspense for nine years, and he asked for a stay pending the appeal.

Mr. Justice Peterson suggested that some security for payment of the money should be given, and he also asked whether defendant was prepared to pay a substantial sum into Court.

Mr. Tomlin said he could not make any offer of that kind, and must place himself in his Lordship's hands without prejudice to any application he might make to the Court of Appeal.

His Lordship said that under the circumstances there would be an order upon defendant to pay a sum found due on the Master's certificate into Court within six weeks, with interest, and an order on defendant to pay the costs of the summons.

British Thomson-Houston Co. (Ltd.) v. Duram (Ltd.)

Mr. Justice Astbury commenced on Monday the hearing of this action for an injunction to restrain defendants from infringing plaintiffs' patent No. 21,513 of 1906 for an invention of "process and apparatus for the treatment of metallic tungsten and for the manufacture of electric lamp filaments therefrom"; and also their patent No. 17,722 of 1911, which was granted to John Thomas Henry Dempster for an invention of improvements in methods of wire drawing. It was alleged that defendants had manufactured wire in accordance with these inventions and sold three spools of pladuram made according to the same to the General Electric Co. (Ltd.). Defendants pleaded that the patents were invalid and denied infringement, and said the processes and manufacture had since the patent of 1906 been carried on mainly outside the United Kingdom—namely, by companies in America, Germany and Holland.

Mr. A. J. Walter, K.C., Mr. Colefax, K.C., and Mr. J. H. Gray appeared for plaintiffs; and Mr. Tom Terrell, K.C., Mr. Kerly, K.C., and Mr. C. Terrell for defendants.

Mr. Walter said the patent of 1906 was generally known as relating to the tungsten drawn wire, and that of 1911 related to improvements in the drawing of the wire. Tungsten was an element found largely in combination with iron and manganese, and in commerce until the 90's or the beginning of this century it was known only in the form of fine powder, practically unfusible. In recent years it had become very prominent for two purposes. Its use had been very largely combined with steel, forming very hard high-speed steels; but its chief use was in connection with the manufacture of filaments for incandescent lamps. After giving an outline of the history of the incandescent lamp filament, he said that for some 20 years carbon held the field entirely. In 1898 Welsbach returned to the study of metals, and he suggested that a filament should be made of osmium; but osmium had very little commercial use in the form of filaments. Following upon the work of Welsbach, in 1902 Siemens & Halske suggested the use of other metals of a high melting point; but the only one which had come into use was tantalum. Then came the 1904 patent of Just & Hanaman, where finely divided tungsten was mixed with organic powder carbonised, and then the carbon removed by the action of steel in the presence of hydrogen. Then the electric current was passed through the wires, cementing the particles of tungsten together, and producing the built-up filament which was the practical form in which tungsten was first introduced. Various other methods of built-up filaments had come on the market. The great objection that was raised to the Just & Hanaman patent was that it was only doing to tungsten what had been done by Welsbach to osmium. It had been suggested that if tungsten could be drawn into the form of wire it would be of great value, but until the patent in question in the present case nobody knew how to do it. It was well to realise that metals differed from one another not only in their chemical properties, but also in their physical properties. He claimed for plaintiffs' invention that it treated coherent tungsten by heat during its working process.

Mr. James Swinburne gave evidence for plaintiffs, but the hearing had not concluded when we went to press.

Lowe v. Weld-Blundell.

In the Court of Appeal last week, the hearing was concluded of this appeal by defendant for a new trial on the ground that damages were excessive. At the trial the jury awarded Capt. Lowe £1,000. It was announced that the case had been settled and plaintiff was to receive £350.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstracts from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible] [illegible]

[illegible] [illegible] [illegible] & [illegible] [illegible] instrument [illegible] 2,233 [illegible] 789 [illegible]

[illegible] [illegible] that the only movement of which it is [illegible] [illegible] [illegible] [illegible] [illegible] armature [illegible] connected to one end of a stretched filament nearly parallel to the axis, the other end of which filament is connected to a fixed support [illegible] [illegible] expansion of the filament will cause a [illegible] of the [illegible].

15,094 Thomas. Attachment for miners' electric safety lamps for detecting firedamp and other combustible gases.

15,237 B.T.-H. Co. (G.E. Co.) Wireless signalling systems.

Relates to an electron discharge device for producing continuous electrical waves in an antenna, comprising a filamentary cathode, a co-operating anode, and a discharge controlling grid enclosed in a highly evacuated envelope, a source of constant potential in the plate circuit of said device, a telephone transmitter for producing potential variations which vary in accordance with variations in sound waves, and means for impressing said potential variations upon the plate circuit of said device.

15,251 Caster & Dow. Automatic apparatus for extinguishing the light from portable electric lamps in predetermined directions.

15,370 Warren. Electric clocks. (30/11/14.)

15,759 Wheeler. Cathode for electrolytic cells. (25/1/15.)

17,752 Jensen. Method and means of indicating or recording the frequency of periodic electric currents.

A frequency indicator or recorder consisting of a solenoid or electric magnet so arranged that the frequency of currents passing in the wires of the solenoid or electric magnet produces a pendulous motion in an armature whose centrifugal force is a measure of the frequency.

1916 Specifications.

951 Lincoln. Electric indicators. (20/1/16.) 101,897.

2,986 Callender & Callender's Cable & Construction Co. Electric cables (28/2/16.) 101,914.

3,084 Deutsche Gold & Silber-Scheideanstalt vorm. Roessler. Electrolytic production of sodium perborate. (10/3/15.) 100,152.

10,099 Akt. Ges. Brown, Boveri et Cie. Multiple control apparatus for electric railways. (29/7/15.) 101,023.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 27, 1916.

15,310 Nuttall. Operation and carriage of electric flash lamps.
15,027 Broucher. Appliance for switching off electric current, &c.
15,323 Jennings. Couplings for direct driven motors, &c.
15,333 Lambert. Circuit closers.
15,334 Lambert. Shoe or skate for electric railways.
15,337 Beaver & Claremont. Electric joint making washers.
15,339 Corder. Multiplex wireless telegraphy.
15,350 Bunoy. Spark plugs. (2/11/15, U.S.)
15,357 Levin. Electrolytic gas generators. (20/12/15, U.S.)
15,358 B.T.-H. Co. (G.E. Co.) Wireless signalling systems.
15,359 Hearn. Electric heating element for kindling.
15,365 Svombo. Trolley heads.
15,366 Exley & Leitner. Electric accumulators.

October 28, 1916.

15,401 Brewer. Adjustable scales for magnetic compasses, &c.
15,419 Shepherd, Wilson, Powell & Hammer. Ferrule or sleeve for braided wire coverings.

October 30, 1916.

15,434 Downes & Young. Telegraph, &c., poles.
15,443 Walker. Battery cells.
15,448 Wilson. Improvements in electrically-propelled rail and road vehicles, &c.
15,468 B.T.-H. Co. (G.E. Co.) Wireless telephone systems.
15,471 Norsk Aktieselskab fur Elektrokemisk Industri. Production of titanium-oxygen compounds. (1/11/15, Norway.)
15,487 Whyatt. Apparatus for operating tramway points.

October 31, 1916.

15,480 Langrish & Elec. & Ordnance Accessories Co. Slow motion or retarding devices.
15,500 Cleaver, Potts & Sandycroft (Ltd.). Dynamo-electric machines.
15,516 Scott. Portable telephones.
15,517 Berry. Electric heat radiators.
15,541 Shearer. Electrographic methods and devices.
15,543 Soc. Francaise Radio Electrique. Electric circuit controlling devices (11/11/15, France.)
15,546 A. H. Sheppard & British Ever-Ready Co. Dry batteries.
15,547 Soc. Francaise Radio-Electrique. Radiotelegraphy and radiotelephony. 8/12/15, France.)

November 1, 1916.

15,555 Dickson. Morse signalling apparatus.
15,561 Angold & Railing. Arc lamps.
15,596 Holt & Smith. Fuses for electric circuits.
15,597 Allen. Commutators.
15,598 Brit. Westinghouse Elec. & Mfg. Co. (Westinghouse Elec. & Mfg. Co.) Making laminated articles.

November 2, 1916.

15,623 Humphreys. Attachment to counterbalance sparking plug electrode against centrifugal force.
15,624 Ashcroft. Electrolytic manufacture of metals and/or alloys.
15,661 Ashcroft. Electrolysis of fused electrolytes.
15,675 B.T.-H. Co. (G.E. Co.) Wireless telephone systems.
15,680 Barnes, Knox & Weston. Locking device for magneto electric machines.

November 3, 1916.

15,712 Wilcox. Sparking plugs.
15,723 Sepulchre. Production of electric light.
15,730 Frost. Electrostatic induction machine.
15,733 Snead & Co. Electric heating and tempering.
15,738 Ferranti. Electric welding.
15,742 Midgley & Vandervell & Co. Dynamo-electric machines.

November 4, 1916.

15,773 Moore. Electric device for giving warning when gas pressure is reduced.
15,780 Ringrose. Switchboards.
15,781 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits.
15,802 De Hardt. Telegraph key.
1,5803 Soc. anon. Appareillage Elec. Grivolas. Magnetos.
15,805 Accumulators (Ltd.). Unspillable electric batteries.
15,807 Bottomley & Sample. Insulators for sparking plugs.

November 6, 1916.

15,821 Fretwell. Filling and ventilating device for rendering accumulators unspillable.
15,829 [illegible]. Anchorage for tramrails.
15,837 Watson & M. A. Magneto Synd. Interrupters for ignition magnetos.
15,858 B. T. H. Co. (G. E. C. Co.) Elec. lamps.
15,835 Valeri. Longitudinal railway and tramway sleepers.
15,859 Bateman. Combined walking-stick, &c., and elec. torch.
15,871 [illegible]. Electrodes of furnaces.

November 7, 1916.

15,901 Cooke. Magneto elec. machines.
15,906 [illegible] & Fyfe, Wilson & Co. Elec. switches.
15,926 Palmer. Coin-freed elec. meters, &c.
15,932 Barr. Elec. heating elements.
15,934 Berriman & Daimler Co. Ignition plugs.
15,966 Nuttall. Elec. flash lamps, &c.
15,975 Fletcher. Supporting elec. hot plates.
16,008 B. T.-H. Co. (G. E. Co.) Making magnetic material.
16,032 Stevens & Sankey. Starters for petrol-elec. vehicles.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

The British Trade Bank. The Central Executive Committee of the Employers' Parliamentary Association has passed a resolution urging upon the Government the extreme desirability of taking immediate steps to establish a British Trade Bank, as recommended by the Departmental Committee which reported on Aug. 31 last, but expressing the opinion that, considering the extended scope of the very necessary work proposed to be undertaken, a capital of £10,000,000 is inadequate.

* * * *

Controlled Establishments. The Minister of Munitions announces that he has made further orders under the Munition of War Acts, 1915 and 1916, under which 129 additional establishments have been declared controlled establishments. The total number of controlled establishments is now 4,512.

* * * *

Brass and Copper Census. The Ministry of Munitions has issued an order that every person engaged in the production of brass rod, tubing, sheet and wire strip, stampings, castings, billets and ingots; and copper rod and wire, tubing, sheets, plates, discs and ingots, shall furnish particulars of his output in such form and at such times as shall from time to time be notified to him by the Director of Materials.

* * * *

Aluminium Supplies. The Minister of Munitions has ordered that the war material to which regulation 30a of the Defence of the Realm (Consolidation) Regulations (1914) applies shall include war material of the following classes and descriptions, namely:—

Aluminium and alloys of aluminium unwrought and partly wrought, including ingots, notched bars, slabs, billets, bars, rods, tubes, wire star and cable plates, sheets, circles, strips, aluminium scrap and swarf, aluminium alloy scrap and swarf, re-melted aluminium scrap and re-melted aluminium alloy scrap and swarf, granulated aluminium powder "bronze," "flake" and "flitter."

The Order of July 21, 1916, relating to aluminium and alloys of aluminium therein mentioned is cancelled. All applications for a permit in connection with the Order should be addressed to the director of materials, Minister of Munitions, Armament-buildings, Whitehall-place, S.W.

* * * *

Accidents to Munition Workers. A Bill has been introduced into the House of Commons which provides that if the Ministry of Munitions frame a scheme whereby the Government assume liability for injuries caused by accidents in munition works, contributions may be obtained from the persons carrying on the works. The Minister of Munitions will appoint an advisory committee, consisting of persons having special knowledge of insurance, to advise him as to the amount of the contributions.

* * * *

Canadian Trade and Commerce. The Dominion Government have appointed an advisory council to encourage industrial and scientific research and to foster trade and commerce in Canada. It is proposed to follow the policy pursued in Great Britain. Dr. Mackenzie, president of Dalhousie University, is chairman of the Council, which consists of a dozen leading scientists in the Dominion.

Russo-British Trade Relations. Last week a luncheon was given in order to inaugurate the recently formed Russo-British Chamber of Commerce. The Russian Ambassador (Count Benckendorff) presided and the guests were representative of the political and commercial world in this country.

Among those present were: Lord Desborough, Lord Cowdray, Lord d'Abernon, Lord Emmott, Lord Claude Hamilton, M.P., Dr. Addison, M.P., Sir John Denison-Pender, Sir W. Clark, Baron A. De Heyking, Sir Algernon Firth, Mr. Stanley Baldwin, M.P., Mr. Shirley Benn, M.P., Sir H. Birchenough, Sir W. R. Brooke, Sir Vincent Caillard, General C. Callwell, Sir R. Carlyle, Sir Stuart Coats, M.P., Commander Sir A. Trevor Dawson, Prof. Dunstan, Sir R. Hadfield, Mr. Gershom Stewart, M.P., Sir Mark Sykes, M.P., Sir C. Wakefield, Col. W. Hall Walker, M.P., Mr. J. H. Whitley, M.P., Rear-Admiral Wolkoff, M.P., Sir T. Wrightson, &c.

It was stated that already nearly 500 firms had become members of the new Chamber. After the usual Royal and Imperial toasts had been honoured, Lord Robert Cecil proposed "The Russo-British Chamber of Commerce." He said the Chamber was one of the fruits of our alliance with the Russian Empire. The alliance was founded in a common aim and would endure until that common purpose was fulfilled. He believed that the alliance with Russia was not only essential for our present purpose, but had every element of permanency. Vitally and essentially, in the things that really mattered we were agreed. We had much to learn from Russia, and we had something, perhaps, that we could give Russia from our stores. Russia had some great industries, and was a country of enormous, boundless, national resources; she had great mineral and agricultural wealth. Those were things most essential to a highly developed industrial country like ours. And we had something perhaps which is essential to Russia; we had the output of our great industries, our great engineering training, our great commercial conditions. It was from union between the two countries that the prosperity of each may be looked for. He was connected with the office which was responsible for the Consular system. He believed it had done great work and was capable of great development. They were accustomed to rely simply on Government assistance. He would be sorry if that characteristic in the British race were changed. He believed the nation that got to rely on the Government was on the road to decay and degeneration. Therefore he believed that it was essential for British commerce to establish its own connection with Russia, and not rely merely on those influential connections which, however admirably organised, would never take the place of individual effort. He would like to see a visit from Russian commercial men and also to see representatives of our commerce visit Russia. He trusted that those efforts which had been begun by some of our great manufacturing firms would not be abandoned, namely, the training and educating of young men, not only in the Russian language, but in Russian thought and traditions, so that they could establish and root in Russia the foundations of British commerce. It was for them, the heads of British industry, to carry out that policy. The union of Russia and England was not merely the work of Governments and Chambers of Commerce; it was also the work of the individual citizens of the two countries. The great work before the Russo-British Chamber of Commerce was not a mere mechanical, official operation, but the strengthening and intensifying of the mutual interests of British and Russian commercial men, so as to draw still closer together the bonds which united the two countries.

Count Benckendorff congratulated those who had contributed to the creation of the Chamber. Great Britain and Russia had been drawn together by the irresistible impulse of a righteous cause which it was their high mission to defend. The immediate task and object of the Allied peoples of Great Britain and Russia was to win the war. Still, it was wise and not inopportune to look beyond that immediate object. The spirit of sympathy which inspired our two nations must create a new and lasting bond between us in the future. He was glad to see that a very powerful movement for the development of an educational, scientific, and literary rapprochement was already on foot. This newly-created Russo-British Chamber of Commerce was an expression of the same solidarity in the domain of industry. It would be a potent factor in the establishment of a close intercourse, commercial and industrial, between Great Britain and Russia. In the task of commercial and industrial union the Russo-British Chamber of Commerce would play a great part.

Sir Algernon Firth said it had been desired that he should endeavour to express the views of the committee which had been got to work to form the chamber. If anything could stimulate their efforts it would be the messages received from the King and the Emperor of Russia. He also wished to thank Count Benckendorff, who had shown the deepest interest in the formation of the Chamber and had facilitated their efforts in every way. They were gratified to learn, too, that Mr. Runciman, the President of the Board of Trade, had expressed sympathy with their objects and his desire to be associated with them. The Committee had arranged to appoint Mr. Runciman co-honorary president, with Count Benckendorff. He expressed his thanks to the members of the committee and especially to Baron A. de Heyking, the Russian Consul-

General in London, who had attended every meeting and given them great assistance. They had taken premises in Kingsway and he hoped that in a few days these premises would be ready for inspection. They intended to work there with two sections—a British and a Russian—so that when a Russian came over to obtain goods the British section would help him, and the reverse process would take place in the Russian section. He thought they would be surprised if they knew the number of inquiries and communications they had already received upon subjects of trade between the two countries. The objects of the Chamber, were to promote trade relations between the Russian and British Empires, to study the requirement of Russia and to inform Russia of our needs, to buy from Russia and to sell to Russia all that was possible, to be a centre for initiating transactions between buyers and sellers on both sides, to improve and sustain credit relations, &c. British merchants would never seek to dominate Russian industries in the selfish, brutal German manner. They would seek a trade that would be mutually profitable.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Nov. 25, 1916, *to* Dec. 2, 1916.

IMPORTS.

LONDON.—*U.S.A.* Wire and cable, £3,371; elec. machinery, £911; telephone material, £1,043; unenumerated, £7,613. *Holland:* Elec. glow lamps, £3,475; unenumerated, £422. *Japan:* Unenumerated, £6,035. *Switzerland:* Carbon candles, £657; unenumerated, £588. *France:* Unenumerated, £270. *Canada:* Telephone material, £30; unenumerated, £580. *Denmark:* Elec. machinery, £205.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £242. *Melbourne:* Elec. machinery, £253; unenumerated, £2,357. *Sydney:* Elec. machinery, £770; wire and cable, £69, unenumerated, £658. *Wellington:* Unenumerated, £299. *Lyttelton:* Wire and cable, £85; unenumerated, £46. *Adelaide:* Elec. machinery, £73. *Christchurch:* Telephone material, £7; unenumerated, £926. *Brisbane:* Wire and cable, £261; elec. lamps 1,800 n.o.; unenumerated, £219. *Dunedin:* Unenumerated, £141. *Newcastle:* Elec. machinery, £148.

AFRICA.—*Durban:* Elec. machinery, £168; elec. lamps, 2,500 n.o.; unenumerated, £490. *Cape Town:* Elec. machinery, £196; unenumerated, £248. *Port Elizabeth:* Elec. machinery, £1[illegible]; unenumerated, £8. *Mauritius:* Unenumerated, £268. *East London.* Wire and cable, £57; elec. machinery, £33; unenumerated, £21. *Beira:* Wire and cable, £22; elec. lamps, 1,000 n.o.; unenumerated, £45. *Delagoa Bay:* Unenumerated, £19.

MOROCCO.—*Casablanca:* Unenumerated, £145.

MALTA.—Telegraph material, £12,514; unenumerated, £59.

EGYPT.—*Alexandria.* Unenumerated £21. *Port Said:* Unenumerated, £10. *Port Sudan:* Unenumerated, £155.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS. *Bombay:* Elec. machinery, £139; unenumerated, £600. *Calcutta:* Elec. wire and cable, £200; elec. machinery, £105; unenumerated, £1,317. *Madras:* Elec. machinery, £83; unenumerated, £496. *Ceylon:* Unenumerated, £136. *Singapore:* Unenumerated, £104. *Bankok:* Unenumerated, £335. *Penang:* Elec. lamps, 166; elec. machinery, £38; wire and cable, £275, unenumerated, £419. *Karachi:* Elec. machinery, £28. *Port Swettenham:* Telegraph material, £45; unenumerated, £31.

CHINA.—*Shanghai:* Elec. lamps, 1,700 n.o.; telephone material, £156; unenumerated, £91. *Hankow:* Unenumerated, £2[illegible]3. *Tientsin:* Telegraph material, £41. *Dalny:* Elec. machinery, £61; unenumerated, £22.

JAPAN.—*Yokohama:* Unenumerated, £160.

SOUTH AND CENTRAL AMERICA. *Buenos Aires.* Wire and cable £476; elec. machinery, £248; unenumerated, £271. *S[illegible]:* Unenumerated, £16. *Montevideo:* Unenumerated, £62. *Rosario:* Unenumerated, £20.

WEST INDIES.—*Dominica:* Unenumerated, £19. *St. Kitts:* Unenumerated, £88. *Demerara:* Unenumerated, £14.

HOLLAND.—*Amsterdam:* Wire and cable, £1,056; elec. machinery, £94. *Rotterdam:* Wire and cable, £1,5[illegible]; [illegible] material, £1,2[illegible]; unenumerated, £90.

FRANCE.—*Paris:* Elec. machinery, £49; unenumerated, £656. *Bordeaux:* Unenumerated, £105. *Havre:* Elec. machinery, £4[illegible].

DENMARK.—*Copenhagen:* Wire and cable, £3,8[illegible]8.

SWITZERLAND.—*Geneva:* Unenumerated, £38.

CANADA.—*Halifax:* Telegraph material, £89.

U.S.A.—*New York:* Unenumerated, £8[illegible]9.

FOREIGN GOODS (duty paid and free).

[illegible] C[illegible] £[illegible]; unenumerated, £14. *Bordeaux.* Unenumerated, £10. *B[illegible]:* Unenumerated, £24. *Durban:* Unenumerated, £12. *Hongkong.* Unenumerated, £[illegible]46. *M[illegible]:* Elec. meters, £1,161. *Singapore:* Unenumerated, £[illegible]. [illegible] E[illegible] 1,[illegible]4 n.o.; unenumerated, £18. *Calcutta:* Unenumerated, £119. [illegible]: Unenumerated, £2. *Fiji:* Unenumerated, £13. *Port Sudan:* Unenumerated, £[illegible].

IN TRANSIT.

H[illegible]: E[illegible] £147.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL.

Swansea Technical Institute.—Over £7,000 has been subscribed in three weeks to the [illegible] fund for technical education.

Wireless Telegraphy School.—At the last monthly meeting of the North of England Steamship Owners' Association, the chairman (Mr. Alfred Robinson) submitted a report of a sub-Committee advocating the establishment of a school of wireless telegraphy in Newcastle in order to educate operators for merchant ships. The report was adopted, and the secretary was instructed to communicate particulars to the shipowners interested.

BUSINESS NOTICES.

Messrs. James Gordon & Co., Water Power Engineers, having had their offices in Canada House, Kingsway, requisitioned by the War Office, have removed to temporary offices at Queen's House, Kingsway; the telephone number and telegraphic address remaining the same.

The partnership between Baron Pearse, Alex. M. Foster and Athol R. Harwood (trading as the Ideal Battery Co.), Nursery-road, Mitcham, has been dissolved. Debts by Mr. Harwood.

Wm. Douglas Goodenough and John Bubyan Skinner, motor engineers, electricians, &c., 62, Hampton-road, Redland, Bristol, have dissolved partnership. Debts by Mr. Goodenough, who continues the business.

On and after Dec. 20 the office of the Superintendent of the "London Gazette" will be at Imperial House, Kingsway, London, W.C.

Sale by Tender.—By order of the Controller (Mr. Maurice Jenks, F.C.A., of Messrs. Maurice Jenks, Percival & Co.), the entire stock of meters, instruments, fittings and electrical accessories of the A.E.G. Electric Co. (Ltd.) will be sold by public tender in one lot. The goods are on view on the premises, Richmond-mews, Richmond-buildings, Dean-street, Soho, London, W.C., and may be inspected upon production of the catalogue, to be obtained gratis from the selling agents for the Controller, Messrs. Wheatley K[illegible]k, Price & Co., 46, Watling-street, London, E.C., to whom tenders are to be sent by noon of Friday, Dec. 15. *See an advertisement.*

Plant for Sale.—Messrs. Marshall, Sons & Co. (Ltd.), 79, Farringdon-road, London, E.C., advertise for sale a Willans high-speed enclosed engine direct coupled to Siemens c.c. dynamo, 230 v., 500 amperes, 350 revs.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Dae Accumulator Synd. (Ltd.) is being wound up voluntarily, and Mr. H. C. Bound, 61 & 62, Lincoln's Inn Fields, London, W.C., has been appointed liquidator. A meeting of creditors will be held at 61 & 62, Lincoln's Inn Fields, London, W.C., on Dec. 15.

Claims against the Bachelet Flying Train Synd. (Ltd.), the Bachelet Shipbuilding, Engineering & Ordnance Co. (Ltd.), the Bachelet Levitated Railway Synd. (Ltd.), and the Bachelet Shuttle & Loom Co. (Ltd.) are to be sent to Sir Wm. B. Peat, 11, Ironmonger-lane, London, E.C., by Jan. 3.

An order was made in the High Court of Justice on Oct. 13 that all further proceedings in the voluntary winding up of the Patent Lighting Co. (Ltd.) be stayed.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—The Corporation have agreed to rent a piece of land for the purpose of erecting a sub-station.

Birmingham.—The L.G. Board have sanctioned a loan of £7,350 for additional cooling towers and pipe line in connection with the alteration of the scheme for the extension of the temporary generating station.

Dover.—The Council has agreed to take up a further loan of £3,884 for laying a new cable.

Leyton.—For the destructor works a 30 or 40 H.P. electric motor is to be purchased at a cost of from £100 to £120 to drive the air compressor when steam is low instead of burning coal.

Sunderland.—The L.G. Board have authorised a loan of £45,000 for the purchase of a new turbine and alternator and condensing plant, &c.

Ald. W. Bruce and Councillor R. J. Wilson have been elected chairman and vice-chairman respectively of the Electricity and Lighting Committee.

Woolwich.—The Electricity Committee has considered communication relating to a further supply of electricity for power and the Borough Electrical Engineer has submitted details of the extensions required, estimated to cost £21,000.

The above sum is made up as follows:—Turbo-alternator, superheater, pumps, piping, valves, &c., £11,000; extra high and low tension mains, £9,000; switchgear, £1,000. The Electricity Committee is satisfied that the extensions will yield a reasonable profit and a loan will be taken up on conditions similar to those of the previous loan of £27,500. Application is, therefore, to be made to the L.C.C. to borrow the £21,000 or such other figure as may be finally agreed upon. The loan of £27,500 has been accepted on the condition that it is repayable on the instalment system (with interest at 4¾ per cent.), over a period of 15 years.

Application is also to be made to the L.C.C. for sanction to borrow £2,442 for main extensions, trenching, &c.

The Borough Electrical Engineer reports that he finds an increasing difficulty to procure capable boys for switching the electric lamps on and off. At present 3 boys are engaged (2 at £1 per week and 1 at 15s. per week), but one boy (at £1 a week) could be dispensed with if 55 of the lamps were fitted with automatic switches at 16s. each. Under this arrangement the cost of the switches would be covered in two years by the saving in wages. This proposal has been agreed to.

GENERAL.

Accrington.—At Monday's meeting of the Council, the chairman of the Electricity Committee (Ald. Higham) said the electricity department had now got delivery of the new turbo-alternator set, but they were still waiting for the pumps. They hoped to have the new plant running by the end of the month.

Bingley (Yorks).—On the recommendation of the Electricity Committee, the following alternative system of charging for electric current for power has been adopted by the Council: £3 per annum per metered horse-power required, plus 1d. a unit for all energy supplied.

Birmingham.—In March the charges to lighting consumers were increased by 15 per cent. and to power consumers 20 per cent.

The Electric Supply Committee reported to the Council on Tuesday that the returns for the first six months of the year show heavy increases in the cost of fuel and labour. The operations of the department have involved much strain upon the machinery and plant, and this condition is likely to continue during the remainder of the year. The cost of repairs will be exceptionally heavy and a substantial sum will be required to meet the accelerated rate of depreciation. This exceptional wear and tear is due to the large increase in the demand necessitating the running of the plant up to the full capacity of the stations instead of reserving the margin usual in peace times. The load has not only been heavy but it has been continuous. It is evident that the expenses of the department will be even heavier proportionately during the forthcoming winter, and the Committee do not feel satisfied that the revenue under the existing scale with the increases made in March will provide a sum sufficient to meet the requirements of the position. The high tension consumers under the coal clause in their agreements automatically pay an increased rate per unit more or less proportionate to the increased cost of generation. The low tension lighting and power consumers pay a fixed rate and the Committee consider that the increase of 15 per cent. to lighting consumers should be raised to 30 per cent., and that the 20 per cent. increase for power, heating and cooking should be raised to 30 per cent., the additional increases to take effect from the December quarter.

Ald. Jephcott set out the reasons for the Committee's recommendations. He said that wages had increased very seriously, and the recent award of 2s. 6d. per week would make matters more serious. The rise in the cost of fuel had been extremely rapid, and had been accompanied by a serious depreciation in the quality; and although they had purchased a higher quality of fuel the benefits which they had hoped for had not been realised. That meant thatmore fuel had to be burnt to obtain an increased output, with the result that more ashes also had to be handled. The repairs, which had been carried out and which yet remained to be executed, had been much heavier than were anticipated. It was their usual experience that, owing to the falling off in the demand for lighting current, it was possible to carry out a thorough overhaul during the summer months, but that had not been possible this year, whilst the margin of plant which they used to keep idle against a breakdown had been substantially reduced owing to the need to supply as much power as possible. They had expected to get delivery of new plant and have it running by the middle of September, but that was not now expected to be accomplished until the middle of the present month at the earliest. The consequence was that the existing plant had had to meet huge demands, causing depreciation and a wear and tear which would necessitate serious repairs. Those points constituted the real reasons for the increased price for current. They were doing all they could in the way of repairs, and each week-end they had 30 skilled men gathered from all parts of the country, so that they might do some of the really necessary work. Notwithstanding that, they were still behind with repairs necessary for a full output. Owing to the operation of the coal clauses, the high-tension consumers were actually at present paying more per unit than they were at the beginning of the year. These users had agreements with the Corporation covering a period of years, so that they could not touch them until the agreements ran out. Thus the only two sources of revenue were from the lighting and low-tension power users. In the case of lighting they suggested an increase of 15 per cent., making with the March increase a total of 30 per cent. In the case of low-power consumers, the Committee asked in March for a 20 per cent. increase; they now asked for another 10 per cent., so that both classes of consumers should be equally treated.

Ald. Brooks moved an amendment that the increase for power, heating and cooking be raised from 20 to 40 per cent. He pointed out that when the proposals of the Electric Supply Committee were submitted to the Finance Committee that Committee came to the conclusion the increased charges were necessary if the department was to be run on sound business lines. It was the policy of the Gas Committee to put the larger increase on the larger consumers, and that seemed to him just and fair. In ordinary circumstances he should have moved that the whole question of the increases should be referred back, but the Committee were carrying on their business under extreme difficulties, and it was necessary the changes should be made as quickly as possible. Was it not time the whole question of the charges and the cost of production should be once more investigated, in order that the Council might be satisfied the department was being run on sound business lines?

Mr. E. C. R. Marks pointed out that if the higher increase suggested by Ald. Brooks was not adopted during the next quarter the department would lose between £3,000 and £3,500, and they could not afford to do that under present conditions.

Ald. Jephcott, replying, protested against the Electric Supply Committee being compared with the Gas Committee; the circumstances in which each traded were entirely different. With regard to Ald. Brooks' amendment, he did not in the least mind if the Council were desirous of accepting the responsibility of charging more for current to consumers. The Committee had given careful consideration to the question, and they advised the Council that the proposals they made would not only meet what was required to carry on the undertaking, but be a fair basis of charge to the consumers concerned. In reply to the question as to why they had altered their views since last March, the Committee, in considering the increases last autumn, were influenced by other considerations well known to members who had come from outside the city before the extension. The economies required of the lighting consumer had reduced his bill considerably, and the return to the department was entirely different to the position which existed in March last. For that reason the Committee did not think they should continue to discriminate between the lighting and power consumer, but make the percentage of increase a uniform one. They were not endeavouring to make one type of consumer pay for another; they did their best to treat all types fairly. The suggestion that they gave favourable consideration to high-tension consumers or consumers of a large amount of current was not true.

The amendment was then put and carried.

Doncaster.—Coun. Balmforth is chairman of the Electricity Committee for the ensuing year.

Dublin.—In a recent issue we gave an abstract of the report of the Special Committee on the electric supply undertaking of the Corporation, together with the report of the consulting engineer, Col. P. W. D'Alton. The Electricity Committee has now issued a criticism of the report of the Special Committee.

At the outset the Electricity Committee protest against the methods of investigation adopted by the Special Committee, and declare that "its proceedings were clothed with Star Chamber mystery, and arrived at a lame conclusion." The Electricity Supply Committee then proceed "to submit to the Council a few general observations on the report presented by the Special Committee." The Electricity Committee protest against the manner in which they have been treated in connection with the so-called investigation of the electricity undertaking. "Some years ago the Council decided that it was advisable that a Special Committee should be placed in direct charge of the electricity undertaking, and duly elected 10 of its members to act as that committee. Most of the members have taken a keen interest in their work and have devoted a very considerable amount of time to it. They have had to meet in the course of their work an exceptional amount of criticism, not always of the fairest kind, and accordingly they raised no objection to the proposal that a Special Committee of Inquiry should be appointed, knowing that any fair investigation would result in the removal of many of the grounds on which previous criticism had been based. They were prepared to assist the Special Committee in every way, but during the entire 18 months the committee which had charge of the undertaking was never consulted on the smallest detail, nor has the slightest inquiry been addressed to its members. The officials of the undertaking have been treated in much the same manner. The resolution fixing the appointment of the Inquiry Committee suggested that the city treasurer, city accountant, Mr. Allan, Mr. Ruddle and Mr. Kettle should be present at all meetings, but during the entire investigation the three officials of the electricity undertaking were never allowed to be present during any sittings of the committee; and when on one occasion they were summoned in error, and attended in accordance with that summons, they were immediately requested to retire. Under these circumstances the Electricity Supply Committee report that they are not surprised that the Special Committee has been unable to carry out the instructions upon which it was appointed." The Special Committee were directed by Council to make their report under seven heads. They have not made the slightest report as a committee under a single one of these heads, and the Council is left entirely in the dark as to the opinions of the Inquiry Committee on any or all of the subjects submitted to them. The engagement of an expert by the Special Committee was carried out under the authority vested in that committee by Council, but it was not unreasonable to presume that the expert engaged (if it were merely a question of obtaining sound advice) would have been the chief engineer of one of the more important central stations of England or Scotland. The advice of any such man, who had personal experience of the building up of a successful business on at least somewhat similar lines to the Dublin undertaking, would have been of value to the Corporation. Your committee have not the least doubt that the services of such an engineer could have been obtained if communications had been entered into with the corporations of other cities. The committee regret that so far as they can judge, they cannot think that Col. D'Alton's experience is of the special nature required, and they are, therefore, all the more impressed by the belief that as his report has not been either analysed or investigated into by the Special Inquiry Committee, the work for which that committee was appointed cannot be disposed of by shelving it on to the shoulders of any outside individual. Some years ago the proposal was put before the Council that the same powers of control should be vested in the Dublin Chief Electrical Engineer as had for a short period been conferred on the consulting engineer (the late Mr. Robert Hammond), but the suggestion was not adopted. It was also proposed that Mr. Hammond should be re-appointed for a more lengthened period with full control; but that proposal was also rejected. Your committee must therefore express regret that the only result of the 18 months' work of the Special Inquiry Committee has been a revival of the Hammond proposal of management from London in a worse form—for at least Mr. Hammond possessed the advantage of having planned out the system. On the other hand, no consideration has apparently been given to the alternative proposal to confer similar power on the Dublin Chief Engineer after his 25 years' of strenuous and faithful service. The Electricity Supply Committee have never desired, and do not desire, to hide anything from the Council or the public. At the frequent L.G. Board inquiries they have again and again been complimented by the inspector representing the Board on the fulness of the information submitted; and at several of these inquiries that information had to meet the criticisms of opposing counsel or engineers. Your committee find it difficult to regard as serious the suggestion to make at the present time an appointment for the purpose of carrying out proposals involving the expenditure of a large amount of money which cannot be raised; involving reductions of wages which even now can barely meet the increased cost of living; involving alterations of plant, &c., which were proposed by the Electricity Committee itself, but held over by Council till after the war; and involving many other changes which it may never be possible to give effect to in the future altered conditions of commercial business." The Electricity Supply Committee are working under very serious difficulties, which, indeed, surround all electricity undertakings. So great is the difficulty of procuring not alone coal but practically every other necessary material in adequate quantities, and in face of growing Government restrictions, that the question which is now exercising every municipality is, whether, or to what extent, the supply of electricity can be maintained. Your Electricity Committee claim to have grasped the situation fully and in good time. Not alone has the full supply been maintained, but, unlike many other cities, the Dublin arrangements are sufficiently complete to enable the Corporation to guarantee future supply without curtailment, if present conditions be adhered to. It is open to your committee to claim that the recommendations, with which the report of the Inquiry Committee closes, is not alone entirely out of place at the present time, but is also entirely out of order. While, saying this, however, they do not wish the matter to end at the position where it now stands; and as no such suggestion as it made could possibly be carried out at the present, and as there is therefore ample time for further consideration, your committee recommend that the entire report be now referred (for the first time) to the Electricity Supply Committee for investigation and report, the references to include the headings not reported on by the Special Inquiry Committee; and that the same powers of investigation be conferred on the Electricity Committee which were conferred upon the Special Committee.

At the Corporation meeting on Monday it was decided to hold a special meeting for the purpose of considering the report of the Special Committee.

Edinburgh.—The Electric Lighting Committee will not insist upon the payment of the minimum rate of charge by consumers who are on active service.

Finchley.—A resolution from the East Finchley Ratepayers' Association upon the subject of electricity charges has been referred to the Electricity Committee.

The association desire the abolition of the minimum electric light charge, and that the 20 per cent. addition recently made be only upon units consumed. They also ask for a flat rate for lighting and power.

Hornsey.—The Council has received a communication from the Hackney (London) B.C., asking for a contribution of £100 towards the costs of defending an action brought by the Gas Light & Coke Co. in respect of a reduced charge made for electric energy supplied for lighting to customers who are also power consumers, it being alleged the charge constituted an undue preference. The Electricity Supply and Finance Committee are considering the matter.

Ilford.—The increase of consumers during September was equivalent to 516 8 c.p. lamps. An application for a supply to a new factory has been refused, as the Electricity Committee is unable to take any action at present.

Linking-up in South Wales.—A meeting was recently held at Cardiff of the engineers of the electricity supply undertakings in South Wales and Monmouthshire to discuss proposals for the linking up of the generating stations within the area.

The meeting was presided over by Mr. W. A. Chamen, chairman of the joint committee of the Incorporated Municipal Electrical Association and the Incorporated Association of Electric Power Companies. After Mr. Chamen had explained the object of the meeting, it was resolved that the committee for the South Wales district should consist of all the representatives invited to the meeting. Mr. Arthur Ellis, city electrical engineer of Cardiff, was elected chairman, and Mr. Lewis W. Dixon (managing engineer of the Merthyr Electric Traction & Lighting Co.) vice-chairman and hon. secretary. The following were elected members of a sub-committee: W. A. Chamen (S. Wales Electrical Power Distribution Co.), J. W. Burr (Swansea), A. Nichols Moore (Newport), G. H. Thomson (Neath), J. E. Teasdel (Pontypridd), J. M. Bowman (Porth), and J. C. Howell, of Llanelly (representing the Pontypool Electric Lighting & Power Co.). The secretary was instructed to write the various authorities in the area for certain information, and to arrange with the chairman to call a meeting of the sub-committee as soon as the information is obtained, in order to consider further steps.

Linking-up in Yorkshire.—The city electrical engineer of York (Mr. J. W. Hame) has reported on the proposal to interconnect the electric supply undertakings of Yorkshire, and has come to the conclusion that it will be of no advantage to York.

Mr. HAME states in his report that, following the Board of Trade's letter to electric supply undertakings in May, attention was given to "linking-up" supply stations and a joint Committee of supply authorities had suggested a division of the country into areas of supply. Those areas where there were a large number of industrial towns with power stations close together were kept distinct from the areas which were more or less agricultural where the towns are further apart. York was in an agricultural area, the nearest towns where there were supply stations of any importance being Leeds, Hull and Harrogate. The distance between those towns was such that the cost and the labour involved in carrying out a "linking-up" scheme would make inter-connection impracticable at present. The power supply companies were the Yorkshire Electric Power Distribution and the Electric Power Companies, the first-named operating down as far as Thirsk, and the latter having mains laid up to their Selby supply area. The time may come when some advantage might be gained by connecting the electric supply stations of the above companies through York, but that time was certainly not yet, and the only way in which "linking-up" could be of practical interest to York at present or in the near future was the transference of much of the power generated by private plant in the city and district to the Corporation's central supply plant. That policy was being adopted, and he was in communication with several large users of power with the object of getting those power users to give the matter their consideration.

Kendal.—Mr. Pennington has been appointed chairman of the Electricity Committee for the ensuing year.

The manager has been instructed to procure samples of electric heating apparatus for advertisement.

The charge for electricity for power purposes to consumers of 8,000 units per annum and upwards has been fixed at a flat rate of 1¾d. per unit.

Salford.—The Corporation have agreed to give a supply of electrical energy to the Diatem Fireproof Construction (Ltd.).

TRACTION NOTES.

Birmingham.—Ald. Jephcott, chairman of the Electric Supply Committee, explained to the Council on Tuesday the position of his department.

He said that as a Committee they had endeavoured, not only recently, but for a long time past, to do their best to prevent a stoppage of the tramcars whenever they could. They had tried various expedients to meet the requirements of munition works, and had also endeavoured to get a fixed time for the tramcars to stop; but they were prevented by a certain authority from carrying out their suggestions. He was hopeful that by the end of this month they would have got over their difficulties. Within the last few days there had been an improvement in what some people would probably call their bad record, and when they got new plant installed at Nechells their troubles would be over. He would not oppose an inquiry, but they would do no good whatever if they limited themselves to the tram stoppages.

Mr. COMBRIDGE moved an amendment to appoint a special committee to inquire into and report to the Council on the failure of the electrical department to supply sufficient current for the needs of the city, the members of such committee to be appointed by the General Purposes Committee.

The LORD MAYOR ruled the amendment out of order.

Mr. JAMES moved that the Electric Supply Committee be asked to furnish the Council with a summary of the advice which their engineer had given since November, 1911, as to the probable necessity for increasing the generating power at their stations. They could not allow the day to go by without satisfying the public that they were prepared to make some inquiry into the very serious state of things which had arisen. He based the case for inquiry on two grounds: (1) That there could be no possible doubt as to the inconvenience the public had suffered; and (2) that it did not appear to him they were satisfied that inconvenience was inevitable. The public were casting aspersions which affected the Council, particularly the Committee, and touched officials. In those circumstances they ought not to be left in doubt as to where the blame rested, if there were any blame. Apart from the monetary loss of the tramways department, there had been an immense loss to the public in time and convenience, while there had been a shortage of supply to factories. Inquiry should be made as to what had been going on during the last five years, whether officials had given the Committee any advice as to what they must have known, and how far it was acted upon, or where the responsibility lay for not doing so.

Ald. CLAYTON asked the Council to bear in mind that at very short notice the consumption of electricity had gone up by leaps and bounds, and the trams had suffered.

The CHAIRMAN of the Tramways Committee (Mr. Harrison Barrow) asked what guarantee the chairman of the Electric Supply Committee could give as to the power necessary to run tramcars up to 9.30 a.m., from 12.30 p.m. to 2.30 p.m., and after five o'clock in the evening. That was the very lowest they should arrange for. He also wished to know whether extensive repairs to the boilers were to begin at Christmas, whether they would last for several weeks, and, if so, whether further disturbance of tramway traffic was likely. He should like to tell the Council of the extremely serious losses there had been to the tramways department in consequence of the failure of the Electric Supply Committee. From Sept. 19 to Dec. 2 last the loss in revenue amounted to £26,000, and there had been no saving in expenditure. Until confidence was fully restored they would not get their proper return. Thousands of people had taken railway season tickets, and until those tickets expired they would not go back to the trams.

In reply Ald. Jephcott said he was not in a position to accept the amendment, but he was prepared to promise that they would bring up a report covering at any rate some of the things brought out in the discussion, so that the Council might form a clear idea of the difficulties of the Electric Supply Committee. None of them even six months after the war broke out realised the seriousness of the situation. The Government itself did not, let alone smaller people in the provinces. But since they understood the great demands for power they had increased their output. Whatever mistakes they might have made, he did not think it could be said they had been remiss in regard to the provision for power purposes. As to the tramway services, barring accidents, they believed they could give the guarantee Mr. Harrison Barrow asked for, except that he could not give a promise to start the cars at night much before six o'clock. The repairs at the station mentioned would occupy about 10 days, but the Committee thought they would be able to make arrangements for carrying out the repairs which would not interfere with the running of the trams. Specially skilled men had been engaged, and they would work throughout the Christmas holidays from the moment the factories closed down on the Saturday night.

The amendment was carried and the report was then adopted.

Hull.—Women tramcar drivers are to be employed by the Tramways Committee.

Ilford.—The Tramway Manager has reported that on Oct. 21 a feeder cable broke down, and on investigation a length of over 300 yds. (between the power station and Dunedin-road) had two serious faults and a number of minor ones, rendering the whole length useless.

At the same time it was found that a considerable amount of water had leaked into the conduits from a defective water pipe. The water company were communicated with, and they shut off the leak. The feeder supplied the whole of the Broadway and Ilford Hill, and was laid in 1912, being supplied by the Standard Cable Co., a German firm. The Tramways Manager made temporary arrangements for the supply of current, but as the cable had to be replaced immediately he invited tenders from first class British cable manufacturers, and accepted the lowest tender—*i.e.*, that of W. T. Henley's Telegraph Works Co.—at £138 for 440 yds. of cable, to be delivered within 10 days.

Leyton.—Increases of wages made to the employees of the tramways department are estimated to cost £1,100 per year.

London County Council.—At last week's meeting the Council authorised the Stores and Contracts Committee to open the tenders received on Dec. 5 for the supply of traction glow lamps.

The Finance Committee submitted a supplemental estimate of £7,000 for additional stock of stores in the tramways department. This increase is necessitated by the prevailing exceptional conditions.

Manchester.—The Workmen Special Committee have refused an application of the electricians and wiremen in the Tramways Department to be paid treble time for work on Christmas Day and Good Friday.

Middlesbrough-Stockton Tramways.—At the instance of Middlesbrough Corporation a conference of representatives of Middlesbrough and Stockton Corporations and of Thornaby Urban Council has been called to consider the proposed purchase of the electric tramway system.

North London Railway.—This company has introduced an electric express which completes the journey between Richmond and Broad-street in 33 minutes, compared with an hour in the steam days.

Woolwich.—The doubling of the tramway track in Plumstead-road is a matter of great urgency, but the General Purposes Committee are unable to recommend a departure from the Council's previous decision, viz., not to consent to the doubling of the track unless the widening of the road is first carried out. The Committee is of opinion that the present traffic will be increased rather than diminished and the Council prefer that the Ministry of Munitions should exercise their statutory powers.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says Footscray (Victoria) Municipal Tramways Trust has secured its Order-in-Council permitting it to construct an electric tramway in the district.

India.—"Indian Engineering" says electric lighting and electric fans are to be installed at the Calcutta Town Hall at a cost of £744.

A committee appointed by the Government of Bengal to consider the charges made for the supply of electrical energy in Calcutta commenced its sittings on Nov. 8. Mr. J. W. Meares, electrical adviser to the Government of India, is a member of the committee.

FOREIGN NOTES.

Chili.—Señor V. L. Núñez has been authorised to utilise the waters of the river Chillan, at the rate of 5,000 litres per second, for the production of power required in connection with the electric lighting of the town of Chillan

Norway.—*Electric Automobiles.*—It is reported that a company is to be formed in Christiania for the construction of electrical automobiles. These are expected to be used along the routes of the western coast, where electric power is available and where tourist travel has developed rapidly.

Railway Electrification.—In connection with the electrification of the State railway from Christiania to Drammen, it has been decided that the Government will erect its own power station at Hakavik, on waterfalls acquired about two years ago. The estimated cost is about £600,000, including generating plant, transmission line, rolling stock, &c. Work is to be commenced at once. It is estimated that the power station will develop 17,200 H.P., but at the beginning it is intended to instal only three 4,500 H.P. sets. The question of electrifying other Government roads is also being discussed.

Technical Education in Russia.—In connection with the scheme for the reform of education in Russia it is reported that the Minister of Education has decided to establish 11 new higher technical institutes in various provincial centres.

Up to the present the higher technical schools exclusively served the capitals, the central regions, Transcaucasus and Western Siberia. The system of schools will now be extended to other regions, and it is proposed to specialise in the class of industry proper to the district. At Vilna there will be two sections, one for engineering and the other for chemistry. In Eastern Siberia there will be three institutes—at Irkutsk, Blagovyeschensk and Vladivostock. The total of higher technical schools will be 35, and the completion of the programme will require 10 years.

MISCELLANEOUS NOTES.

Enemy Firms Wound Up.—The Board of Trade has now ordered the winding up of 373 businesses controlled by alien enemies.

In the latest list is included the Vincit Company (Ltd.), Apollo Works, 21, South-rd., New Southgate, London, N., agents for the sale of carborundum and electric machinery. (Controller: Chas. Eves, Capel House, 62, New Broad-st., E.C.)

Claims against the Quarzlampen Gesellschaft m.b.H. (original Quarz Lamp Co.), 62, Red Lion-st., London, W.C., are to be sent by Dec. 16 to the Controller: Mr. R. W. Brown, 12, Old-sq., Lincolns-Inn, W.C.

Claims against Feld Bros. & Co. (Ltd.), 326, Goswell-rd., London, E.C., and against Turner & Burger, 149, Farringdon-rd., London, E.C., are to be sent by Jan. 6 to the Controller, Mr. J. E. Percival, 6, Old Jewry, E.C.

Exports to China.—The "London Gazette" of Dec. 1 contains lists of additions to and removals from the list of firms and persons in China to whom goods may be consigned from the United Kingdom.

London Waste Trade Ambulance Fund.—Mr. A. Joseph, metal merchant and manufacturer, has started a movement to emulate the example of the Dewsbury rag merchants in providing motor ambulances for the British Red Cross service, and he has offered to subscribe £500 for the same purpose if other members of the London waste and scrap trades will subscribe £1,500 before the end of the year. Cheques are to be made payable to the "Waste Trade World," and contributions may be sent either to the "Waste Trade World" 38, Shoe-lane, E.C., or to Mr. Joseph, Earl-street, London-road, Southwark, S.E.

Match Box Covers.—While it is true that matches are dear and scarce, there are still people who carry them, but whether they buy them or purloin them is another matter. Probably the safety match is more in vogue than formerly, and these, of course, only strike on the box, which in these days of economy and general "cutting down" is none too sturdy for striking operations. Messrs. Mosses & Mitchell are helping to strengthen the safety matchbox by issuing a neat metal cover with white xylonite coating, bearing the company's trade-mark and names of their chief specialities in insulating fibre and materials. There is a limited supply of these covers available, and applications for them to 122-124, Golden-lane, London, E.C., will, we understand, be treated in strict rotation.

South Wales Coal Mines.—On Nov. 29 His Majesty in Council ordered the insertion of the following clauses in the Defence of the Realm (Consolidation) Regulations, 1914 :—

After Regulation 9 G ;

1. The Board of Trade may by Order apply this regulation either generally to all coal mines or to coal mines in any specified area, or to any special coalfields or in any special coal mine.

2. Any coal mines to which this regulation applies shall, by virtue of such Board of Trade Order, pass into the possession of the Board of Trade as from the date of such Order or any later date mentioned therein, and the managers and other officers shall comply with the directions of the Board of Trade as to the management and uses of the mines.

3. The possession by the Board of Trade shall not affect the liability of the owner, agent or manager under the Coal Mines Act, 1911, or any Act amending the same.

Since the issue of the above amendments the South Wales coalfield has been placed under State control, and the men's demands for increased wages have been conceded.

TENDERS INVITED.

Electric Bell Wiring Materials.

The COMMISSIONERS OF H.M. WORKS, &c., are prepared to receive tenders for the supply of Materials for Electric Bell Wiring. Forms of tender, conditions of contract, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W., and tenders (by 11 a.m. of Dec. 18) to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W. *See also an advertisement.*

Steam Turbines, Alternators, Condensing Plant, &c.

SUNDERLAND Corporation invite tenders for the installation of a Steam Turbine, Alternator and Condensing Plant at their Hylton-road electricity works. Specification and forms of tender may be obtained from the general manager, Mr. Alfred S. Blackman, and tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Sunderland, must be delivered at the office of the town clerk, Mr. Henry Craven, Town Hall, Sunderland, by first post Saturday, Dec. 9.

DURBAN Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-alternator and Condensing Plant. Specification (No. S.238) from Borough Electrical Engineer.

Telegraph and Telephone Material.

Tenders are required by Dec. 13 for the supply and delivery to the POSTMASTER-GENERAL'S DEPT., State of Queensland, of Caps and Lamps for Switchboard (schedule 388), Covered Wire (schedule 393), and Binders, Sleeves and Tapes (schedule 398) ; and by Jan. 10 for Cords (store schedule 389), Switchboard Parts and accessories (schedule 392), Measuring Instruments (schedule 396), and Telegraph Instruments (schedule 397). Tender forms, specification, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited up to Dec. 22 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492,

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. Dec. 12 for supply of about 320¾ tons of Ammonium Chloride during the five years succeeding June 30 next for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. (Schedule No. 1,375.) Specifications from the Deputy Postmaster-General, Melbourne.

Telephone Exchange.

Tenders are required by Dec. 14 by the ITALIAN MINISTRY OF PUBLIC WORKS for the Construction of a Telephone Exchange in Roma at a cost of about £6,350.

Motor-Generator, &c.

DUNEDIN (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

Motors, &c.

CAPE TOWN (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

Electrical Fittings, &c.

WEST HAM Guardians require tenders by 10 a.m. Dec. 21 for their [illegible] supply of Electrical Fittings, Oils, &c. Forms of tender, &c., from the Clerk, Union-road, Leytonstone, London, N.E.

Electricity Supply Concession.

Extension of Time.—The time for sending in tenders for Generating and Supplying Electrical Energy for Lighting and Power in ST. GEORGE (Grenada) and its suburbs is extended to Dec. 31. Particulars from Colonial Secretary, Grenada (British W. Indies).

Tramcar Materials, &c.

LONDON COUNTY COUNCIL require tenders by 1 p.m. Dec. 19 for supply of 325 tons of Rolled Steel Bar for magnetic brake shoes. Forms of tender from the Chief Officer, L.C.C. Tramways, 62, Finsbury-pavement, E.C.

JOHANNESBURG Corporation require tenders by noon Jan. 3 for Iron Axles and Bushes (contract 163). Specifications, &c., from the Municipal Offices (Room 53).

Conduit.

WARRINGTON Electricity and Tramways Committee require tenders by noon Dec. 12 for 12 months' supply of Earthenware Conduit. Specifications from Borough Electrical and Tramways Engineer.

Pressure Regulators.

JOHANNESBURG Corporation require tenders by noon Dec. 20 for Automatic Pressure Regulators for a.c. Turbo-generators. Specification from Municipal Offices (Room 53), Johannesburg.

Electric Crane and Coal Transporter Plant.

The N.S.W. RAILWAY AND TRAMWAY DEPARTMENT require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Tenders are invited for the supply, delivery and erection in MELBOURNE, of a Coal Transporter Plant of the travelling tower type and electrically operated. Tender form with specification can be obtained from the agents for the Melbourne City Council, Messrs. McIlwraith, McEacharn & Co. Ppty. (Ltd.), Billiter-square-buildings, London, E.C. Tenders by noon Dec. 11.

TENDERS RECEIVED AND ACCEPTED

CHESHAM.—The Council has accepted the tender of the Chesham Electric Light & Power Co. for wiring the Council offices.

LUTON.—The Council has accepted the tender of the British Vacuum Cleaner Co. for flue cleaning suction plant at £280.

SALFORD.—The Corporation has accepted the tender of J. Lomax Kendal & Co. (at £110) for wiring the tramways depot at Broughton ; and that of Mossay & Co. (at £795) for an "Orwell" two-ton electrically driven tipping wagon, fitted with electrical tipping gear.

WOOLWICH (LONDON).—The Borough Council has accepted the tender of the Rees Roturbo Mfg. Co. (at £73. 10s.) for a 6,000 gal. pump for the electricity works.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Melbourne.—J. Bartram & Son, 8,000 clips for waterpipe earth connections, 6d. each ; Melbourne Pottery Co., 2,000 earthenware conduits, 1s. 10¾d. each : 500 ditto, 2s. 3¼d. each.

Postmaster-General's Dept., Sydney.—T. K. Steanes, oil engine and generator, £138. 6s. 5d. ; switchboard, £249. 18s. 1d. ; 330 accumulators, 20 ampere-hour, £310. 9s. ; seven accumulators, 80 ampere-hour, £18. 13s. 8d., for Wagga Wagga telegraph office. P. Price & Co., cable bearers for manholes, 8s. each ; and 180 ditto, 12s. each. Jas. Paton & Co., 5,000 plugs, 1s. 6d. each. British Insulated & Helsby Cables, 12⅝ miles cable, £1,660 per mile.

Department of Home Affairs, Melbourne.—Sutherland & Ashman, electric lighting plant, North Head (Victoria), quarantine station, £126. 10s.

N.Z. Government Contracts.—The following tenders have been accepted by the N.Z. Public Service Stores Tender Board :—

Laurence & Hanson Elec. Co., 3,500 vulcanite earpieces, £47. 7s. 11d. A. D. Riley & Co., 1½ tons resin core solder, £291 ; Jones & Co., 3 tons tinmen's solder, £301.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

CALLENDER'S SHARE & INVESTMENT CO. (LTD.)—The accounts for the year ended Aug. 31 show an available sum, after providing for debenture stock interest, &c., and including £3,010 brought forward, of £11,292, compared with £10,876 in the previous year. The directors recommend a further dividend of 2½ per cent., making 5 per cent. for the year, the same as for each of the two preceding years, and propose to transfer £500 to reserve, leaving £4,175 to be carried forward.

CASTNER-KELLNER ALKALI CO. (LTD.)—The chairman (Mr. G. W. Balfour) stated at the meeting last week that, apart from the question of excess profits tax, the profits of the year ended September last exceeded those of the previous year by about £100,000. In these circumstances the auditors had expressed the opinion that the directors wou'd be warranted in recommending the payment of a final dividend of 13 per cent., making, with the interim dividend, 22 per cent. for the year. The tax on excess profits had been in operation for two years, but they were quite unable to estimate what the company's liability wou'd be. Their case was a somewhat peculiar one owing to the fact that they had expended very large capital sums in extending their plant in the period immediately preceding the outbreak of war. The increased profits were in considerable measure due to those extensions, and would have accrued to them equally in times of peace. The greater part of the company's output was now devoted to supplying the Government with materials required for the war. The problem of finding the necessary labour became more and more insistent. The directors had hoped that the very generous bonus enjoyed by their employés would have saved them from labour troubles, but they had not found it to be so, and they felt that the system under which the bonus was now paid might ultimately require reconsideration. He was confident that the alliance with Messrs. Brunner, Mond & Co. would justify itself more and more as time went on, and that it would prove a source of strength to the chemical industry of this country.

CLEVELAND TRUST (LTD.)—At the recent meeting the chairman (Mr. W. H. Hustler) said they were especially hit by the war conditions in connection with their electric light undertaking at Saltburn-by-the-Sea. He was afraid there was no possibility of improvement so long as the present lighting restrictions and the greatly increasing cost of fuel oil last. So far, thedirectors had not thought it advisable to meet the position by increasing the price of current to consumers in the special circumstances obtaining in Saltburn. They had confidence that their electrical undertaking would give them a fair return as soon as the lighting restrictions were removed.

DELABOLE ELECTRIC LIGHTING & SUPPLY CO. (LTD.)—At the recent annual meeting it was reported that the smaller income was due to the absence of street lighting. The company had entered into a contract with the Parish Council to light the streets, and it was not their fault that that was not being carried out.

ELECTRICAL SECURITIES TRUST (LTD.)—The report for the year ended Nov. 14 states that, after charging all expenses and the interest due and accrued on the debentures, there was a loss of £564. No credit has been taken in the accounts for interests or dividends which may have accrued and which have not been paid within the period. The directors regret that they have been unable to dispose of any of the investments he'd by the trust during the year, but out of cash in hand the trustees, on Dec. 23, 1915, made a further distribution of 5 per cent. on the debentures.

FELLOWS MAGNETO CO. (LTD.)—At the recent statutory meeting the Chairman (Mr. Douglas Fellows) said that the whole of their available factory space was fully occupied, but there had been delays in procuring ironwork and machines. Mr. Alleyn, who gave particulars of the financial position, said that they had received applications for about 38,000 shares, leaving over 12,000 shares for subscription.

INTERNATIONAL LIGHT & POWER CO.—The report for the year ended June 30 shows that, after payment of debenture interest and London and Canadian administration charges, and setting aside £2,500 as a special reserve, the net profit is £7,994, to which is added £1,831 brought forward, making £9,826. During the year 1½ per cent. has been paid on the 6 per cent. cumulative preference shares, absorbing £3,082 and the balance (£6,714) will be carried forward.

REUTER'S TELEGRAM CO. (LTD.).—At an extraordinary meeting last week the scheme for transferring the undertaking to new proprietors was unanimously approved. The scheme provides that each holder of a £10 share shall receive £11 in cash. The purchasers are the Hon. Mark Napier, Lord Glenconner, Viscount Peel and the Right Hon. Sir L. S. Jameson, and it was stated that the shareholders might rest assured that Reuter's Agency wou'd be safe in their hands, and that its British character, impartiality and independence were assured. The chairman of the company (the Hon. Mark Napier) was present, but Mr. Williams presided over the meeting and gave an explanation of the scheme.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The report for the year 1915 states that after deducting depreciation and adding £334,039 brought forward, the balance is £1,186,387, which is reduced to £1,086,387 by the transfer of £100,000 to general reserve. The preference share dividends and dividends on the ordinary shares, amounting to 1s. per share (less tax) and 1s. 8d. per share (tax free), have already been paid for 1915, leaving £461,387 to be carried forward. The question of special taxation has not been settled.

WELSBACH LIGHT CO. (LTD.)—Meetings of the 4½ per cent. debenture stockholders and ordinary shareholders were held last week to consider the proposed scheme of arrangement and also the provisional agreement entered into under the authority of the Board of Trade with the Deutsche Gasgluhlicht (A. G.) for the complete purchase of their share and debenture stock interest and for the sale of the Welsbach Company's large asset in Austria. Mr. J. R. Yates, Chairman of the company, presided and explained the proposals which were ultimately approved.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

CANADIAN CAR & FOUNDRY CO. (ENGLAND) (LTD.) (145,192.)—Reg. Oct. 31, capital £25,000 in £1 shares, to carry on the business of dealers in railway, tramway and other carriages, trucks, locomotives and rolling stock, engineers, founders, &c. Private company. First directors are W. F. Angus, R. W. Blackwell, W. W. Butler, G. Condon, the Hon. Nathaniel Curry, A. E. Messer, A. E. Nicholls and F. A. Skelton.

FRY'S (LONDON) (LTD.) (145,307).—Reg. Nov. 13, capital £5,000 in £1 shares, to carry on the business of mechanical and electrical engineers, founders, machinists, metallurgists, hardware merchants, &c., and to adopt an agreement with A. P. Schove. Private company. First directors are A. P. Schove and C. Howell (life directors). Reg. office ; 46, Upper Thames-street, E.C.

GENERAL ENGINEERING AND EXPORT CO. (LTD.) (145,240)—Reg. Nov. 7, capital £5,000 in £1 shares, to carry on the business of general merchants, engineers, contractors, brokers, commission agents, manufacturers of mechanical and electrical plant, &c. Private company.

JOHN MOUNTFORD & CO. (LTD.) (145,193.)—Reg. Oct. 31, capital £5,000 in £1 shares, to take over the business of engineers carried on by Fred, Harry and Effie Mountford as John Mountford & Co., and to carry on the business of mechanical and electrical engineers, tool makers, &c. Private company. First directors are Miss Effie Mountford, F. B. Mountford and H. Mountford. Reg. office, 2-4, Hulme-st, Manchester.

TEMPLEBOROUGH ROLLING MILLS (LTD.) (145,321).—Reg. Nov. 16 capital £100 in £1 shares, to carry on the business of steel makers, converters and refiners, rollers, forgers and tilters, ironmasters, electrical engineers, metallurgists, &c. Private company. First directors are H. Steel (representing Steel, Peech & Tozer), H. G. Elso (representing Wm. Cooke & Co.), and H. Smith (representing E. & A. Smith & Co.), among which three firms or their nominees the whole of the original capital is to be issued.

TOWNMEAD ENGINEERING WORKS (LTD.) (145,228)—Reg. Nov. 4, capital £50,000 in £10 shares, to take over the business carried on as the Townmead Engineering Works, and to carry on the business of mechanical and electrical engineers, founders, &c. Private company. First directors are H. J. Buckmaster, J. W. Jenkins and T. H. Nelson. Secretary : H. Birch. Reg. office : 25, Victoria-street, S.W.

WOLF SAFETY LAMP CO. (WM. MAURICE) (LTD.) (145,428).—Reg. Nov. 30, capital £6,000 in 2,000 preferred shares of £1 each and 80,000 ordinary shares of 1s. each, to acquire the business of the Wolf Safety Lamp Co., and to carry on the business of manufacturers of and dealers in lamps of all kinds, manufacturers of, agents for and dealers in accumulators and other bases for incandescent electric lamps, electric lamp fittings, electrodes, batteries, electrical plant, &c. Private company. W. Maurice is permanent governing and managing director and chairman. Reg. office : Star Works, Boston-street, Sheffield.

WOODS-GILBERT (BRITISH) RAIL GRINDING & MILLING CO. (LTD.) (145,417).—Reg. Nov. 29, capital £10,000 in £1 hsares (5,000 10 per cent. cumulative preference), to take over the business and undertaking and all or any of the assets, contracts and liabilities in Great Britain or elsewhere of Woods-Gilbert Rail Planer Co. (Ltd.) (incorporated in Victoria, Australia), and to carry on the business of contractors, electrical and mechanical engineers, patentees and manufacturers of rail grinding, milling and planing machines, tool makers, &c. Private company. First directors are the Hon. Sir John Taverner, K.C.M.G., J. Cameron and H. M. Collins, who may hold office until 1919 unless previously removed therefrom with the consent of the Woods-Gilbert Rail Planer Co., of Melbourne.

MORTGAGES AND CHARGES.

CUTTING BROS. (LTD.)—Issue on Nov. 16, 1916, of £1,550 debentures, part of series of which particulars have already been filed.

WAKELINS (LTD.)—Memorandum of deposit dated Nov. 17, 1916, charged on moneys payable under certain contracts, to secure all moneys due or to become due from company to London & South Western Bank.

CITY NOTES.

MEMORANDA (Dec. 6).—Bank rate 6 per cent. (since July 13, 1916). Consols, 54¼. Consols Pay Day, Jan. 4. Stocks and Shares Ticket Days, Dec. 13 & 28. Pay Days, Dec. 14 & 29. Price of Silver, 36⅛d.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—The directors have declared a final dividend of 5 per cent., making 10 per cent. for the year, together with a bonus of 2 per cent. (both tax free) on the ordinary shares in respect of the financial year ended Aug. 31.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—An interim dividend of 1s. per share (tax free) has been declared on the ordinary shares.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on Nov. 17 :—

Acton Lamp Co., Co-operative Traction Co., De Laval Ignition Co., Flexible Transmission Gears, New Motive Power, Superheated Steam Engine & Generator Synd., Telephone Duplicating Recorder Co., Thermo-Insulation & Engineers Supply Co.

MACKAY COMPANIES.—The regular quarterly dividend of 1 per cent. on the preferred shares and the regular quarterly dividend of 1¼ per cent. on the common shares in the Mackay Companies will be paid on Jan. 2, 1917, to shareholders of record as they appear at the close of business on the 9th inst.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO (LTD.)—An interim dividend on the preference shares for the half-year to Sept. 30 last at rate of 6 per cent. per annum (less tax) has been declared, but there will be no interim dividend on the ordinary shares.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the first quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1917, being at the rate of 6 per cent. per annum. The transfer books will be closed from Dec. 13 to 19 inclusive, and the dividend will be payable on the 20th inst. to shareholders registered on Dec. 13.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec. 6, the following as the present basis prices of—

New Metals.	Per lb.		Per ton
Solid Drawn Brass Tubes	18¼d.	English Lead	Nominal.
Solid Drawn Copper Tubes	22¾d.	Antimony	Nominal.
Brazed Copper Tubes	22¾d.	Old Metals.	Per ton
Brazed Brass Tubes	20¾d.	Clean Copper Scrap	£135 0 0
Brass Wire	17¾d.	Clean Brass Scrap	76 0 0
Copper Wire	22d.	Braziery Copper Scrap	110 0 0
Rolled Brass	17¼d.	Old Lead	27 10 0
Brass Sheets	17¼d.	Old Zinc	42 0 0
	Per ton.	Hollow Pewter	130 0 0
Copper Sheets	£189 0 0	Black Pewter	90 0 0
Spelter	58 0 0	Gun Metal	105 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Dec. 5, the following approximate prices of Scrap Metals:—

	Per ton.		Per ton.
Aluminium Cuttings	£110 0 0	Old Lead	£29 10 0
Scrap Brass	76 0 0	Tea Lead	26 10 0
Clean Copper	130 0 0	Old Zinc	45 0 0
Braziery Copper	105 0 0	Hollow Pewter	140 0 0
Gun Metal	105 0 0	Shaped Black Pewter	100 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £84; Commercial Tinman's solder, £105, Blowpipe Solder, £115.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 5.

Shrs.	Last Dividend	Name.	Price, Tues., Dec. 5	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	6%	Bournemouth & Poole E.L. Ord.	8½	7 1 2	Mar., Sept.
10	4½%	Do. 4½% Cum. Pref.	7¾	5 16 2	Feb. Aug.
10	6%	Do. 6% Cum. 2nd Pref	9¾	6 1 6	Feb. Aug.
5	10%	Brompton & Kensington Ord.	6 11/16	7 6 9	Mar, Sept
5	7%	Do. 7% Pref.	6⅜	5 9 10	Mar, Aug
St	4%	Central Elec. Supp. G. Deb. St.	80¾	4 16 8	..
St	4%	Charing Cross West End & City Debs.	79¼	5 0 8	Jan, July
5	2 3	Do. 4½ Pref.	3⅜	6 13 4	..
5	5%	Do. Ord.	3½	7 2 10	Aug, Feb
5	4½%	Do. City Pref.	3¼	6 18 6	Jun, Dec
5	4%	Chelsea Elec. Supply Co. Ord.	3⅛	6 8 7	Mar, Sept
St	4½%	Do. do. Deb.	87	5 3 5	Jan, July
10	8%	City of London Elec. Lt. Ord.	11½	6 19 2	Feb, Aug
10	6%	Do. 6% Pref.	9¾	6 3 1	Mar, July
St	5%	Do. 5% Deb. St	97½	4 17 6	Jun, Dec
St	4½%	Do. 4½ Deb.	79	5 11 0	Jun, Dec
1	7%	County of London Ord.	10¼	6 16 7	Mar, Sept
10	6%	Do. 6% Pref.	9¾	6 1 6	Feb., Aug.
St	4½%	Do. 1st Deb.	85	5 5 11	Jan, July
St	4½%	Do. 2nd Deb.	84½	5 6 6	May, Nov
St	4½%	[illegible] 4½% Debs.	73½	6 2 10	July
5	7%	K[illegible] & K[illegible] Ord.	5 1/16	6 18 3	Feb. Aug
St	4%	Do. [illegible]	7[illegible]	5 6 4	Jan, July
5	6%	L[illegible] 6% Pref.	4[illegible]	6 18 2	
St	4%	Do. 4% [illegible]	[illegible]	4 19 10	Jan, July
5	3%	Met[illegible] E[illegible] Ord.	2[illegible]	6 9 9	Mar, Aug
St	4½%	Do. 1st Mort. [illegible]	80	5 12 6	Jan, July
St	5%	M[illegible] 1st Mort. Deb. St.	97	5 1 0	Jan, July
5	6%	New[illegible] & D[illegible] 6% 2nd Debs.	99¼	6 0 6	Mar, Sept
St	5%	New[illegible] 1st Mt Db St.	87	5 14 11	Mar, Sept
1	6%	N[illegible] 6% Pref.	[illegible]	[illegible] 11 9	Apl. Oct
4	6%	S[illegible]	[illegible]	6 19 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price Tues., Dec. 5	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electricity Supply—*cont.*			
5	8%	St. James' & Pall Mall Ord.	6⅛	6 10 7	Feb, Aug
5	7%	Do. do. Pref.	5¾	6 1 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	67½	6 15 2	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1¼	6 8 0	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5⅞	5 19 2	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	3⅞	5 16 2	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St	6%	Do. 6% Cum. Pref.	76	7 17 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	65	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70¾	5 13 8	..
St.	4½%	Do. 4½% Pref.	82½	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	74¼	5 7 6	Jan, July
St.	4%	City & S. London Deb.	67	5 19 1	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2 11/32	6 2 2	Jan, July
St.	4%	Do. 4% Pref.	60½	6 12 9	Mar, Sept
St.	4%	Do. 4% Debs.	70¾	5 13 1	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23⅜	4 5 7	Feb, Aug
St.	3½%	Do. 3½% Pref.	59	5 18 8	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	56	6 5 0	Feb, Aug
St.	3½%	Do. 3½% A Debs.	63	5 11 1	Jan, July
St.	3½%	Do. 3½% Debs.	65	5 9 5	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15½	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	68½	5 7 8	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105½	5 13 6	Jan, July
St.	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 17 7	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2 31/32	5 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1 7/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1½	4 13 4	Mar
100	5%	Do. Prior Lien Debs.	88½	5 12 8	Jan, July
1	6%	Do. 6% Pref.	31/32	6 12 5	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12	7 5 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 5/32	5 16 4	Jan, July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	29/32	6 12 5	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅞	5 18 10	April
100	6%	Do. 6% Prior Lien Debs.	101	6 0 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan. July
5	20%	Callender's Cable, &c., Co. Ord.	13 3/32	7 12 9	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A. £3 pd.	½	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1⅛	6 13 4	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	13⅜	7 9 6	July
10	6%	Do. 6% Pref.	9½	6 3 1	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16 5/8	6 3 9	Feb, Aug
5	4½%	Do. 4½% Cum. Pref.	3¾	6 0 0	..
St.	4½%	Do. 4½% Db.	88½	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	13 9/16	7 11 8	Feb, Aug
10	5%	Do. Pref.	7¾	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	38	6 6 4	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	1 9/32	6 11 2	May, Aug
1	5%	Do. 5% Pref.	13/16	6 3 1	May, Aug
St	4%	Do. 1st Debs.	77½	5 3 3	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99¾	4 10 2	June, Dec
St	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95½	6 5 2	Fb, My, Aug, N
St	1½%*	Do. Def. Ord.	23½	7 1 6	Fb, My, Aug, N
..	4%	Commercial Cable 4% Debs.	70½	5 13 11	Ja, Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6	6 13 4	Ja, Ap, Jly, O
St.	8%	Eastern Tel. Co. Ord.	140½	5 14 3	Ja, My, Jly, O
St.	3½%	Do. 3½% Pref.	61½	5 13 10	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	73½	5 8 6	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77½	5 3 7	Feb, Aug
10	8%	Do. Ord.	13½	5 16 4	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. With Coup. 11	37½	5 18 1	Ja, My, Jly
25	13%	Indo-European	51⅛	6 7 2	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2⅞	3 9 7	April
1	7%	Do. 7% Pref.	2½	2 10 11	July
10	4%	West India & Panama Ord.	1 1/16	3 12 7	May, Nov
10	6%	Do. 1st Pref.	7¾	7 12 5	May, Nov
10	8%	Western Telegh. Co.	14⅛	5 13 3	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	72	5 10 3	June, Dec
..	4½%	Western Union 50-yr. Bds.	99½	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	9/32	6 12 5	Nov
1	10%	Oriental Telephone Ord.	2¼	4 8 11	Apl, Oct
St.	4%	Do. Db. St.	78½	5 1 7	Jan, July
St.	4½%	Teleph. Co. of Egypt Db. St.	82	5 9 9	Jan, July
5	6%	United River Plate Ord.	6¼	5 18 6	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	5 14 3	Jan, July
St	4½%	Do. Deb. Stk.	80½	5 16 6	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	12 9/16	4 15 6	Sp, Dc, Mr, Jn
10	6%	Do. 6% Pf.	10	6 0 0	Sp, Dc, Mr, Jn
100	5%	Mackay Companies' Common	85½	5 11 9	Ja, Apl, Jly, O
..	4%	Do. $100 Pref.	70	5 14 3	Ja, Apl, Jly, O
100	6%	Submarine Cable Trust Cert.	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4 11/16	6 1 6	Mar, Sept
St	5%	Do. 5% Debs.	94½	5 5 10	Jun, Dec
10	6/0	Bombay E.S. & T. 6% Pref.	10½	5 17 1	..
St	4½%	Do. 4½% Debs.	82½	5 8 5	Jan, July
5	9%	Calcutta E.S. Corp. Ord.	6½	7 1 2	May, Nov.
5	5%	Do. 5% Pref.	4 5/16	5 16 0	Mar. Sep

* Plus 3/0 bonus. † Ex dividend or interest.

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NOTES.

Colonial Telegraphy and Telephony.

Mr. R. W. WEIGHTMAN's Paper on this subject, read last night before the Institution of Electrical Engineers, contains an account of work which is highly creditable to those who, in the outposts of the Empire, are engaged in its execution. The ground covered by the author is so extensive, and there is such a wealth of detail that there is little either to supply or to criticise. A well-deserved tribute is paid to the engineers of the British Post Office, and Mr. WEIGHTMAN states that as the bedrock of the practice in the Colonies the methods of the British Post Office are outstanding. Owing to its great length and to the pressure on our space we have been compelled to cut out a considerable amount of valuable information. Those interested in this important field are advised to read the original Paper. We would direct the attention of those concerned to the section of the Paper devoted to the appointment and remuneration of engineers. These are subjects on which we hold very strong views, and views which we know to be sound. We believe that the proper thing to do in selecting men for any position of responsibility is to get the very best men available, and pay them salaries commensurate with their abilities. Moreover, in those branches of engineering in which rapid developments are taking place we maintain that it is true economy to grant generous leave of absence not only to the senior engineers but to the juniors in order that they may see what is being done elsewhere. At home when Town Councils are sufficiently gracious to grant leave of absence it is usual for the engineer to find himself tied to one or more Town Councillors who know little or nothing about the subject that is being investigated.

THERE is much matter of interest in the engineering section of Mr. WEIGHTMAN's Paper. If the primary idea of a designer is to make all parts of the structure for which he is responsible equally durable and strong, we think that certain of the details described are faulty. As an example may be mentioned the light pole used in South Africa, in which a galvanised steel tube is wedged into a cast-iron base, the joint being several feet above the ground. Although such a pole may serve to carry an unimportant line, the design, nevertheless, is faulty, and, in fact, could not conceivably be worse. The existence and long life of thousands of trolley-wire standards with the tapered steel tubes themselves buried several feet in the ground shows that the corrosion trouble can be overcome without having to use a material that is known to be unsuitable from a mechanical standpoint. Were the construction limited to light poles the matter would call for no comment; but in the past, poles of this kind on several important and heavy lines at home have failed. We believe that the use of the poles we have in mind was due more to inadvertance than to incompetence, but the impression is apt to be formed that because such poles fail, and in the long run they are bound to fail, iron or steel is less suitable than wood for the purpose.

A Triumph of Continuous-current Engineering.

THE big things that have been done in recent years in the design of alternating-current machinery have tended to dwarf the development that has taken place in continuous-current apparatus. Notwithstanding the enormous progress that has been made with alternating-current machinery it is probable that even greater progress has been made with high-voltage continuous-current machines. Not so very long ago it was the common experience of users of low-voltage dynamos to find that the brush position had to be altered as the load varied in order to secure satisfactory commutation. In some cases an attendant had to be stationed at the brush-rocker. By many it was thought that the limit of direct-current pressure was in the neighbourhood of 600 volts, and even with this low voltage every care had to be taken to avoid sparking at the commutator. The commutation problem has been attacked by many able engineers with the result that in little more than a decade the limit of voltage in commercial apparatus has been trebled. An excellent idea as to the difficulties encountered in the design of high-voltage continuous-current equipment will be obtained from the description, given elsewhere in this issue, of the electric equipment of the locomotives for the Chicago, Milwaukee and St. Paul Railway. Each item of the equipment has its own peculiar difficulties, and not the least of these are connected with the auxiliaries and control equipment. It is fortunate for us that we are able to appreciate and to understand the meaning of this engineering achievement, otherwise we might be tempted to envy those who work unceasingly for the betterment of mankind at a time when European engineers are, of necessity, at least equally actively engaged upon devices for the destruction of mankind.

Teaching the Teacher.

In his recent lecture on "Science and Industry," Mr. James Swinburne expressed the opinion that "no commercial works wants college professors loose in them attempting to keep up-to-date in practical matters." This statement has brought forth a protest from Mr. A. Gray, which we publish in our correspondence columns. From this it will be seen that the Westinghouse Co. make a point of organising a teachers' school for five weeks during each summer with the special object of keeping teachers in touch with manufacturing practice. All teachers are free to apply for admission, and thirty of the applicants are selected to work in the departments in which they wish to gain experience. They are paid by the company at the rate of £10 per month. Much of their time is spent in discussing the problems of construction and the best means of teaching with the engineers of the company, and the remainder of the time is spent by each teacher on some problem for which the company's staff has insufficient time. Every teacher is provided with a pass so that he may wander through all the departments of the works and become familiar with what is taking place. It seems to us that this is an admirable scheme and shows that the Westinghouse Co. appreciate the importance of keeping the teacher in touch with practice. Cannot some of our large firms in this country adopt a similar enlightened policy?

The Work of our Universities.

It would be well if those who doubt the national value of university work in this country would visit some of our younger universities and see just what is being done. This week we have had the privilege, along with the Circle of Scientific, Technical and Trade Journalists, of being a guest of the Universities of Liverpool and Manchester. A point with which we were much impressed was the way in which in both these cities the university has responded to the needs of the locality. Liverpool is a great port, but is not a manufacturing centre as compared with Manchester. Thus at Liverpool we find particular attention being paid to the subject of refrigeration in connection with the transport of food, and to the prevention of those diseases which may be so easily introduced at any time by shipping coming from abroad. Intercourse with foreign countries has led to much research on tropical diseases, with the result that the Liverpool School of Tropical Medicine has become world-famous. In the case of Manchester, development has been in quite other directions. Being in the centre of the textile industry, the School of Technology can boast of a textile department which we believe is unique. Engineering also is prominent and the chemical department, with the traditions of Roscoe, and now under the direction of Prof. H. B. Dixon, possesses a fine record and is one of the most extensive in the country. In both cities there is a very marked and very happy co-operation between the municipality and the university. We feel that this is a most important feature and must obviously tend to that co-operation between the universities and the industries that is so desirable. In making this remark we do not mean that pure science should in any way be neglected. It is most important, in our opinion, that such work as that carried on by Sir Ernest Rutherford on radio activity, which was attracting students to Manchester from all parts of the world before the war, should be continued. The pure science of to-day is the basis of the applied science of to-morrow. We hope that the University of Manchester will continue to grow and prosper until it can provide university education on the same scale as in the United States, in which case we understand that the number of students (on the basis of the population involved) would amount to 15,000 per annum compared with the present annual number of 2,000.

City and Guilds Examinations.

Notwithstanding its brevity the Report on the Work of the Department of Technology for the session 1915-16 of the City and Guilds of London Institute makes very gloomy reading. Last session classes in technology were held at 1,570 centres, which shows a decrease of 359 centres on the previous year. The number of students in attendance decreased from 47,050 in 1914-15 to 35,203 last year, and during the same period the candidates who presented themselves at the examinations decreased from 15,623 to 8,508. The successes gained decreased from 9,866 to 5,239. Equally disturbing is it to find that no classes were held in salt manufacture, sugar manufacture, pottery and porcelain, and glass making. Alkali and soap manufacture were taught at three and two centres respectively, and coal-tar products at one centre. Electrical engineering, including wiremen's work, takes the first place as regards the number of classes; dressmaking taking the second place. In electrical engineering 603 candidates presented themselves for examination in Grade I. and of these 376, or 62·4 per cent., failed. Of the 224 candidates in Grade II., continuous current, 164, or 73·3 per cent., failed. More than 47 per cent. of the 139 candidates in the alternating-current examination failed. Seven candidates out of a total of 20 passed the final examination. The figures for the classes and results in electric wiremen's work are equally depressing. Although no classes, to speak of, are being held, there are still some people who hope that we shall be able to put our house in order as regards chemical manufactures. Next year the report will be even more gloomy, and in the meantime the technical colleges and their staffs are being utilised for the purpose of making second-class air mechanics out of third-class gardeners. If our readers are able to derive any satisfaction from these facts we marvel at their optimism.

◆

"Science and Industry."—*Erratum.*—In the Paper by Dr. R. T. Glazebrook, of which we gave an abstract in our last issue, we regret to note an error. The opening sentence of the fourth paragraph, instead of reading "As regards the National Physical Laboratory . . ." should read "As regards the Works Laboratory . . ."

Railway Fares.—An Order-in-Council was issued on Wednesday which confers extensive powers on the Board of Trade in respect of railway fares, &c.

Statutory requirements with respect to maximum amount of passengers' fares may be modified, the running of trains may be curtailed, certain classes of traffic (including passengers' luggage) may be restricted or prohibited, and a line or station may be thrown out of use, &c.

"Air."—The first number of the official organ of the Aeronautical Institute of Great Britain, just to hand, contains a number of articles of general interest as well as a number of technical articles. The purpose of "Air" is said to be to arouse an intelligent and active public interest in aerial questions, to encourage the study of aeronautics and aeronautical problems, to stimulate research and invention, to foster new applications of aerial locomotion, to extend interest in the British aeronautical industry and to emphasise the importance of air power.

An Aerial Tramway in California.—One of the most remarkable tramways in the world, according to "Popular Mechanics" is the aerial line used to convey salt from the Saline Valley in California. These salt deposits are situated in an extremely desolate district. It was formerly necessary to carry the salt in wagons, which took 13 days to cover the distance over an almost impassable road. To-day buckets each carrying 700 lb. of salt are conveyed on wires over the same distance in about two hours and 20 minutes. The line is 13½ miles long. It ascends to a height of 6,000-7,000 ft., and at one point the line ascends 1,950 ft. in a distance of 1,100 ft.

Ore for British Steel Industry.—Speaking on "The Mineral Requirements of the British Iron and Steel Industries" at the Society of Engineers in London last week, Prof. W. G. Fearnsides said that about one-half of the pig-iron made in this country had its origin in iron ores which came from overseas. Moreover, the fact that an amount of metal equal to between one-fifth and one-fourth of the whole output of pig-iron was imported as semi-manufactured iron and steel to supply the British heavy engineering trade must not be overlooked when the mineral supplies drawn upon by the British iron and steel trades are being considered. In 1913 over 1,200,000 tons of semi-manufactured metal came to us from Germany and 585,000 tons from Belgium. The importance of Lorraine in supplying the iron ore from which the bulk of the metal was produced was a matter which should be emphasised at the present time. There were immense potentialities for inter-trade between Britain and France if the produce of British coalfields could be bartered for French iron ore.

Amalgamation of Manufacturing Concerns.—An electrical correspondent in "The Times" Engineering Supplement remarks: "At any time during the past dozen years there has been on opening for the collection under single directoral administration of eight or 10 electrical manufacturing compaules in this country. It is not essential that the factories should be on adjacent sites. Transformers need not be made next door to turbines, nor lamps within hail of switchboards. The same practice which has proved worth while in textile combinations, with as many as 100 mills owned by one company, or "association" as it may prefer to call itself, is clearly applicable. But since they have kept their independence so long it remains to be seen whether munition prosperity will stimulate them to new schemes of amalgamation, or whether still deeper planning of collective action will first be attempted.

Thompson Memorial.—A fund is being raised to purchase the very valuable scientific library of the late Dr. Thompson and to present it to the Institution of Electrical Engineers as a memorial of his life and work. the library to be accessible to the public on the same conditions as the Ronalds library.

The Committee includes the following: Sir William Bennett, Prof. C. V. Boys, F.R.S., F. J. Cheshire, Wm. Duddell, F.R.S., Sir Robert Hadfield, F.R.S., Capt. C. Thurston Holland, M.R.C.S., J. E. Kingsbury, F. W. Lanchester, W. M. Mordey, J. E. Raworth, Sir John Rolleston, Sir John Snell, C. P. Sparks, A. Campbell Swinton, F.R.S., Sir J. J. Thomson, President of the Royal Society.

The Committee wishes to give every member of the Institution of Electrical Engineers an opportunity of joining in this movement, which has already received substantial support, amongst others, from the past and present members of the Council of that Institution, to whom a private appeal has been made. Those who wish to subscribe to this fund, now or later, or to bave further information regarding it, are requested to communicate with Mr. W. M. Mordey, of 82, Victoria-street, London, S.W.

Luminous Switches.—The "Electrical World" gives some particulars of the proposed applications of luminous paint of the "permanent" variety, in which a constant luminous glow is produced by the action of a small proportion of radium element on zinc sulphide, to switches and other objects which it is desirable to see in the dark. The use of ordinary zinc sulphide, which glows after exposure to light, has been suggested for this purpose, but the effect is rather fugitive and the intensity depends on the degree of exposure. The new form of paint, which gives a steady glow, independent of exposure, has greater possibilities. It is stated that paint of sufficient brightness, having a relatively low radium component, will give an effective light for as much as 15 years. It is calculated that the cost of painting the screw-heads or push-button of switches with sufficient paint to give a clear indication in the dark will not exceed about 1d. to 1½d. per switch.

The New Ministry.—In the formation of his new Ministry Mr. Lloyd George has departed somewhat from customary practice, and we are glad to notice that there will be a large commercial and business element in charge of the leading administrative departments.

Sir Albert Stanley, hitherto managing director of the Underground Electric Railways Co. of London, the Metropolitan District, London Electric, Central London and other electric railway and transport companies, has been appointed President of the Board of Trade.

Lord Rhondda, who was a director of over 30 coal and shipping companies, becomes President of the Local Government Board.

Sir Alfred Mond, chairman of the Mond Nickel Co. and of the Power Gas Corpn., and director of Brunner, Mond & Co., and other companies, is First Commissioner of Works.

The most striking and most felicitous appointment is that of Dr. H. A. L. Fisher as President of the Board of Education. We are glad that this important office should be filled by one who is both a scholar and a sound authority on education.

Other noteworthy appointments are Lord Davenport as Food Controller, Mr. R. E. Prother as President of the Board of Agriculture, Mr. A. Illingworth as Postmaster-General, and Mr. J. Hodge as Minister for Labour.

Mobilising the Engineers——At Last.—The following letter from Prof. W. C. Unwin, President of the Institution of Mechanical Engineers, is published in the current issue of "The Engineer":—

The Institution of Mechanical Engineers,
Westminster, London, S.W.,
December, 1, 1916.

Sir: I have been requested by a Government Department to receive applications from a number of assistant engineers who would be willing to undertake work as salaried and whole-time officers.

It is desirable that candidates for these posts should not only be well qualified, but experienced in the values of machinery and questions of depreciation of machinery.

I know that many members of the engineering institutions, who are above military age or otherwise incapable of giving military service, are anxious to serve their country in a capacity in which their professional experience may be of value.

The salaries for the positions in question range from about £250 to £400 per year.

Applications should state the age of the candidate, and, if he is of military age, why he is not in military service, and should give details of the candidate's qualifications, past training and experience, and should be sent to the above address marked "Private."

Suitable candidates will be interviewed by Capt. H. Riall Sankey, C.B., R.E., and Mr. Charles L. Morgan, M.Inst.C.E., and will receive a communication on the subject of an interview in due course.

I am, Sir,
Your obedient Servant,
(Signed) W. C. Unwin, *President.*

Standard Methods of Testing Moulded Insulation.—A bulletin giving standard methods of testing moulded insulation has been issued by the Standards Committee of the Moulded or Formed Insulation Section of the Associated Manufacturers of Electrical Supplies of America.

Four kinds of tests are specified for moulded insulations, but the present bulletin covers only a few specific tests in each of these four groups. The first group, electrical, provides now only for a test of dielectric strength, for which the standard test piece is made up in the form of a cup 2·5 in. high and 2·5 in. in diameter, having a thickness of its bottom of 5 mm. In testing, the cup is floated on mercury, and has a small amount of mercury inside, these two bodies of the liquid metal forming the electrodes.

Under mechanical tests there are specified tests of tensile strength, compressive strength and transverse strength. The standard test piece for the tensile test corresponds very closely to the standard test samples used for testing cement, but has a cross-section at the middle of ½ sq. in. For the compressive test a cube 1 in. on each side is used. For the transverse strength test the sample is 5 in. long and ½ in. square.

For testing the effect of temperature, particularly distortion under heat, a sample identical with that for the transverse strength test is used. This is subjected to heating in a special apparatus, and the distorting point is considered to be that temperature at which the test piece has deflected 10 mils.

In the fourth group, chemical tests, so far there has been developed only the test for absorption of moisture, which uses the standard test cup employed for the electrical test. This sample is immersed in distilled water for 48 hours and removed at intervals of 12 hours during that time, the excess moisture carefully wiped from it, and weighed. The aim of this test is to determine the percentage of moisture absorbed during each of the intervals and at the end of 48 hours.

The Corrosion and Electrical Properties of Steels.—A paper on this subject was read recently before the Royal Society by Sir Robert Hadfield, F.R.S., and E. Newbery, D.Sc. The authors point out that the condition that a metal shall dissolve in an acid with evolution of hydrogen is: single potential of metal + over-voltage < single potential of hydrogen electrode, all measurements being, of course, made in the acid given. If, therefore, we assume that the atmospheric corrosion of a metal is a process similar to that of dissolution in an acid, it should be possible to predict the corrosion-resisting power of a given metal by determining its single potential referred to a hydrogen electrode, together with its over-voltage in a suitable electrolyte. Experiments on a number of special steels have been carried out to test the validity of the above assumption. The over-voltage, single potential and loss of weight in acid of each specimen was determined and compared with the atmospheric corrosion observed after exposing clean surfaces to the air for 10 weeks. The results showed that the electrical method gives decidedly better estimates of the corrosion-resisting powers of steels than the acid method, and although neither method gives reliable estimates in all cases, yet the electrical method appears to rest upon a sound theoretical foundation, and is probably capable of further developments which may result in the formation of reliable corrosion data.

OBITUARY.

A. M. WORTHINGTON.—We regret to record the death of Prof. Arthur Mason Worthington, C.B., F.R.S., which took place at Oxford on the 4th inst. He was educated at Rugby and Trinity College, Oxford, Owens College, Manchester, and in the laboratory of Berlin University under Helmholtz. For two years he was headmaster of the Salt Schools at Shipley, and then served for five years as a master at Clifton. In 1887 he became headmaster and professor of physics at the Dockyard School, Portsmouth, and in the following year he was appointed to a similar position at the Royal Naval Engineering College, Devonport, where he remained 20 years. From 1909 to 1911 he was professor of physics at the Royal Naval College, Greenwich. He was the author of various Papers on physical subjects.

J. J. INNISS.—The death is also announced of Mr. John James Inniss, senior member of the firm of Messrs. Inniss & Riddle, consulting engineers.

Mr. Inniss, who was 57 years of age, was for 10 years with Messrs. Kynoch and afterwards he was works manager of the British Thomson-Houston Co., joining them before building operations were commenced by the firm at Rugby. Mr. Inniss was president of the Birmingham Association of Mechanical Engineers in 1900-1 and was the first president of the Birmingham Electric Club.

W. A. WALTON.—The death is announced of Mr. Wm. Aloysius Walton, A.M.I.C.E., electrical and mechanical engineer, of Gloucester.

KILLED IN ACTION.—The following have been killed in action or have died of wounds:—

Lieut. C. C. O. Taylor (E. Kent Regt.), who was killed on Dec. 3, in his 22nd year, was educated at the City and Guilds Engineering College

We regret that the following former employees of the County of London Electric Supply Co. have been killed:—Sec. Lieut. D. A. Lardner, (9th Bedfordshire), L.-Corp. C. Wilson (K.R.R.), Pte. E. Alexander (3rd E. Surrey), Pte. W. Amey (Middx. Regt.), Rfmn. A. B. Watkins (L.R.B.), L.-Corp. G. Tebby (W. Surrey Regt.) (died of wounds).

We regret to learn that the following employés of the Edison Swan Electric Co. have been killed in action: Private E. A. Fassum (4th Middlesex), Private J. E. March (13th Middlesex), Private B. Pennington (Machine Gun Corps), Private Albert Cooper (1st Gloucestershire), L.-Corp. H. Finch (1st Middlesex).

PERSONAL.

An engagement is announced between John Turner Morris, M.I.E.E., elder son of the late James Morris, M.D., and Annie Elizabeth Frances MacGregor, B.A., B.D., elder daughter of the late John MacGregor, M.A. (Rob Roy) and of Mrs. MacGregor, of Hampstead, London.

Dr. José M. Giuffra was recently appointed to the Director-Generalship of Posts and Telegraphs of Argentina.

We are sorry to learn that Mr. W. G. Pickvance, borough electrical engineer of Wrexham, has met with a serious accident. While motoring from Mold to Wrexham his car collided with another car, and he sustained injuries to his shoulder blade and ribs. We hear, however, that he is making good progress.

At the recent meeting of the Senate of the University of London the Degree of D.Sc. (Physics) was conferred on Mr. David Owen, and the Degree of D.Sc. (Engineering) on Mr N. W. McLachlan.

ROYAL ENGINEERS (T.F.).—The following appointments and changes have been made:—

London Electrical Engineers: Sec. Lieut. F. J. Collet is seconded for duty with Aeronautical Dept.

Tyne Electrical Engineers: H. Algar and E. L. Hampton to be second-lieutenants (on probation).

City of Edinburgh Fortress Engineers Electric Light Company: Sergt. J. B. Stocks (from London Electrical Engineers) to be second lieutenant (on probation).

WAR HONOURS.—The following rewards for bravery have been awarded to employés of the India Rubber, Gutta Percha & Telegraph Works Co.:—

The D.C.M. to Battery Sergt.-Maj. C. F. Hunter (R.F.A.) for extinguishing a fire in a gun pit containing about 500 rounds of ammunition.

The Military Medal to Sergt. G. W. H. Beckett (R.F.A.) for repairing and maintaining telephone wires under fire. He had previously been mentioned in despatches.

APPOINTMENTS VACANT.

An assistant engineer is wanted immediately at the Sevenoaks electricity works. Applications to the Resident Engineer. *See advertisement.*

An electrical and mechanical engineer is wanted as tutor at the Bennett College, Sheffield. Salary £200 per annum. Applications to the Governors. *See advertisement.*

An electrical and mechanical engineer is wanted (temporarily) by the University of Bristol. Applications to the Registrar. *See advertisement.*

A shift engineer, with h.t. a.c. and turbine experience, is required for Watford electricity works. Commencing salary £104 per annum, with war bonus. Applications to the Chief Engineer. *See advertisement.*

An advertiser wants lady assistants for an electrical test room.

An experienced foreman armature winder is required for a.-c. and d.-c. winding department of Manchester controlled firm. *See advertisement.*

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Dec. 15th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street Westminster, S.W. Paper on "Variable-speed Gears for Motor Road Vehicles," by Mr. R. E. Phillips.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the Holborn Restaurant (King's Hall).

SATURDAY, Dec. 16th.

MIDLAND BRANCH, ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

3.30 p.m. At the Midland Hotel, Mansfield. Paper, "Electric Signalling with Bare Wires," by Dr. R. V. Wheeler and Prof. W. M. Thornton.

MONDAY, Dec. 18th.

FARADAY SOCIETY.

8 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. Agenda: "On a Precision Method of Uniting Optical Glass—the Union of Glass in Optical Contact by Heat Treatment," by Messrs. R. G. Parker, B.Sc., and A. J. Dalladay "The Effect of Pressure on the Equilibrium Constant of a Reaction in a Dilute Solution, a simple proof of the expression," by Prof. W. C. McC. Lewis, M.A., D.Sc.; "Do Equiatomic Solutions in Iron Losses Equal Resistances?" by Mr. E. D. Campbell; "Grain Growth in Deformed and Annealed Low Carbon Steel," by Ralph H. Sherry, M.A. Messrs. Ezer Griffiths, M.Sc., and E. A. Griffiths will describe and exhibit a new electric furnace for testing the softening points and compressive strengths of refractory materials.

TUESDAY, Dec. 19th.

ENGINEERS' CLUB.

7.30 p.m. At the Engineers' Club, Albert-square, Manchester. Debate on "Engineering Education and Research," to be opened by Mr. A. P. M. Fleming.

WEDNESDAY, Dec. 20th.

ROYAL SOCIETY OF ARTS.

4 p.m. At John-street, Adelphi, W.C. Paper on "Classical and Scientific Education," by Mr. A. C. Benson, C.V.O.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week:—

Officer for the Week.—Platoon Commander C. H. C. Bond.

Next for Duty.—Platoon Commander L. C. Hughes Hallett.

Monday, December 18th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.25 to 8. Lecture on Telephones, 7.30.

Tuesday, December 19th.—School of Arms, 6 to 7. Lecture 7.15, "Bridging," Company Commander E. J. Castell.

Wednesday, December 20th.—Instructional Class, 6.15. Platoon Drill, Platoon No. 1 2.

From Thursday, December 21st to Thursday, December 28th inclusive.—Headquarters closed.

Musketry.—For all Companies, see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

The story of the development of the great transcontinental railway system between the Great Lakes and the Pacific Coast of America is a most interesting one, and is told by the General Electric Co., of Schenectaday, in a recently issued pamphlet. The present era is eminently the electrical era. All the achievements in transcontinental railroad transportation in the past have been accomplished with steam locomotives, but to-day the steam locomotive is outclassed in power, in flexibility, in reliability, in ease of control, in economy, in comfort and in substantially every feature, by the electric locomotive.

While many terminal and tunnel installations have been made in the past for the purpose of eliminating smoke, taking care of suburban traffic or other local conditions, the Chicago, Milwaukee and St. Paul electrification is the first project of the kind where electric locomotives were installed to operate over several engine divisions.

The tracks of the mountain district of the Chicago, Milwaukee and St. Paul Railway, in surmounting the obstacles imposed by the Rocky Mountain and coast-wise ranges, represent the solution of one of the most difficult problems ever mastered by railway engineers. Out of this section of rugged mountain railway, including many long grades and short radius curves, four steam engine divisions were selected for electrification, aggregating 440 miles in length. Steam engines were first abandoned on the Three Forks-Deer Lodge division, 115 miles long, and crossing the main Continental Divide, thus giving the electrical equipment its initial tryout under the severest service conditions of the entire system. The first electric locomotives were placed in regular service on Dec. 9, 1915, and during the month of April, 1916, service was extended to Harlowton, making a total of 220 miles of electrically-operated road. By the end of the year it is expected that steam engines will be superseded over the entire distance of 440 miles from Harlowton, Montana, to Avery, Idaho.

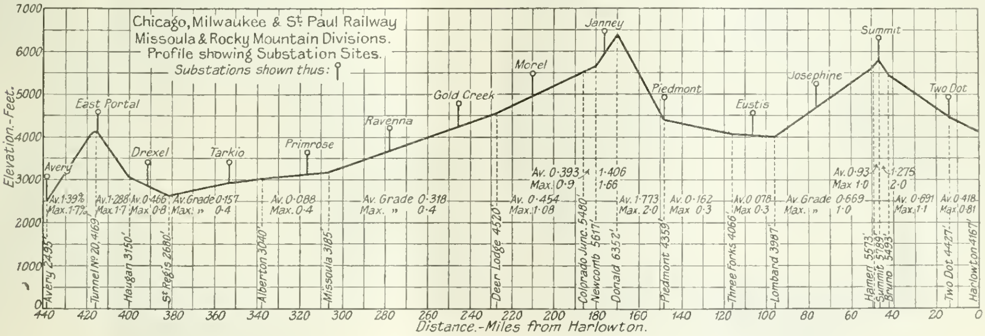

Fig. 1.—Profile of Electric Zone.

This project is the most extensive steam railway electrification in the world, the length of haul being nearly six times as great as any trunk line now operating with electric locomotives.

In crossing the three mountain ranges included in the electric zone, there are several grades of 1 per cent. or more, the most difficult of which is the 21-mile 2 per cent. grade between Piedmont and Donald, and the longest the 49-mile 1 per cent. grade on the west slope of the Belt Mountains. The curvature is necessarily heavy, the maximum being 10 degrees. There are also numerous tunnels in the electric zones, 36 in all, of which the longest is the St. Paul Pass tunnel, over a mile and a half in length, through the ridge of the Bitter Root Mountains. The passenger service consists of two all-steel finely equipped transcontinental trains in each direction, the "Olympian" and "Columbian," and a local passenger train in each direction daily between Deer Lodge and Harlowton.

Goods traffic through the electric zone comprises from four to six trains daily in each direction. Westbound, the tonnage is made up of manufactured products and merchandise for Pacific Coast points and foreign shipment. Eastbound tonnage includes grain, lumber, products of the mines and some live stock.

Electrification promises a material reduction in running time. It has been found, for example, that on the 21-mile 2 per cent. grade from Piedmont to Donald, the electric locomotive can reduce the running time of passenger trains from an hour and five minutes to approximately 40 minutes. On the run from Deer Lodge to Butte which, under the steam locomotive schedule, required an hour and 20 minutes, a saving of approximately 30 minutes can be made.

In the goods service, it has been found that on the first division where the steam locomotives have required 10 to 12 hours to make 115 miles, electric locomotives can meet a schedule of from 7 to 8 hours for the same distance. The heavy grades and frequent curves at certain points offer serious obstacles to steam locomotive operation even in the summer time, but with winter temperatures as low as −40°F. and heavy snowfalls in the Bitter Root Mountains, serious delays have occurred, owing to engine failures or to inability to make steam. The capabilities of the electric locomotives are in no way impaired by cold weather or by inability to obtain fuel or water in case of snow blockades. During a series of record-breaking temperatures in December, 1915, Mallet engines were frozen up at different points on the system and the new electric equipment was rapidly pressed into service to replace them. On several occasions electric locomotives hauled in disabled steam engines and trains which would otherwise have tied up the line.

During initial operation on the Rocky Mountain division, the capacity of the new locomotives has been thoroughly tested. Trains of 3,000 tons trailing have been hauled east and 2,800 tons west, using a helper on the heavy grades. From the operating data obtained on the first division, it is evident that much heavier trains can be hauled with the electric locomotives than with steam engines, and all passing tracks are being lengthened to take advantage of longer trains. On some of the runs where the grades are less than 1 per cent. trains of as many as 130 cars and as heavy as 4,000 tons have been hauled with a single locomotive.

The four through passenger trains, "Olympian" and "Columbian," are taken across the two mountain ranges by a single passenger locomotive. These trains at present consist of eight full vestibuled steel coaches, weighing approximately 650 tons. Instead of changing locomotives at Three Forks, as has been the practice under steam operation, the same locomotive is run through the 220 miles from Deer Lodge to Harlowton, changing crews midway. Passenger trains will travel over the entire electrified division in approximately 15 hours, including all stops, and the tourist thus will have an opportunity of traversing by daylight some of the most beautiful scenic regions in the United States and without suffering the annoyance of cinders and smoke incident to the use of steam locomotives.

The local passenger train operating in the electric zone between Deer Lodge and Harlowton is handled by a half unit weighing about 150 tons with equipment similar to the main line locomotives.

Regeneration.—Regeneration, or the recovery of energy on the descending grades, by reversing the function of the electric motors reduces the cost of operation and furnishes a ready solution of the difficult braking problem. On the long sustained grades encountered in crossing the three mountain ranges, great skill is required to handle either the heavy and varied freight or the high-speed passenger trains with the usual air brakes. The entire energy of the descending train must be dissipated by the friction of the brake shoes on the wheels, and it approximates 3,500 kw. or 4,700 h.p. for a 2,500-ton train running at 17 miles per hour on a 2 per cent. grade, thus explaining why brake-shoes frequently become red-hot and other serious damage is done.

With regenerative braking, the motors become generators which absorb the energy of the descending train and convert it into electricity, thus restricting the train to a safe speed down the grade and at the same time returning electric power to the trolley for use by other trains. The strain on draw bars and couplings is reduced to a minimum, since the entire train is bunched behind the locomotive and held to a uniform speed. The electric-braking mechanism automatically controls the speed by regulating the amount of energy fed back to the line. This smooth and easy descent is in marked contrast to the periodical slowing down and speeding up of a train controlled by air brakes.

The usual speed of the electrically-hauled goods train is 15 miles per hour ascending and 17 miles per hour descending the maximum grade, but half these speeds can easily be maintained with series connections of the motors should conditions require it.

In case there are no other trains between the substations to absorb the power generated by a descending train, this power passes through the substation machinery, is converted from direct to alternating current and fed into the distribution system connecting all substations. The Power Company's lines are so extensive and the load of such a diversified character that any surplus power returned by regenerating locomotives can readily be absorbed by the system; credit is given for all energy returned.

The advantages of regenerative braking may be summarised as follows: Elimination of difficulties incident to the use of air brakes on heavy goods trains when descending mountain grades; elimination of brake-shoe and wheel wear with resultant reduction in maintenance; reduced wear on tracks, especially on severe curves; a probable saving of approximately 15 per cent. in the total power consumption; maximum safety in operation assured by a duplicate braking system relieving the air brakes; the entire absence of grinding of the brakes which is especially disagreeable on a heavy passenger train; increased comfort to passengers and reduced wear and tear on equipment, owing to uniform speed on grades.

THE ELECTRICAL EQUIPMENT.

The scheme of electrification includes the generation of electricity from the several water-power plants of the Montana Power Company; transmission at 100,000 volts, three-phase, 60 cycles; conversion in the substations to 3,000 volts direct-current and distribution to electric locomotives over catenary overhead construction.

The main line Chicago, Milwaukee & St. Paul Railway electric locomotives shown in Fig. 2 are constructed in two units permanently coupled together, the halves being duplicates and each capable of independent operation. The enormous tractive effort of these will be appreciated when it is stated that 50 years ago wood-burning locomotives weighed 20 tons and had a tractive effort of only 5,000 lb. The modern Mallet steam locomotive weighing 278 tons with tender, which has been released, has a tractive force of 76,200 lb. while the electric locomotive, weighing 282 tons, has a running tractive force of 85,000 lb. or a starting tractive force of 136,000 lb. Characteristic curves of the goods locomotives are given in Fig. 3.

There are 42 of these main line locomotives (30 goods and 12 passenger) and two switching locomotives. The locomotives are the first to be used for railroad service with direct-current motors operating at a potential as high as 3,000 volts[*] and the first to use direct-current regeneration. The passenger locomotives are equipped with a gear ratio permitting the operation of 800-ton trailing trains at speeds of approximately 60 miles per hour on tangent level track. The average passenger train weighs from 650 to 700 tons and is hauled over the 2 per cent. grade without a helper. The goods locomotives are designed to haul a 2,500-ton trailing train at approximately 16 miles per hour on all grades up to and including 1 per cent. On 2 per

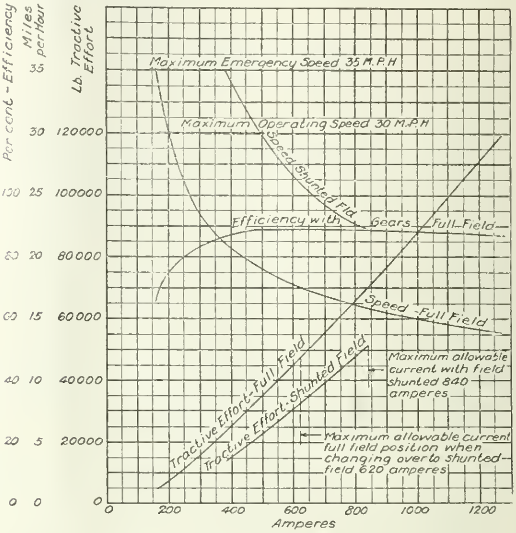

FIG. 3.—CHARACTERISTIC CURVES OF MAIN LINE GOODS LOCOMOTIVES.

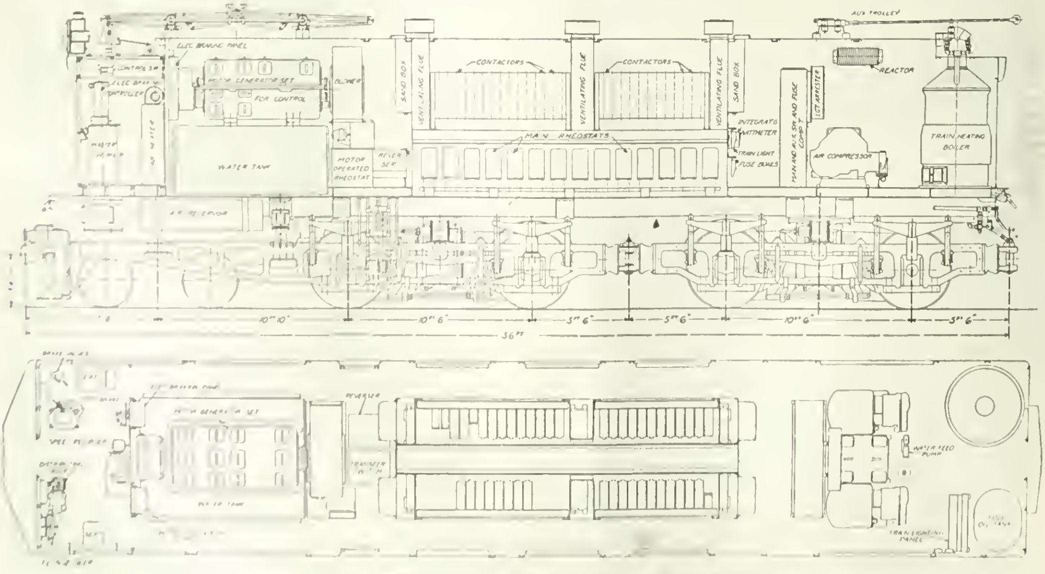

FIG. 2.—PLAN AND ELEVATION OF HALF-LOCOMOTIVE UNIT.

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[*] It is of interest to note that this is the first direct-current installation to use a potential as high as 3,000 volts, and this equipment was adopted after a careful investigation of all systems available for electrification. The Butte, Anaconda & Pacific Railway, in the immediate vicinity of the Chicago, Milwaukee & St. Paul electrification, has been in operation with 2,400-volt direct-current locomotives since May, 1913, and has furnished an excellent demonstration of the entire practicability of high-voltage direct-current operation.

cent. grades the trailing load was limited to 1,250 tons, although this figure has been exceeded in actual operation.

Each locomotive is equipped with eight Type GE-253-A, 1,500-volt motors, insulated for 3,000 volts to ground. This motor has a normal 1-hour rating of 430 H.P. and a continuous rating of 375 H.P., so that the locomotive power plant has a normal 1-hour rating of 3,440 H.P. and a continuous rating of 3,000 H.P. Each motor is twin geared to its driving axle in the same manner as on the Butte, Anaconda & Pacific, the Detroit River Tunnel, and the Baltimore & Ohio locomotives, a pinion being mounted on each end of the armature shaft. Additional flexibility is obtained by the use of a spring gear, Fig. 4, and a spring nose suspension which minimise the effect of shocks and reduce gear wear to a minimum. The motor is of the commutating-pole type and is constructed with longitudinal ventilating ducts in the armature for forced ventilation from a blower in the cab.

The control equipment is the well-known Sprague General Electric Type M arranged for multiple unit operation. The main control switches are mounted in steel compartments inside the locomotive cab with convenient aisles for inspection and repairs. In each half of the locomotive a motor-generator set furnishes low-voltage current for the control circuits, head-lights, cab lighting and for charging the storage batteries on passenger coaches. Under steam operation, the charging current for these batteries is furnished by the steam turbo-generator set located in the baggage car. The blower for ventilating the traction motors is also direct connected to one end of this set.

The air brake equipment is practically the same as that used on steam locomotives, except that motor driven air compressors are used to furnish compressed air. In addition to the air brakes, compressed air is also used for signals, whistles, bell-ringers, sanders, flange oilers, pantograph trolleys, Fig. 5, part of the control equipment, and on the passenger locomotives for the oil-fired steam boilers.

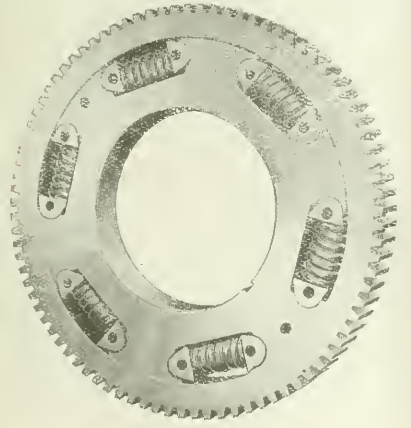


FIG. 4.—SPRING GEAR.

The switching locomotives are of the swivel truck type, weighing 70 tons each, and equipped with four geared motors. A single pantograph of construction similar to that used on the main line locomotives is mounted on the cab, and in other ways the locomotives represent the standard construction commonly used with the steeple cab type of switcher. The motors (known as Type GE-255) are of box frame, commutating-pole, single-geared type designed for 1,500 volts with an insulation of 3,000 volts to the ground. Many of the switching locomotive parts are interchangeable with those used on the main line locomotives; for example, the air compressors, small switches, headlights and cab heaters.

Utmost precautions were taken by the railway company in making plans for this electrification to ensure a reliable source of power.

Montana Power Company, with whom the contract was closed for electric power, operates a network of transmission lines covering a large part of Montana, which are fed from a main plant at Great Falls, and a number of other widely separated water power plants of adequate capacity at all seasons of the year. A notable feature of this pioneer electrification is, therefore, the conservation of fuel consequent upon the utilisation of water powers.

The Montana Power Company's transmission lines, which are carried in some cases on steel towers and in others on wooden poles, tap into the railway system at seven different points where the power is most needed. The railway company's transmission line extends the entire length of the system on wood poles. In most cases this line is built on the company's right-of-way, although at several points there are cutoffs which make a considerable saving in the length of line. With this completely inter-connected transmission system each substation may be fed from either direction and also at the tie-in points from a third source of power.

Fourteen substations are equipped for converting the 100,000-volt alternating-current to 3,000 volt direct-current. They are distributed along the route at average intervals of 32 miles. Each station contains step-down transformers, motor-generator sets, switchboard and the necessary controlling and switching equipment. The transformers receive the line current at 100,000 volts and supply the synchronous motors at 2,300 volts. Each synchronous motor drives two 1,500-volt, direct-current generators connected permanently in series, thus supplying 3,000-volt current for the locomotives. The fields of both the synchronous motors and the direct-current generators are separately excited by small direct-current generators direct connected to each end of the motor-generator shafts.

The overhead construction is of the modified flexible catenary type designed by the General Electric Company (U.S.A.) and installed under the direction of the railway company's engineers. With this quite novel but remarkably successful construction the current is collected in both high-speed passenger service and heavy freight service without any sparking. The construction comprises two 4/0 copper wires flexibly suspended side by side from the same steel messenger by independent hangers alternately connected to each wire. Bracket construction is used wherever the track alignment will permit, and cross span construction on passing tracks and in the switching yards. All of this work is supported on 40-ft. wooden poles suitably guyed and spaced.

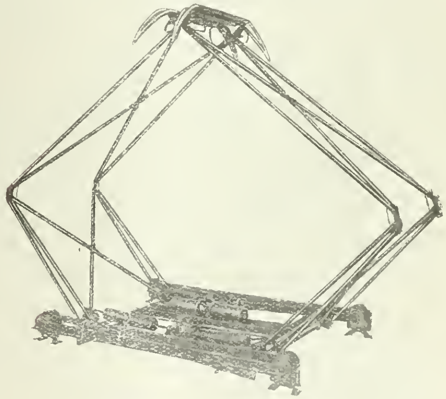


FIG. 5.—SLIDING PANTOGRAPH TROLLEY.

According to statements made by the railroad officials, about £2,400,000 will be expended on the enterprise, and with the work more than half completed there is every reason to believe that the cost of construction will come within the estimates.

A 500,000 c.m. feeder is installed the entire length of the electrification and a supplementary feeder on heavy grades. The feeder is tapped to the trolley wire at every seventh pole, or approximately every 1,000 ft. On top of the poles is carried a supplementary 4/0 negative feeder which is tapped to the middle point of every second reactance bond. These bonds are used for insulating the 60-cycle signal circuits, and are installed at points averaging from 5,000 ft. to 6,000 ft. apart. Each track is bonded with a 250,000 c.m. bond on each joint and double-bonded on the heavier grades.

The passenger and freight locomotives are identical, with the exception of gear ratio and the addition of an oil-fired steam boiler in each half of the passenger locomotives for heating the trailing coaches. The two boilers are capable of evaporating 4,000 lb. of water per hour, and this equipment with tanks for oil and water bring the weight of the locomotive up to approximately 300 tons. The interchangeability of all electrical and mechanical parts of the locomotives is considered of great importance from the standpoint of operation and maintenance.

THE ELECTRIC EQUIPMENT OF THE LOCOMOTIVES FOR THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

The 300-ton electric locomotives in service on the Mountain divisions of the Chicago, Milwaukee and St. Paul Railway possess more than ordinary interest on account of their many novel features, the most notable of these being the use of 3,000-volt direct-current and the adoption of direct-current regenerative braking. These locomotives were first placed in regular service in December, 1915, so that some of them have now been in operation for 12 months. The purpose of this article is to describe the electric equipment of the locomotives. At the outset we wish to record our indebtedness to the "General Electric Review" and to the "Electric Railway Journal" for much of the information concerning this notable engineering achievement.

Motors.—The motors are the largest geared motors mounted on an axle which have been used in the electrification of steam railways. Based on the A.I.E.E. standard method of rating, the one-hour rating of the motor is 452 H.P.: the continuous rating, based on 100°C. rise by resistance of the armature and 120°C. rise by resistance of fields, is 396 H.P. These ratings are for a potential of 1,500 volts, two motors being coupled in series for operation on 3,000 volts. The motor is designed for operation with an external blower, and the volume of air used at the continuous rating is approximately 2,500 cubic ft. per minute. The air is blown into the motor through a large opening on the front of the magnet frame at the commutator end. It passes in parallel streams through the armature and over the field coils, and is exhausted through openings in the magnet frame and bearing head at the opposite end of the motor from the commutator.

The motor complete, including spring gears, pinions, gear-ease and axle lining, weighs 14,860 lb. It has four main poles and four commutating poles. It is designed for shunted field control, the fields being shunted 50 per cent. in running at full speed.

The armature has 49 slots, with seven coils per slot, and the commutator 343 segments. The armature coil has a single-turn winding. The diameter of the armature core is $29\frac{1}{2}$ in. The coils are insulated with mica and asbestos. At the one-hour rating the speed of the armature is 446 revs. per min. There are four brush holders per motor, each brush-holder having two brushes $\frac{11}{16}$ in. by $1\frac{3}{4}$ in.

The main field coils are wound with strip copper in two sections with asbestos between turns. They are insulated with mica and asbestos, and have a final wrapping of strong cotton tape. They are, therefore, capable of withstanding high temperatures without injury. The commutating coils are made of edgewise wound strip copper, and are insulated in a similar manner to the main field coils. All the field coils are thoroughly impregnated by the vacuum process. The main exciting field coils are not subjected to full voltage since the armatures of two motors are connected in series with the fields of both motors on the ground side.

The commutating characteristics of the motor are excellent, and it is possible to raise the voltage on a stand test 50 per cent. above normal without injurious sparking. During operating periods of regeneration at voltages materially higher than 3,000 the fields can be shunted to a surprising extent without appreciable sparking.

Fig. 1 shows the speed, torque and efficiency curves of the motor with gearing for passenger service.

In mechanical design the motor, in general, follows well-known and thoroughly tested lines of construction. Fig. 2 shows longitudinal and transverse sections of the motor. It will be noted that the armature core and commutator end core head are mounted on a central hub or spider, into which is pressed the armature shaft. The commutator is mounted on the core head. Large openings are provided through the commutator, core head, armature core and spider head to secure effective internal ventilation of these parts. At the back end of the armature the end windings are protected by a removable flange. By making the flange removable the armature can be more easily wound or repaired.

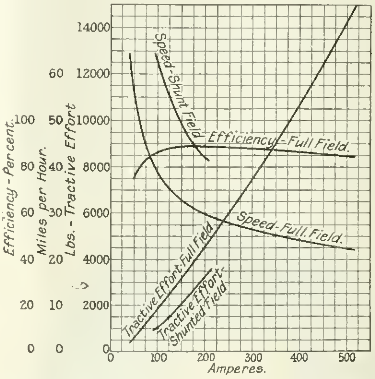
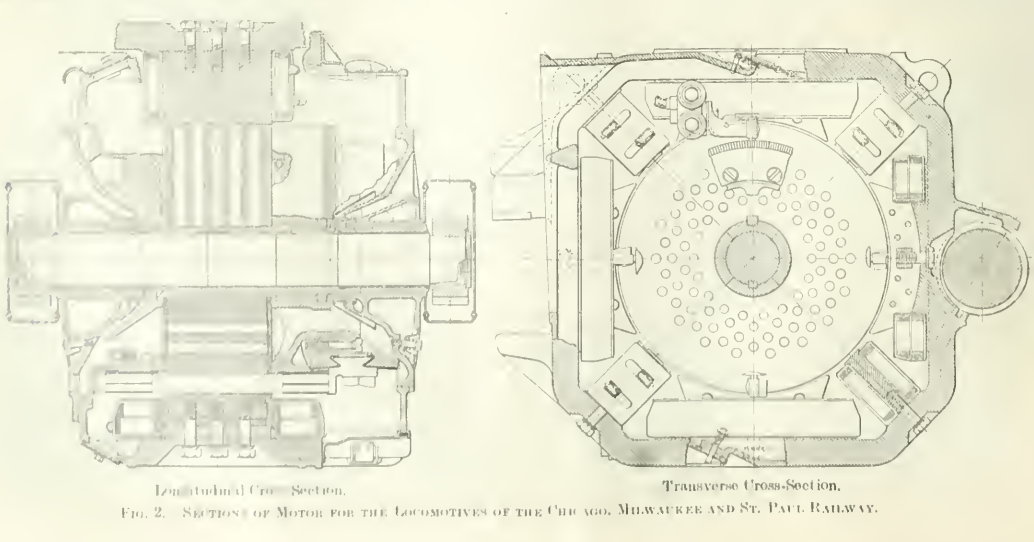


FIG. 1.—CHARACTERISTIC CURVES. G.E. 253-1,500/3,000-VOLT RAILWAY MOTOR. VOLTS PER MOTOR, 1,500; GEAR, 71 TEETH; REDUCTION, 2·45; PINION, 29 TEETH; WHEEL DIAMETER, 52 IN.

The clips connecting the top and bottom bars at the back end of the armature are electrically brazed to the bars, thus ensuring a reliable connection at any abnormally high temperature which might occur at excessive overloads.

The armature bearings at each end are liberal in dimensions, being $5\frac{3}{4}$ in. in diameter and 10 in. long. They are lubricated with oil and waste, this method of lubrication having been found most reliable through long years of service on standard railway motors.

The motor has twin gears with a 4-in. face and No. 2 diametral pitch. For the goods locomotives there are 18 teeth in the pinion and 82 teeth in the gear, and for the passenger locomotives there are



Longitudinal Cross-Section.

Transverse Cross-Section.

FIG. 2. SECTIONS OF MOTOR FOR THE LOCOMOTIVES OF THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

29 teeth in the pinion and 71 teeth in the gear. Both gears and pinions are made of high-carbon oil-treated stock, having an elastic limit of 85,000 lb. per square inch.

The gear cases are made of sheet-steel, with rim and sides securely riveted together. The supporting brackets extend over the rim of the case and are securely riveted to the rim and sides. The magnet frame is made of cast-steel, and, except in size, differs but little in general appearance from standard box frame railway motors.

The front of the motor is carried on the truck through an improved spring suspension. The design is such that both the downward and upward thrust is taken through springs. This form of suspension largely reduces the shock on the motor in passing over switches, crossings or other rough places in the track. The spring gears, and to a less extent the motor suspension, relieves the teeth of the gears of "hammer blows," and equalises the load on the pinion and gear teeth at each end of the motor.

The effect of the spring gears and spring suspension is to make the motors run with unusual quietness. There is no noticeable gear noise while the locomotives are in motion, and the absence of vibration is also noticeable. The motors run at a comparatively low temperature in service, the capacity of the motors being sufficient to handle heavier trains than originally contemplated.

Current Collection.—The locomotive has two pantographs, one mounted on each half unit of the locomotive. Each pantograph has two sliding contacts or shoes, which are provided with copper wearing strips, and further provision for increased contact area is obtained by the use of double-contact wires of copper for the overhead catenary system. With the four points of contact at the pantograph it becomes easy to collect the heavy currents that obtain in the service. Sparking is entirely eliminated, although the current required for a single locomotive at continuous rating is 840 amperes, and in passenger service speeds up to 60 miles per hour are attained.

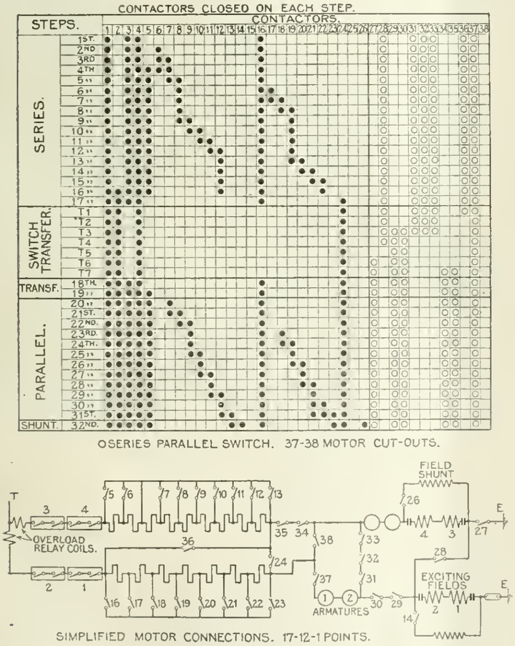


Fig. 3.—Simplified Connections of Control. Motor Operation only.

The motorman controls the operation of his pantograph by means of an air valve, which admits air to a pair of cylinders energising powerful springs, the latter in turn raising the pantograph and at the same time regulating the pressure against the trolley wire. The range of action of the shoe is between 17 ft. and 25 ft. above the rail. An auxiliary trolley pole with a swivel base is supplied to collect current for the air compressor when the locomotive is first put into service. The two pantographs on each complete locomotive are connected by a 'bus line so that the duplex electrical equipment can be supplied from either one.

3,000-volt Protective Apparatus.—When 3,000 volts was chosen as the desirable line potential a further innovation was introduced into the design of the control equipment. It was appreciated from experience that, provided the protective devices in the main trolley circuit are reliable, short-circuits clear themselves more quickly with high than with low voltages, and there is less attendant damage. The design of the main emergency switches and fuses was considered of great importance, and these devices were accordingly mounted in a single high-tension compartment of ample dimensions.

The trolley lead starting from the pantograph trolley first enters the high-tension compartment and is divided into two circuits main and auxiliary. A combination switch and fuse is in the main circuit. From the main switch and fuse the main power lead goes directly to the controlling apparatus of the traction motors. The auxiliary lead passes to four disconnecting switches and from there, separate supply leads run to the motor generator set, air compressor and cab heater.

The compartment is made of sheet steel strongly reinforced with angle and channel irons, and is thoroughly lined with insulation. A great saving in space has been effected by using for each combination switch and fuse a single arc chute containing two stationary contacts, to which the incoming and outgoing leads are attached.

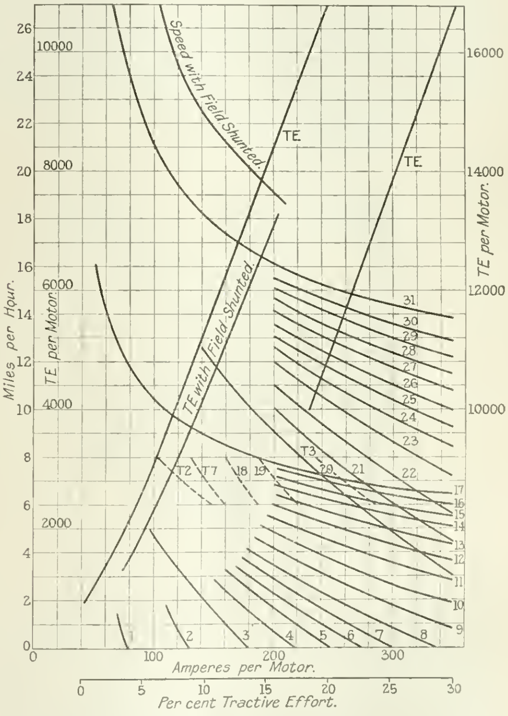


Fig. 4.—Motor Operation in Goods Service at 3,000 Volts Line for each Point of Controller. Typical Speed Tractive-Effort Curves.

The high-tension compartment is equipped with three doors, one each for the main and auxiliary switches, and one for the separate disconnecting switches. These doors are interlocked with the external operating handles, so that no conducting parts can be approached without first opening its circuit by dropping the switch cradle. When either switch cradle is dropped, it will be noted its fuse is entirely disconnected from the circuit.

In addition to the protective apparatus in the high-tension compartment, a 3,000-volt aluminium-cell lightning arrester is tapped into the main lead near the collectors. The lightning arrester, installed in a grounded sheet iron box, is mounted on the back of the high-tension compartment.

3,000-volt Contactor Compartment.—In addition to the apparatus already mentioned, the 3,000-volt equipment of a locomotive consists of eight traction motors, two air-compressor motors, two cab heaters, two driving motors for the motor-generator sets, and the control equipment for all these devices. Since all this 3,000-volt equipment is in duplicate, the following description will cover only that portion located in one of the two cabs which is entirely independent in operation. This controlling apparatus is grouped in a sheet-iron compartment located near the centre of the cab. Allowing for aisles on either side, the space occupied by this compartment extends from the floor to the roof of the cab.

The complete set of rheostats used in regulating the current in the four-traction motors is assembled at the bottom of the compartment along the floor of the cab. The rheostat is of the cast-grid type shaped effectively to meet the space limitations of locomotive service. The remaining controlling apparatus is located in four groups directly above the rheostats. The rheostats are separated from the equipment groups above by a partition. The bottom of the rheostat compartment is open, and complete ventilation of the rheostats is obtained through six chimneys leading up to ventilators at the top of the cab. The control groups are installed between the chimneys.

The circuit connections of the main power system supplying the traction motors are shown in Fig. 3. The relative location of the overload relay tripping coils, line contactors, rheostats, rheostat contactors, series-parallel contactors, field shunts with their contactors and reverser, are indicated. This wiring diagram shows the complete progression, in schematic form, of the different circuits necessary to motor operation only. It may be noted that the motors of each half unit are connected in two series pairs. The master controller provides for operating these pairs in series through 16 rheostat points, and a 17th full series running point; then through 11 rheostat points in parallel and a 12th full parallel point. An additional parallel point with the fields of the traction motors shunted is provided on both the freight and passenger locomotives for efficient higher speed running.

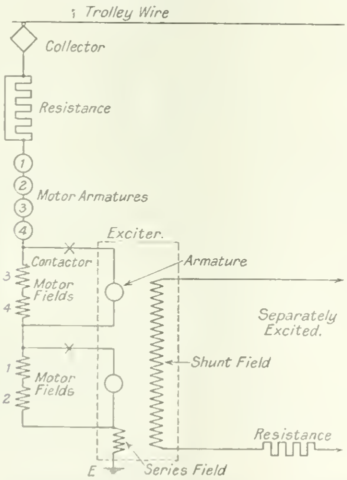


Fig. 5.—Simplified Connections for Regenerative Electric Braking, showing Four Traction Motors and Exciter.

Due to the large number of rheostatic steps provided to vary the voltage at the traction motor terminals during acceleration, and due to the extremely flexible drive between motors and drivers, the acceleration is very smooth. Characteristic curves showing all the rheostat points of the goods locomotives, based on a constant potential of 3,000 volts, are shown in Fig. 4. The curves made in dash lines show the transfer steps made while the series-parallel switch passes from one position to another. This transfer can be effected without appreciable decrease in torque and any jerking of the train is absolutely eliminated by the method of transfer employed.

Low-voltage Equipment.—Practically all the equipment not as yet described is more closely related with the master control circuits leading to the engineer's position, and is therefore designed for low voltage—125 volts or less.

While the reverser switches the fields of the 3,000-volt traction motors, it is necessary to insulate for low voltage only, since the fields are maintained on the grounded side of the armatures at all times. The same type air motor which drives the series-parallel switch is used to operate the reverser. By means of a cam shaft and a set of powerful spring contacts driven from the former, through rocker arms, a very positive wiping contact is obtained. The reverser is completely enclosed in a sheet-iron box, and is located outside and adjacent to the high-tension compartment of the high-voltage control apparatus.

The shunts and similar apparatus associated with the motor fields are designed for low voltage.

Motor-Generator Set.—A motor-generator set driven by a motor directly connected to the 3,000-volt trolley supply is used for auxiliary purposes. This set consists of a direct-connected fan, the driving motor, an exciter and a small 125-volt generator. The fan is used for ventilating the traction motors, thereby materially increasing their continuous capacity. The 3,000-volt switching apparatus of the driving motor is located in the control compartment, as already described. The exciter is used during electric braking to super-excite the traction motor fields, and while not thus employed in passenger service to re-charge the storage batteries required to light the trailing passenger coaches. The generator supplies power for the master control circuits, cab lights, head light and other low-voltage auxiliaries.

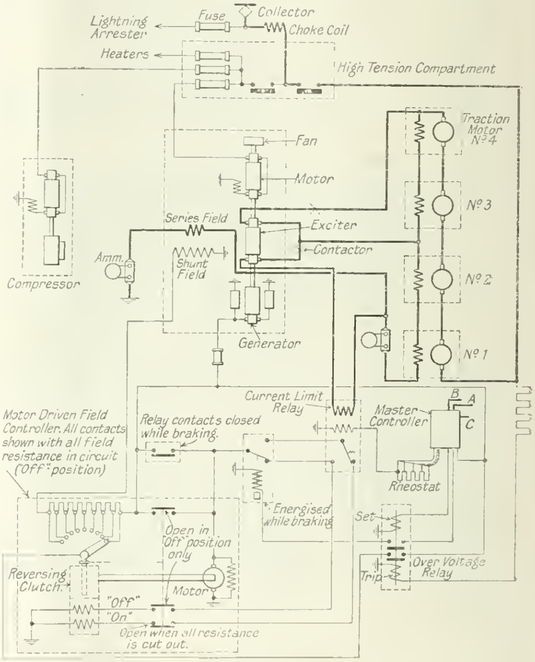


Fig. 6.—Simplified Diagram of the Electric Braking Connections.

Regenerative Electric Braking.—Regenerative electric braking adds materially to the safety of operation by supplying a second braking system in addition to the air brakes. It provides increased economy of operation by reducing wheel, track and brake-shoe wear. It permits faster speeds down grades, due to the better ability of definitely controlling the locomotive which is difficult at best with the air brakes. It also adds materially to the comfort of the passengers, due to smoother operation down grades. All this is attained by very simple and reliable additions to the equipment required for motor running.

With the simple direct-current motor adopted for these locomotives, operation as motors or generators depends upon whether the voltage of the trolley system at the locomotive is above or below the voltage at the motor terminals. When the locomotive is motoring, the voltage at the motor terminals is lower than the trolley potential and power flows into the locomotive. When the locomotive descends a grade, and is braking, the engineer, through his controlling means, effects an increase in the voltage across the motor terminals, so that power flows from the locomotive into the transmission system. The generation of this returned energy reacts on the locomotive so as to cause retardation or braking. Besides effecting an economy by returning power to the line. The means for raising the voltage level of the motors, thereby returning power to the line in electric braking, rests in the use of the exciter before mentioned, so connected as to super-excite the traction motor fields when braking. Fig. 5 is a simplified diagram of these connections.

The series direct-current motor has been found to be particularly well suited to traction service, because of its inherent characteristic which automatically adjusts torque for change in grade. That is, to any particular speed and voltage there always corresponds one definite value of torque and current. With a decrease in speed there is an automatic increase in tractive effort, and with an increase in speed there is an attendant decrease in tractive effort.

With the connections as shown in Fig. 5, by properly proportioning the design of the exciter for its service in super-exciting the traction motor fields, the stable characteristic is inherent in the braking connection as in the motor connection. As the generator function is a reversal of the motor function, the traction motors in this case provide in regeneration that, with an increase in speed, there is an increase in braking effort, and with a decrease in speed there is a decrease in braking effort. The fact that a stable characteristic is closely maintained during regenerative braking is one of the greatest contributing elements to the success of electric braking in this service. This stable characteristic permits operation down grades at constant speeds with little regulating effort on the part of the engineer, except as changes in grade or curves occur, which require large variations in the intensity of the braking.

Fig. 6 is a simplified diagram of the electric braking connections, showing master controller, relays, field rhsostat, exciter and the traction motors.

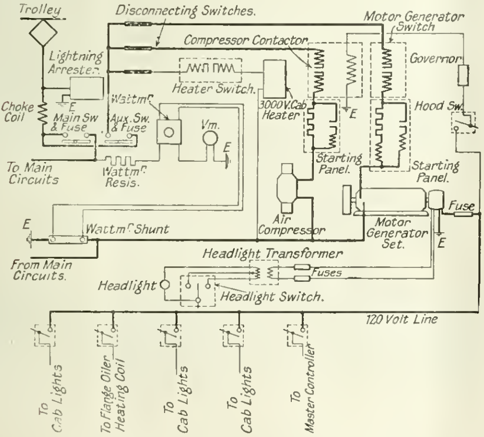


Fig. 7.—Connections of Auxiliary Apparatus.

Auxiliary Equipment.—In addition to designing an electric locomotive so that it will exert drawbar pull, there are many other features which have to be taken into consideration; although these features are called auxiliaries, many of them are really essential to the commercial operation of the locomotive.

By referring to Fig. 7 an idea may be obtained of the connections of the electrical apparatus which is auxiliary to the main circuits of the locomotive. As both halves of the locomotive are alike, the diagram only shows the auxiliary equipment for one-half a locomotive. At times only half a locomotive is used on some of the local passenger trains.

Train Lighting Apparatus.—The train lighting system used is the head-end system with three train lines. One line carries the outgoing current from a generator, and is called the generator line. The batteries along the train are connected between the generator line and a second line known as the battery line, while the lamps are connected between the generator line and a third line, which is known as the lamp line. An adjustable resistance is provided in the locomotive, so that the voltage between the generator line and lamp line may be held constant while the voltage between the generator line and battery line is being varied in order to maintain the desired amount of charging on the batteries.

When the trains are being operated by steam locomotives the power for lighting is furnished by a steam turbine driven generator installed in a baggage car at the front of the train, and the voltage is controlled there. When in the electric zone, the train lines are coupled up to the locomotive, and power for lighting is furnished from the two exciters ordinarily used for regenerative braking, but now connected in series to give the proper voltage.

An electro-pneumatic commutating switch is used to change over the connections from braking to train lighting. This switch is very similar to the main reverser, but with different sequence of contacts. The connections are so arranged that the engineer always has control of this switch, and is enabled to throw it from lighting connections to braking connections at any time unless he has opened the small snap switch which controls the commutating switch on the rear half. This commutating switch can never be thrown over to the lighting connections if it is being used by the engineer for braking. The snap switch is provided so that the rear half of the locomotive may be left with train lighting connections while the front half is braking. This is usually the procedure at night, except while going through Butte on the 2,400-volt section, and also on the heavy grade. In the daytime, however, the batteries are not on charge, unless they are pretty low or there is a lamp load of 20 to 25 amperes.

The control of the battery charging in the locomotive is taken care of at a large panel. The two lines from the generator armatures, after passing through fuses, lead to this panel. Here the positive lead goes through an ammeter shunt to a knife blade switch and then to the generator line. The negative lead goes through an overload and reverse current circuit to a knife blade switch and thence to the battery line. The circuit-breaker also has a shunt coil which will trip the breaker when relay A, Fig. 8, is de-energised. This relay is energised only when the batteries are to be charged, and when it drops out it short-circuits a resistance and allows sufficient current through the shunt coil to trip it. In changing back from lighting connections to braking this takes place before the commutating switch throws, and thus opens the generator circuit. Between the circuit-breaker and battery switch a lead goes through an adjustable resistance, ammeter shunt and knife blade switch to the lamp line. As the voltage of the generator has to be held constant between 75 and 78 volts while charging, this resistance is used to reduce the voltage on the lamps to 62 to 66 volts.

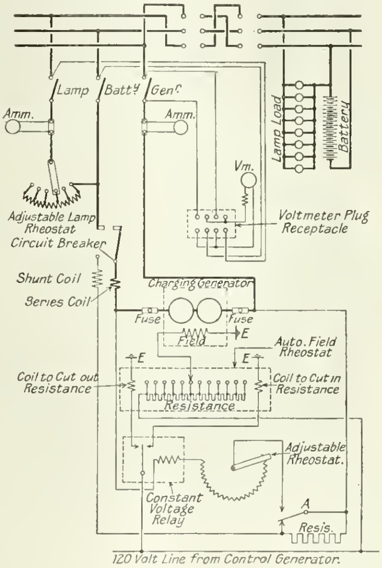


Fig. 8.—Connections of Train Lighting Apparatus.

In making the change from steam to electric operation the lamps of the train are thrown directly on the batteries by closing the lamp switch at the panel in the baggage car. This ensures having the train lighted during the change of engines.

The voltage is kept at any desired point by means of a constant voltage relay, which energises either the "cut in" or "cut out" coil of an automatic field rheostat in the generator field. The setting of this relay may be varied by means of an adjustable resistance in series with the coil.

This lighting apparatus is only used on the passenger locomotives, and a few freight locomotives which are expected to be used at times in place of regular passenger locomotives.

PROGRESS OF HIGH-VOLTAGE DIRECT-CURRENT RAILWAYS.

	Permanent way.				Overhead construction.									
					Trolley or third rail.		Transmission line.							
	Length of route.	Length of line (single track basis).	Miles of 600-volt City operation.	Track gauge S = 4 ft. 8½ in. Weight of rail	Type.	Voltage.	Voltage.	Freq'ency.	Phases.	Principal motor equipment on motor coaches.	Free running speed.	Motor equipment on locomotives.	Type. A = Auto. NA = Non-auto. K = Cylin.	Date started high-voltage operation.
Aroostook Valley R.R., Presque Isle, Maine	32	38	0	S-70	Direct suspension	1,200	11,000	60	3	(4) G.E. 217-600 (4) G.E. 205-600 volts	30	(4) G.E. 206-600 volts	M-NA (2) K	July, 1910
Butte Anaconda & Pacific Ry., Butte, Mont.	30	114	0	S-85	11 point catenary trolley	2,400	100,000	60		....	..	(4) G.E. 229-1,200 volts (2) G.E. 229-1,200 volts	..	June, 1913
Canadian Northern Ry., Montreal, Can.	10	30	0	S-90	Catenary trolley	2,400	11,000	60	3	(4) G.E. 239-1,200 volts	50	(4) G.E. 229-1,200 volts	M-NA	Building.
Central California Traction Co., Stockton, Cal.	69	71	7	S-75	Third rail and catenary	1,200	60,000	60	3	(4) G.E. 205-1,200 volts	45	(4) G.E. 205-1,200 volts	M-NA	June, 1908
Charles City Western Ry., Charles City, Iowa	25	30	0	S-70	Direct suspension	1,200	2,300	60	3	(3) (2) G.E. 217 (1) (4) G.E. 217	30	(4) G.E. 205-600 volts	K-R-200	July, 1915
Chicago, Milwaukee & St. Paul Ry.	440	650	0	S-90	Catenary double trolley	3,000	100,000	60	3	....	..	(8) G.E. 253-1,500 volts (4) G.E. 255-1,500 volts	..	Dec., 1915
Chicago, Milwaukee & St. Paul Ry., Great Falls Terminal	4	7	0	S-90	Catenary trolley	1,500	6,600	60	3	....	..	(4) G.E. 207-750 volts	..	Feb., 1915
Davenport & Muscatine Ry., Davenport, Iowa	30	30	4	S-70	Catenary trolley	1,200	33,000 Y	60	3	(4) G.E. 217-600 volts	39	....	K	Aug., 1912
Fort Dodge, Des Moines & Southern Ry., Boone, Iowa	120	145	5	S-70	Direct suspension	1,200	22,000 Δ	25	3	(4) G.E. 205-600 volts	45	(4) G.E. 206-600 volts (4) G.E. 251-600 volts	K	Sept., 1911
Grand Rapids, Holland & Chicago Ry., Grand Rapids, Mich.	45	77	5	S-60, S-70	Direct suspension	1,200	20,000	30	3	(4) W-333-600 volts	60	....	M-NA	May, 1915
Hocking-Sunday Creek Traction Co., Nelsonville, Ohio	14·8	15·2	0	S-70	Direct suspension	1,200	..	..	..	(4) W-324-600 volts	42	....	HL	May, 1915
Indianapolis & Louisville Traction Ry. Co., Scottsburg, Ind.	41	41	Traffic rights 75	S-75	Direct suspension	1,200	none			(4) G.E. 205-600 volts	53	....	M-NA	Oct., 1907
Iowa Ry. & Lt. Co., Cedar Rapids, Iowa	28	28	..	S-70	Direct suspension	1,200	16,500	60	2	(4) G.E. 205-600 volts	41	(4) G.E. 207-600 volts	M-K	Op. at 600 volts
Jefferson County Traction Co. (E. Texas Elec. Co.), Beaumont, Texas	20	20	4	S-70	Catenary	1,200	none			(4) G.E. 233-600 volts	45	....	K	1914
Kansas City, Clay County & St. Joseph Ry.	72	74	9	S-70	Catenary	1,200	33,000	25	3	(4) G.E. 225-750 volts (4) W-327-750 volts	60	....	M-A-HL-A	Jan., 1913
Lake Erie & Northern Ry., Ontario, Can.	54	56	1	S-85	Catenary trolley	1,500	20,000	25	3	(4) W-85 H.P., 750 volts	45	(4) W-562-D-5, 750 volts	West.-A-B	Feb., 1916
London & Port Stanley Ry., London, Ont.	24	30	0	S-70	Catenary	1,500	13,200	25	3	(4) G.E. 225-750 volts	50	(4) G.E. 251-750 volts	M-NA	Aug., 1915
Maryland Electric Ry. Co., Annapolis, Md.	25·3	32·3	0	S-80	Catenary	1,200	13,200	25	3	(4) W-317-A-4, 600 volts	45	(4) W-562-600 volts	H-L-F-NA	Jan., 1914
Michigan Ry., Kalamazoo-Grand Rapids Allegan-Battle Creek	92	95	4	S-80	Third rail over-running catenary	2,400	70,000	30	3	(4) G.E. 239 (2) G.E. 239-1,200 volts	70 50	(4) G.E. 239-1,200 volts	M-NA	May, 1915
Michigan Ry., Flint-Bay City	46	46	5	S-80	3rd rail over-rung. d. sus.	1,200	20,000	60	3	(4) W-333-600 volts	60	....	HL	May, 1914
Michigan United Traction Co., Jackson, Mich.	150	150	0	S-70	Over-running third rail direct sus. trolley	1,200	44,000	60	3	(4) W-333-600 volts (4) G.E. 254-600 volts	60	....	HL	Op. at 600 volts
Milwaukee Electric Ry. & Lt. Co., Milwaukee, Wisc.	135	135	47	S-80	Catenary trolley	1,200	13,200 38,000	25	3	(4) G.E. 205-600 volts (4) G.E. 207-600 volts	45	....	M-NA	March, 1910
Nashville-Gallatin Inter. Ry., Nashville, Tenn.	27	27	3·5	S-70	Direct suspension trolley	1,200	33,000 Y	60	3	(4) G.E. 205-600 volts	40	....	K	April, 1915
Oakland Antioch & Eastern Ry., San Francisco, Cal.	118	118	4	S-70	Catenary	1,200	11,000	60	3	(4) G.E. 205-1,200 volts (4) W-322-600 volts	55	(4) W-308-B, 600 volts (4) W-321-600 volts (4) G.E. 205-1,200 volts	M-NA W-HL	Sept., 1913
Ogden, Logan & Idaho Ry., Ogden, Utah	97	97	5	S-70	Catenary	1,500	44,000	60	3	(4) W-334-750 volts	50	(4) W-562-A, 750 volts	West HL-NA	April, 1915
Oregon Electric Ry., Portland, Ore.	154	180	25	S-70 S-75	Catenary	1,200	60,000	33	3	(4) G.E. 205 (4) G.E. 222-600 volts (4) W-321-600 volts	45	(4) G.E. 212-600 volts (4) G.E. 207-600 volts	M-A	Aug., 1912
Orleans & Kenner Ry., New Orleans, La.	11·6	12·5	4·3	S-70	Catenary	1,200	6,600	60	3	(4) W-50 H.P., 600 volts	40	....	HL	Op. at 600 volts
Pacific Electric Ry., Los Angeles, Cal.	57	91·5	1·7	S-70 S-75	Catenary	1,200	15,000	5	3	(4) G.E. 254-600 volts (4) G.E. 222-600 volts (4) W-333-600 volts	60	(4) W-308-600 volts	M-A-HL-A	May, 1914
Piedmont & Northern Lines, Charlotte, N.C.	125	125	10	S-80	Catenary	1,500	2,400, 13,200 2,000, 44,000	60	3	(4) W-321-750 volts (2) G.E. 217-750 volts	45	(4) W-308-750 volts (4) G.E. 212-750 volts	West. HL-R-200	May, 1912
Pittsburgh & Butler St. Ry. Co., Pittsburgh, Pa.	33	33	5	5 ft. 2½ in., 80	Catenary	1,200	22,000	25	3	(4) G.E. 225-600 volts	47	....	M-NA	Aug., 1913
Pittsburgh, Harmony, Butler & Newcastle Ry.	71	82	4	5 ft. 2½ in. 80	Direct suspension double trolley	1,200	13,200	60	3	(4) G.E. 205-600 volts (4) W-322-600 volts	45	....	M-A	July, 1908
Salt Lake & Utah Ry., Salt Lake City, Utah	67	67	0	S-75	Catenary trolley	1,500	44,000	60	3	(4) W-334-E-750 volts (2) W-530-750 volts	50	(4) W-334-E-6, 750 volts	HL-NA R-200	July, 1914
Shore Line Electric Ry. Co., Saybrook, Conn.	56·4	58	10·3	S-70	Catenary and direct suspension	1,200	11,000	25	3	(4) G.E. 217-600 volts (4) G.E. 205-600 volts (4) W-327-600 volts	43	....	M-NA HL-NA	Sept., 1910
Southern Cambria Ry. Co., Johnstown, Pa.	23	24	0	S-70	Direct suspension double trolley	1,200	none			(4) G.E. 205-600 volts (4) G.E. 217-600 volts	43	....	M-A-K	1910
Southern Illinois Ry. & Pr. Co., Harrisburg, Ill.	15	17	0	S-80	Catenary trolley	1,200	33,000	60	3	(4) G.E. 205-600 volts	41	....	M-NA	Sept., 1913
Southern Illinois & St. Louis Ry., Harrisburg, Ill.	60	60	0	S-80	Catenary trolley	1,200	33,000	60	3	(4) G.E. 240-600 volts (4) G.E. 233-600 volts	41	(4) G.E. 212-600 volts	M-NA	Building
Southern Pacific Co. Electric Division, Portland, Ore.	146	162	3	S-75, S-90	Catenary	1,500	13,200, 60,000	60	3	(4) G.E. 205-750 volts	45	W-308-750 volts ?	M-A	Jan., 1914
So. Pacific Railroad (Oakland, Alameda & Berkeley Div.)	118	138	0	S-80	Catenary	1,200	13,200	25	3	(4) G.E. 207-600 volts (4) W-337-600 volts	40 27	....	M-A HL	April, 1911
Southern Traction Co., Dallas, Texas	158	158	5	S-70, S-80	Catenary	1,200	66,000	60	3	(4) G.E. 225-600 volts	65	(4) G.E. 225-600 volts	M-NA	Oct., 1913
South-western Traction & Pr. Co., New Iberia, La.	14	14	0	S-60	Catenary	1,200	none			(4) G.E. 217-600 volts	36·5	....	K	May, 1912
Texas Traction Co., Dallas, Texas	76	76	0	S-70	Catenary	1,200	33,000	60	3	....	..	....	..	Op. at 600 volts
Tidewater So. Railroad Co., Stockton, Cal.	33	33	0	S-65	Catenary	1,200	16,500	60	3	(4) G.E. 201-600 volts	43	(4) G.E. 207-600 volts	M-A	Nov., 1913
Toronto Suburban Ry., Toronto, Can.	49	56	3	S-70	Catenary	1,500	25,000	25	3	(4) G.E. 240-750 volts	52	....	M-K	Building, 1916
United Rys., Portland, Ore	20	27	0	S-60 S-90	Catenary	1,200	60,000	33	3	(4) G.E. 73 and 205 (4) G.E. 205-600 volts	45	....	M-A	Jan., 1913
Valparaiso & Northern Ind. Ry., Valparaiso, Ind.	46	46	..	..	....	1,200	2,200	60	3	....	..	....	..	Op. at 600 volts
Washington, Baltimore & Annapolis Elec. R.R., Baltimore, Md.	61	103	14	S-80	Catenary	1,200	33,000	25	3	(4) G.E. 205-600 volts (4) G.E. 233-600 volts	45	(4) G.E. 207-600 volts	M-A	Feb., 1910
Waterloo, Cedar Falls & Northern, Waterloo, Iowa	60	65	..	S-72	Catenary	1,200	40,000	25	3	(4) W-333-600 volts (4) W-317-600 volts	60	(4) W-308-600 volts	HL	Sept., 1914
Willamette Valley Southern Ry.	30	32	0	S-60	Catenary	1,200	57,100	60	3	(4) G.E. 240-600 volts	40	(4) G.E. 207-600 volts	M-NA	Jan., 1914
Foreign High Voltage D.C. Railways, General Electric—														
Bethlehem Chile Iron Mines Co., Tofo, Chile	15	24	0	S-100	Catenary	2,400	2,300	60	3	....	..	(4) G.E. 253-1,200 volts	..	Building, 1916
Imperial Railways, Japan	20	40	4	42 in.	Catenary	1,200	11,000	25	3	(4) G.E. 244-600 volts	45	....	M-A	1915
South Manchurian Ry., China	25	25	0	S-50, S-80	Catenary	1,200	2,300	60	3	(2) G.E. 205-1,200 volts	25	(4) G.E. 206-600 volts	M	1914
Victorian Rys., Melbourne, Australia	150	325	0	85 5 ft. 3 in.	Catenary	1,500	20,000	25	3	(4) G.E. 237-750 volts	52	....	M-A	Building, 1916

PROGRESS OF HIGH-VOLTAGE DIRECT-CURRENT RAILWAYS.

In an article in the November number of the "General Electric Review," of America, Mr. G. H. Hill sets out the economic reasons that led to the adoption of higher voltages in railway work, and points out that it is the inherent characteristics of the higher voltage direct-current apparatus that have led to its extensive adoption for inter-urban railways, and also for the heaviest kinds of steam railway electrification.

The table on the opposite page, which has been condensed from a table in Mr. Hill's article, shows that the high-voltage direct-current equipments are widely distributed, and include all varieties of service. The results accomplished have stood the critical analysis of independent engineers, and have exceeded the expectations of practical operators. In no case, says Mr. Hill, has the high-voltage direct-current system been abandoned. On the contrary, many roads have been converted from 600 volts direct-current or single-phase alternating current to high-tension direct-current, and in no case has the system failed to meet the economic success anticipated. Emphasis can especially be placed on the freedom from apparatus failures and low maintenance as contributing a large measure of the practical success.

It appears that at the present time there are about 2,800 miles of track equipped for 1,200 or 1,500 volts, and about 700 miles of 2,400 or 3,000-volt direct-current track.

As to the probability of developing still higher voltage systems, Mr. Hill states that 3,000 volts seem to be adequate for the heaviest trunk line traffic, and is likely to represent the true economic balance between cost of sub-stations and feeder copper on the one hand, and cost of locomotives on the other, and to present the greatest flexibility and the lowest operating charges. But 5,000 or 6,000 volts direct-current is a possibility if there arises a real field of usefulness for this further extension.

COLONIAL TELEGRAPHS AND TELEPHONES.*

BY R. W. WEIGHTMAN.

Summary.—After referring to British Post Office practice, the author deals with the appointment of engineers, with working staffs and sources of supply. He then considers telegraph and telephone administration in the Crown colonies, and amalgamation of railway telegraphs with postal telegraphs. The next section of the Paper is devoted to overhead construction. The telegraph and telephone systems of the Crown colonies, South Africa, Canada, Australia and New Zealand are described at some length, and in conclusion the important question of lightning protection is considered.

Throughout the Paper it has been necessary to deal with the great Dominion of Canada separately. There, the methods are based on American practice, as distinguished from British Post Office practice, which is followed more or less throughout the other dominions and colonies. It will therefore be understood that where the "dominions and colonies" are referred to Canada is not included unless otherwise expressly stated.

If the Paper appears to give an undue amount of attention to practice in South Africa and the Crown colonies, it will be understood that this is because the author is more closely in touch with those countries than with the others.

British Post Office Practice.—With the gradual standardisation of materials and plant generally in the Home Department, and the publication by the department of books of technical instructions, the dominions and colonies have got more or less into the way of accepting Post Office practice as beyond question. There is the feeling that, no matter what the subject may be, the practice laid down for it has been well thought out, and is the result probably of years of experience and of capable and careful research.

Colonial methods vary in many matters of detail from those in vogue at home. The administrations of the dominions send their chief technical officers to see what is being done elsewhere, and to cull from the various systems those features which are the most advantageous for adoption in their own countries. But as the bedrock of it all, British Post Office practice is outstanding.

Appointment of Engineers.—In the earlier days many of the engineers, and many officers of other ranks as well, appointed in the dominions and colonies, were men who had received their training in the various Home services. This still applies to appointments in the Crown colonies, but it is only rarely the case now in the dominions. In a general way, any youth starting at a Government primary school can, with the aid of Government bursaries, pursue his studies through the Government high schools until he finally reaches the university college, where he can qualify in a degree of practically equivalent value to the B.Sc. of England. The colonial youth certainly has few opportunities of acquiring a practical training, but this is not so necessary as in the case of students in the heavier branches of engineering. So we find the youths of the dominions qualifying in their respective engineering departments for even the highest positions in them.

There are, however, several colonies in the tropics in which the conditions are so trying that Europeans must have the relief of a change to a temperate climate at frequent intervals. The Colonial Office Leave Regulations wisely make generous provision in this respect as regards some of these colonies, but other colonies with equally trying climatic conditions are not so well off. For the filling of engineering appointments in these colonies the Colonial Office will always look for men at home, and provided that they offer sufficiently remunerative salaries, they need not fear any dearth of applications from men of the right sort for these appointments. But there is a tendency to parsimony in this respect in many of the colonies. In the interests of colonial engineering, and in the higher interests of colonial administration, only the best men should be selected for these posts, and such men will not come forward unless the salaries offered are sufficiently tempting. Low salaries for men in positions of responsibility is false economy.

In another direction the Governments of the Crown colonies are very short-sighted. They do not encourage their engineers sufficiently to keep themselves up to date. A technical officer should be commissioned by his Government to visit England frequently to enable him to keep in touch with the latest developments.

Working Staffs.—With well-trained staffs of European character, the engineers of Canada, Australia and New Zealand are relieved of much of the worry which falls to the lot of the engineers in those countries where the bulk of the labour is black. In Australia there is an Arbitration Court, established by Act of Parliament, for the investigation and settlement of labour disputes. Any difficulties of this nature that arise are referred to it, and the award of the court is loyally accepted and acted upon by both sides. In New Zealand there is a Board of Appeal on somewhat similar lines.

In Canada there is a law of doubtful value, under which employés can apply for a board of conciliation to discuss differences between themselves and their employers.

In South Africa and in most of the Crown colonies the rough labour is performed almost entirely by men of the native races, while generally the positions of control are held by Europeans. In Ceylon the main supply of labour is drawn from the South of India. All positions higher than that of overseer are held by Europeans.

The author next deals with the provision of rough and semi-skilled labour in British East Africa, Uganda, Nigeria, the Malay States and South Africa, and points out that engineers in all the black colonies are hampered by the disinclination of the natives to work and by the utter lack of a sense of responsibility on the part of the natives.

Sources of Supply and Delays in Delivery.—Of all the dominions and colonies, Canada is the only one that has made any headway in the manufacture of apparatus and material for telegraph and telephone purposes.

In Australia, cast-iron pipes, stoneware conduits, copper tapes and certain fittings are manufactured in the country. Prior to 1913 practically all the insulators used came from Germany, but insulators of both porcelain and stoneware are now being made within the Commonwealth. A fair amount of magneto telephone apparatus and switchboard material is obtained from Sweden, while some of the larger exchange switchboard plant and automatic apparatus come from America. Wire, cable, telegraph apparatus generally, and material of a kindred nature are obtained almost exclusively from Great Britain. It is the rule to invite tenders for all supplies and to give preference to goods of British manufacture. The other dominions and colonies import practically all their plant. This is largely obtained from England, but quantities of apparatus have been supplied from both the Continent and the United States.

The great distances these countries are situated from their sources of supply, and the delays in delivery that have taken place, have been serious drawbacks to the smooth working of most of the colonial engineering departments. The author would like to impress upon manufacturers of telegraph and telephone plant the great need there is for the more prompt execution of orders from the colonies. Before the war it was no uncommon thing to hear an engineer say he would not put up with the dilatoriness of British manufacturers, and that he would send his orders to the Continent, and in some instances orders were actually sent there.

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* Abstract of a Paper read last night before the Institution of Electrical Engineers.

In the dominions and in some colonies these difficulties are got over by the establishing of "reserve stores," in which ample supplies are kept to meet all ordinary demands. This is a plan which every colony with any considerable system should adopt in order to minimise delays.

ADMINISTRATION.

The methods of administration throughout the colonies are naturally varied to meet the local conditions, but in all the dominions (with the exception of Canada) and also in all the larger Crown colonies the telegraphs and telephones are combined with the postal service of the country, and the Postmaster-General is the officer responsible to the Government for the proper management of the organisation as a whole.

Small Crown Colonies.—In some of the smaller colonies telephone exchanges have been established by private companies; but they are generally on so small a scale that their control falls to the colonial public works engineer, and for anything of a technical nature in which he is not quite sure of his ground he obtains advice from consulting engineers in England.

Large Crown Colonies.—In the larger Crown colonies we usually find an organisation on the lines of the Home Post Office. It has been argued that the engineer should be directly responsible to the Colonial Secretary, but this arrangement would not be likely to work well in practice. It is most desirable that the relations between the head of the department and the engineer should be of an amicable nature. The efforts of the most capable engineering body in the world may be thwarted and the engineers themselves engaged discouraged if there is undue interference and a lack of sympathy and support from the Postmaster-General and his staff.

Dominions: Telegraph Administration.—The main feature of note is that more care is given to the consideration of traffic matters than used to be the case. Following the example of the Home Department, more attention is given to comparing the merits of the various systems of telegraphy for the differing traffic conditions and to selecting that which is the most suitable in each case. Up-to-date type-printing systems are already in use.

Telephone Administration.—Telephone administration is a more complex question. In America, more than anywhere else, it has been studied and developed into a fine art, particularly by the American Telephone & Telegraph Company, whose operations extend over the whole of the United States. This Company introduced a new system called the "Functional System," in which the organisation is divided into three sections—viz., traffic, engineering and commercial—and on the headquarters staff a specially qualified officer is placed in charge of each section. In each division the work is similarly divided; there is an officer in charge of each section of the work, and each is directly responsible to the headquarters chief of his section. The duties and responsibilities of the officers of each section are carefully defined, but they are so correlated that a certain amount of overlapping is unavoidable. This feature of the system is claimed to be one of its chief advantages, inasmuch as it necessitates the full verbal discussion of a subject in all its bearings before it is reported upon, and much time and correspondence are thus saved.

Canada.—The telegraph and telephone services of Canada are quite separate from each other, as in the United States. By far the larger portion of the system is in the hands of the North-Western Telegraph Company and the telegraph departments of the Canadian Pacific and the Grand Trunk Railway Companies. The operations of the companies are subject to the Dominion Railway Act. There is no active competition between the different administrations. The form of administration adopted by the companies is comparable with that of the railway companies of Great Britain. The Government Department is controlled by a general superintendent under the office of the Minister of Public Works.

The telephone services of Canada are partly in the hands of the provincial Governments and partly under private and rural companies. There is no real competition between the large administrations. The rural companies, are, however, frequently started in competition with the ruling company, and intercommunication difficulties arise. Where a question of interconnection between any company's system and the long distance lines of another company arises, the Board of Commissioners have the power to direct what shall be done, and they determine the terms as to compensation on the merits of the case.

The construction of rural lines by independent local companies for the purpose of giving telephone service to farmers is much encouraged by the various provincial Governments, and in this respect Canada is a shining example to the other dominions and colonies. The regulations of the Saskatchewan Provincial Government under which these companies are formed are typical. The companies are not allowed to operate their systems within towns or villages. The lines are built to a standard laid down in very complete specifications and instructions prepared by the Government Department of Telephones. Poles for the construction of the lines can be obtained from the Government at cost price. The specifications are accompanied by drawings, and they, also, are so comprehensive that but little difficulty is experienced by the farmers in constructing their own lines themsleves.

Australia.—The telegraphs and telephones are a close monopoly under the Post Office.

Under the Department's regulations it is provided that lines for public use in country districts which may not be immediately remunerative to the Department, may be erected under a system of guarantee, under which the Department bears 50 per cent. of the estimated annual loss. In other cases the local residents are permitted to erect the lines themselves, to the Department's specifications and at the Department's expense, provided that the work is carried out at such a cost as will bring it within the guarantee regulations. It is found that the local people can carry out the work at a cheaper rate than the Government Department, owing to their being in better touch with the local labour supply, and with the transport and other local facilities.

The fullest encouragement is given to persons living in the country to erect their own lines, either individually, or conjointly with their neighbours, for connection with post offices or exchanges, and the Department furnishes applicants with all the information they may require, both as to the best means of establishing connections and as to the class of construction best suited to their requirements. The system of administration is one which has been built up with the development of the services, and it may be said to follow "territorial" lines. The Department has a complete monopoly of the telegraphs and telephones of the country, and it does not encourage the formation of private companies for the establishment of rural or other lines. Under the Telegraph Act no person or persons may construct telegraph or telephone lines for hire or profit, but there is no hindrance to persons erecting lines for their own use. Many such lines have been put up by farmers in the back blocks of the country where the Government do not feel warranted in spending money on lines which offer little prospect of paying their way. Such lines usually terminate in a Government office or exchange where they are given connection with the Government system

South Africa.—In South Africa the telegraphs and telephones are also under the Postmaster-General. Of all the dominions outside Canada, South Africa is the first to adopt the "functional" system. With the advent of the Union the separate administrations were merged in the one central administration, and a system closely allied to the "territorial" was applied to the whole of the Union. With the great development of the telephone system this method of administration was found to be unsuitable, and the "functional" system was introduced about three years ago.

Amalgamation of Government Railway Telegraphs with Postal Telegraph Systems.—In practically all the colonies and dominions the railways belong to the State, and in some of the smaller colonies a feature of the administration is the amalgamation of the railway telegraph engineering and electrical signalling systems with the Engineering Department of the Post Office. All electrical signalling systems are of a cognate character and come naturally within the scope and training of telegraph engineers and linemen, and any colonial administration which may contemplate such an amalgamation need have no fear for the results, provided a capable and well-organised staff is available.

Electric Lighting in Charge of Telegraph and Telephone Engineers.—The author's opinion is that in the specialisation which is necessary to-day in telegraphy and telephony it is too much to expect an engineer to be expert also in the lighting and power applications of electricity in the larger sense. The practice in this respect throughout the dominions and colonies varies. In Canada most of the administrations have their lighting done from outside, but there are exceptions to this rule

In Australia all installations are put in by a Government department corresponding with the Government Office of Works of England, but the Postal Department's engineers are responsible for the maintenance of the installations. In New Zealand, the Department's engineers are responsible for the electric lighting. In South Africa the lighting of all Government buildings, apart from the railways, and including those of the Post Office, is done by a special branch of the Public Works Department. In the Crown colonies the practice varies, but it is generally on the lines followed in South Africa.

ENGINEERING.

Overhead Construction.—There is practically no overhouse construction in any of the dominions or colonies, and the chief difference in the construction of pole lines lies in the character of the pole employed. Where timber is plentiful and there are no local drawbacks to its use, wood poles are the rule, but where it is scarce or not of suitable size or quality, or where it is liable to be attacked by white ants, or destroyed by grass or bush fires, iron poles are used.

White ants abound in practically all the tropical colonies, and while it is usual in such countries to find an indigenous wood which is more or less immune from their attacks, it is not always suitable for use as telegraph poles. South Africa is not what may be termed a timber country, although there are forests of indigenous trees here and there. Amongst these the "sneeze-wood" is the only one that will withstand the ravages of the white ant for any length of time, but even this wood is not free from attack. The core of the "sneeze-wood" is almost as hard as iron while yet as flexible as whalebone, and the author has heard of only rare cases in which the ant has been able to eat into it.

These "sneeze-wood" poles served their purpose well in the construction of the lines that were built in the early days. The poles were not suitable either in height or strength to carry more than a few wires, and with the gradual opening up of the country they were replaced with tubular iron taper poles imported from England.

In British East Africa and Uganda there is a "live" pole in use which is perhaps unique in its way. Some years ago a temporary line was erected with poles which when planted unexpectedly took root and became trees. These poles were found to stand much better than ordinary "dead" wood poles, and, benefiting by this experience, the administration built about 1,000 miles of line with this type of pole. They were cheap and they have served their purpose well in the development of the country during a period when funds were limited. They have their disadvantages, however. With improved financial conditions these colonies are now using tubular iron poles.

POLE LINES.

Crown Colonies and South Africa.—There are two types of tubular iron poles with cast-iron bases and wrought-iron taper upper tubes in general use in the Crown colonies. In all these poles the cast-iron base is of sufficient length to keep the wrought iron tube out of the ground when the pole is planted to its proper depth.

One type of pole has its base pointed, the point being solid for about 5 in., so that it can be driven into the ground by means of a special rammer, which is dropped inside the base. The standard type of pole used has a cylindrical cast-iron (parallel) base with square flange at the bottom end to which a buckled base plate is bolted.

Poles of this type are made in a number of standard lengths and strengths. Where the length is 40 ft. or over, the upper part is made in two or more sections. A factor of safety of 2 based on a wind pressure of 17 lb. per square foot is sufficient for these poles in countries where there are no snow and ice accumulations to be taken into account. Where snow and ice occur a factor of safety of 4 should be allowed.

Fig. 1 shows a light pole specially designed for South Africa. It is used on farmers' lines and carries one or two pairs of wires between main routes and the homesteads. It will carry wires having a total lateral stress of about 80 lb. 12 in. from the top. It is probably the lightest and cheapest pole used in telephone practice anywhere.

There is a parallel pole of a more ornamental type, which is used for special street work in South Africa. There is no cast-iron base with it, but it is protected from corrosion at the ground line by means of a sleeve which is shrunk on. It is 26 ft. in length and will bear a maximum load of about 300 lb. at the top when planted 4 ft. in the ground. Where poles of similar type have been planted without the sleeve protection, corrosion has often taken place at and above the ground line.

In some of the Crown colonies tubular poles of the type introduced by the Indian Government and known as the Hamilton pole are used. A full-length pole is about 58 ft. out of the ground, and it comprises eight sections each 8 ft. long. The poles taper from about 12 in. at the bottom to 3 in. at the top.

The number of poles to the mile varies with the class of line. Twenty to the mile may be said to be the lowest number that is allowed on a light country line, but the author knows lines on which the average per mile is much below this figure. From this the number ranges up to 40 to the mile. The author has had experience of spans up to 800 yds. standing quite satisfactorily for many years. The poles are specially stayed, double width spacing is given on the arms, only one quality and gauge of wire is erected, every care being taken to adjust all the wires to the same dip, and no joints are made in the spans. With these precautions the wires all swing in unison, and there is no trouble.

The stays used throughout these countries are of British standard types, with tighteners and with iron anchor plates which are usually tarred. In South Africa a "Crosby" clip is now used for clamping the stay wires at the pole and also at the tightener.

Where iron poles are employed near the sea they can only be preserved from corrosion by being frequently painted or tarred. The author has tried every kind of paint for this purpose, but he found none to stand any better than coal tar applied in the heated state. Reinforced concrete poles would be more serviceable than iron in these situations, but the weights of these poles in proportion to their strengths are against them for lines where the difficulty of transport is a serious factor.

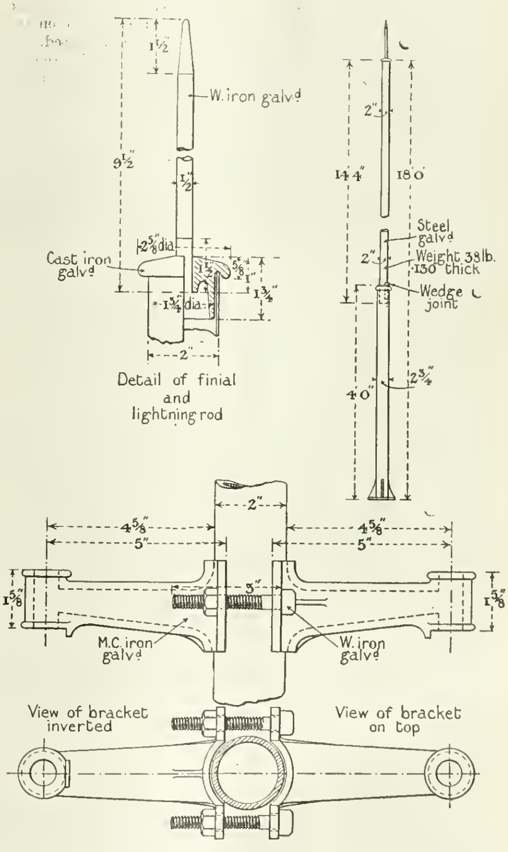

FIG. 1.—LIGHT POLE WITH DOUBLE BRACKET (SOUTH AFRICA).

Hollow reinforced concrete bases made in moulds locally and fitted with wood tops are sometimes used. Discarded railway rails are also used, the rails being set with the web of the rail at right angles to the direction of the line.

Canada.—In Canada, wood poles and arms are used. There are no iron or reinforced concrete poles in use.

Each railway company's telegraph lines are erected on the right of way of the railway concerned. The lines of the Great North-Western Company follow the highways except in cases where the company have contract privileges for the construction of lines along the railways, but it may be said of Canada as a whole that there are few highway telegraph lines in the country.

The main telephone lines follow the public roads. Short cuts across country, except in the case of rural companies' lines, are resorted to only in special cases and where the right of way can be obtained.

These wood poles are generally of cedar. The standard lengths of poles used vary considerably. The standard length pole of the Canadian Pacific Company is 25 ft., but in broken country the poles vary up to 45 ft. in length. The Grand Trunk Company's standard lengths are 25 ft. to 30 ft., set 5 ft. in the ground, 35 ft. to 40 ft. set 6 ft., and 45 ft. to 50 ft. set 7 ft.

The standard of the Bell Telephone Company is 35 ft. With other administrations 30 ft. to 35 ft. is usual for exchange construction and long-distance lines, while on their rural lines 20 ft. and 25 ft. lengths are commonly employed.

The practice in respect of the providing of earth wires on poles varies, but it is nowhere the rule to earth wire every pole. The spacing of the poles is varied in the different administrations, and it varies with the class of line. One system, which is typical, allows 40 poles to the mile on heavy routes, 36 to the mile on less heavy, 32 to the mile on lighter, and 30 to the mile on light routes.

Stays and struts and overhead stays attached to stubs where there is obstruction to the use of ordinary stays, are liberally used on angle and terminal poles. Anchors of both wood and iron are used.

Australia.—Both wood and iron poles are used, the selection depending generally upon whether or not dangers from white ants or bush fires have to be met. Several types of iron poles are employed, the principal being the Siemens taper pole with cast-iron base and screw ring joint.

All the wood poles used are obtained from trees indigenous to the country. Up to the present no treatment for the prevention of decay has been applied, but the question of introducing creosoting plant for this purpose at the larger centres is under consideration. In districts infested with white ants all poles are protected from their attacks by the application of a solution of arsenic (1 lb.) and caustic soda (2 lb.) dissolved in 1 gallon of water.

Poles vary from 20 ft. to 75 ft. in length and from 5 in. diameter at the small end and 8 in. at the butt, to 12 in. at the small end and 20 in. at the butt. The minimum height from the ground of the lowest wires along the road is 12 ft. and at the road crossings 18 ft. All wood poles are provided with lightning conductors of No. 8 galvanised iron wire. Where poles are stayed anchor logs not less than 9 in. diameter and 4 ft. in length with 4 in. square washers are used.

New Zealand.—New Zealand has a greater variety of types of poles than most countries. Poles of wood, tubular iron, reinforced concrete, and discarded railway rails are in use. The wood poles are mainly got from indigenous trees, but timber generally is scarce. A good many poles of ironbark wood have been obtained from Australia. There are no white ants in New Zealand and poles are but rarely damaged by fires. The standard lengths of wood poles in use are 18 ft., 20 ft., 25 ft., 30 ft., 35 ft., 40 ft. and 45 ft., and the poles are not earth-wired.

Tubular iron and steel poles have come more into use within the past few years. They are used in the larger towns for telephone exchange distribution purposes, also in the lighter sizes on some light country lines.

The reinforced concrete pole used is of solid construction, the cross-section being rectangular. The dimensions and strengths of two typical 25 ft. poles are:—

1. 7 in. by 4 in. at the butt, tapering to 3½ in. by 3 in. at the top. Weight 490 lb. Working load 150 lb.

2. 7 in. by 5½ in. at the butt, tapering to 5 in. by 3½ in. at the top. Weight 720 lb. Working load 250 lb.

Hollow concrete poles are not employed.

Poles of 52 lb. and 70 lb. discarded railway rails are largely used, and are said to make splendid lines. Poles of this type have been used for a great many years, and are so favoured that they would be in general use but for the fact that they are not available in the quantities required.

(*To be concluded.*)

MEASURING FEEBLE HIGH-FREQUENCY CURRENTS.*

BY BÉLA GÁTI.

The accurate measurement of high frequency alternating-currents is by no means a simple problem. At low frequencies, shunted ammeters can be used satisfactorily; but when dealing with frequencies such as are met with in telephonic or wireless telegraphy work, some other apparatus must be used, to secure at once accuracy and variable range of measurement. The barrette method offers many advantages. Referring to Fig. 1, the principle employed is that two fine platinum wires B, B_1 are arranged in a balanced bridge circuit, round which a weak constant current is circulated by accumulators A A. The high-frequency current to be measured is applied to one of the barretter coils, B_1 (inductances D D preventing flow of high-frequency current through the remainder of the direct-current circuit) and the resultant heating of B_1 disturbs the balance of the bridge and yields a deflection on G which is a measure of the strength of the high frequency current examined.

The author finds that barretter wires 0·0005 mm. in diameter can be employed without difficulty, but they are too fragile for transport—particularly by post. For telephonic measurements, 0·003 mm. wires are suitable; gold is slightly more sensitive than platinum, but the latter metal possesses the important advantage of being less susceptible to damage by shock. Such telephonic barretters can be sent safely through the post.

The barretter wires are mounted in metallic capsules from which the air is *not* exhausted; owing to the simplicity of its construction, a burnt-out barretter can be repaired very economically. The repair of an equivalent hot wire instrument is a much more costly matter.

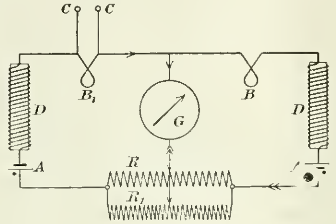

Fig. 1.

In its practical form, a barretter equipment comprises barretter capsules, inductances and regulating rheostats, R R_1, mounted together with the necessary connecting terminals in a wooden case. The necessary connecting leads are provided with the equipment and are distinctively coloured; the use of other leads may affect the calibration of the apparatus. When adjusting the latter prior to use, the galvanometer is not connected till the accumulator circuit has been closed. The shunt resistance across the galvanometer is gradually increased, the bridge circuit being meanwhile balanced by aid of the coarse and fine rheostat cursors, R R_1. Finally, the galvanometer shunt circuit is opened. At all times, care should be taken that neither the barreter shells nor the rheostat contacts be touched by hand; the former would absorb a quantity of heat which would only be slowly dissipated, and the latter, by becoming greasy, would vary in contact resistance. The bridge circuit being balanced, the high-frequency circuit is closed on C C through a condenser preventing flow of direct current through this branch. A galvanometer having 50 scale divisions (each corresponding to 1 micro-ampere direct current) yields, when used with a 2-micron barretter, 10 deg. deflection for 300 micro-amperes, 50 deg. for 560 micro-amperes, 30 deg. for 700 micro-amperes and 50 deg. for 850 micro-amperes high frequency current. By using a three-micron barretter with 1·1, 1·2, 1·10 and 1·100 galvanometer shunts, it is possible to measure from 0·1 milliamperes to 20 milliamperes high-frequency current. The maximum direct current in the bridge is 15 milliamperes to which the barretter offers about 95 ohms' resistance. Using 1·1, 1·2, and 1·10 shunts, 20, 50 and 100 micron barretters permit measurement of currents up to 150, 700 and 1,000 milliamperes respectively. Small tungsten filament lamps can be used as barretters in measuring currents exceeding 1 ampere. Their resistance is low compared with that of hot wire instruments in common use to-day, hence they are very suitable for "wireless" measurements.

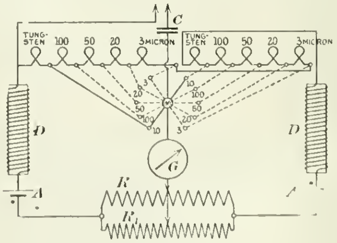

Fig. 2.

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* From "L'Industrie Électrique."

Fig. 2 shows the connections of an apparatus employing several barretters. When using the tungsten barretters, only the latter must be connected in each half of the bridge. It is not difficult to manufacture tungsten and other resistances with such accuracy that the microammeter shows no deflection in a bridge initially balanced, when the position of the barretter selector switch is changed. Barretters not in use should be short-circuited (*see* Fig. 2), unless very high frequencies have to be measured, in which case (since there is a danger of current being induced by higher harmonics, in short-circuited barretters) the solution indicated by Fig. 3 may be employed.

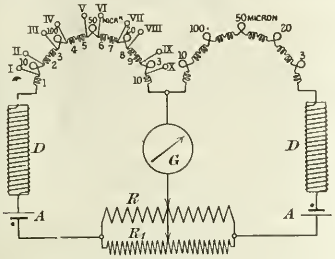

Fig. 3.

Coils 1, 2, 3, &c., are of small inductance sufficient to obstruct the flow of very high frequency current (such as used in wireless work). Connections are made to the barretters by jacks I., II., &c. Where this arrangement is used, barretters may be at some distance from each other—*e.g.*, the tungsten barretter may be close to the earth, 10 yds. or 20 yds. from the compensating bridge, the 3 micron barretter being used in the receiving circuit.

THE SILVER VOLTAMETER.

For over 10 years the Bureau of Standards has been making a study of the silver voltameter, which is used in precision measurements of electric currents. A summary of the experiments and proposed specifications are given by Dr. E. B. Rosa and Mr. G. W. Vinal in Scientific Paper No. 285. A few of the principal results are summarised below:—

1. The effect of filter paper on silver-nitrate soltions (whether the paper is used in the voltameter itself, as has been commonly done, or whether it is used in the preparation of the silver-nitrate solution) was shown to be serious and to result in the formation of colloidal silver. This effect of the filter paper is due to the formation of reducing agents from the oxycellulose of the paper itself and is not due to impurities.

2. The appearance of the deposit is altered by the presence of impurities in the solutions (such as those resulting from filter paper). Pure solutions give crystalline deposits of very pure silver, but colloids, if present, break up the crystals and produce striated deposits which are too heavy to represent accurately the amount of electricity which passed through the voltameter.

3. Many forms of voltameter have been compared. The Bureau has found that the most satisfactory are the porous-cup voltameter and the new form devised by Dr. F. E. Smith, of the National Physical Laboratory, England.

4. The Bureau has devised means for preparing pure silver nitrate and suitable tests for it, so that an electrolyte of a uniformly high state of purity can be prepared. These tests are for acidity and for reducing agents. The Bureau has also found that the agreement between the results obtained from large and from small sizes of voltameters, used simultaneously, is a valuable test of purity; impure solutions (except for acid) invariably give heavier deposits in the large-size voltameters.

5. The temperature coefficient of the voltameter is found to be zero.

6. Tests of the purity of the silver deposits show that when made from pure electrolyte the impurities included with the silver crystals represent on the average only 0·004 per cent. of the weight of the deposit.

7. The absolute electrochemical equivalent of silver was found to be 1·11800 milligrams per coulomb and the voltage of the Weston normal cell was found to be 1·01827 volts at 20°C.

8. Comparisons with the iodine voltameter were made and the ratio, the amount of silver deposited to the amount of iodine deposited by the same current, was found to be 0·85017, which, corrected for the inclusions in the silver deposits, gives 0·85013. The electrochemical equivalent of iodine in absolute measure was computed to be 1·31507 milligrams per coulomb.

The value for the faraday on the basis of the absolute electrochemical equivalent of silver and of iodine and the atomic weights is as follows:—

On the silver basis (Ag = 107·88)	96,494
On the iodine basis (I = 126·92)	96,512
Mean	96,503

The best round value can which be assigned to this constant appears to be 96,500 coulombs.

THE PARALLEL OPERATION OF ELECTRIC POWER STATIONS.

The following discussion followed the reading of Mr. J. S. Peck's Paper on this subject at the Birmingham Local Section of the Institution of Electrical Engineers. An abstract of the Paper appeared in our issue of the 24th ult. (p. 240):—

Mr. R. A. **Chattock**, in opening the discussion, spoke of the advisability of linking-up generating stations, as this contributed to greater over-all efficiency of the stations and increased the reliability of general supply. He thought the case for linking up was quite made out by such considerations and the practical difficulties were not insuperable.

Mr. A. M. **Taylor** explained by the aid of diagrams that the use of Tirrill regulators was inadvisable in linked-up systems owing to their inability to permit the voltage of one station to adjust itself to variations of conditions in another station.

Mr. R. **Orsettich** referred to two great difficulties in the linking-up of stations, namely, that of the switchgear which must be capable of standing the current of the combined systems, and the possibility of heavier surges than would occur in the systems when operated separately.

Dr. G. **Kapp** said he was not able to agree with the author's definition of "total synchronising power." Apparently the author took this to be the sum of the excess power given out by the leading machine and the deficiency of power in the lagging machine. He (Dr. Kapp) thought synchronising power should be defined separately for each machine. He said it was convenient to give the synchronising power in kilowatts per unit electrical degree phase difference between the two machines. Dr. Kapp also explained a diagram which he had devised for finding the total inductance for any ampere load on the machine. In conclusion, he added, that when dealing with the induction motor and synchronising generator the author had pointed out that by making the slip fairly large it was almost impossible to overload the link between two stations, and that a smaller set might be used than if both machines were synchronous. The two disadvantages mentioned were large differences in speed and a bad power factor. Both these, to Dr. Kapp, did not seem to be very serious, whilst the flexibility of the system and the freedom from dangerous overloading were very important advantages.

Dr. C. C. **Garrard**, in a communication, also laid emphasis upon the switchgear difficulty and then went on to explain the urgent necessity for the appointment by the Institution of Electrical Engineers of a Committee whose function should be to collect and make available for the industry in general information regarding control gears for very large supply systems. He said that he had heard of various troubles which had been experienced by supply companies. No doubt the engineers concerned had profited by these experiences, and he thought it would make for progress if the details of the occurrences were available to engineers generally so that others could guard against their repetition. Such a Committee as he had in mind would have to make experiments and it should be possible to obtain a Government grant for the work.

Mr. C. **Jones**, in a communication, wrote of the improvement he had been able to obtain in the power factor by the use of static condensers. In the particular system with which he was concerned three sets had been installed of 340, 400 and 600 mfd. capacity. These had been in use for twelve months without the slightest trouble.

Dr. C. C. **Garrard** (in a further communication) emphasised the importance of control gear. It was now recognised that control gears, for example oil-switches, must be chosen having regard to the maximum value of the short-circuit current which might occur in the place where the switches were situated. Even with existing supply stations it was very doubtful whether the breaking capacity of the oil-switches which were available had kept pace with the growth of the generating plant. It was not unusual to find supply stations equipped with switchgear which, owing to the continual addition of generating machinery, had become insufficient in size for their duty. The result of this was that on the occasion of short-circuits the switches failed, with consequent interruption of the supply. We could, therefore, conceive two stations each of whose switchgear was adequate, having regard to the individual totals of plant installed. The effect of linking them up, however, by diminishing the inherent reactance of the system, greatly increased the short-circuit current and rendered the whole of the switchgear inadequate. As had already been indicated this trouble could partially be guarded against by the introduction of reactance in the inter-connectors. There was, however, to his mind, no doubt that if we were to go in for large schemes of linking-up it would soon be found that the types of control gear which we had available were inadequate, and that this would prove a limiting feature.

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A REMARKABLE RAILWAY ELECTRIFICATION.

In our present issue we are able to give a detailed description of the Chicago, Milwaukee & St. Paul Railway, which was electrified about a year ago. This railway is remarkable, partly on account of its length, which amounts to 440 miles, and partly owing to the natural difficulties that are encountered in a mountainous country. There are many long gradients and many short radius curves, and the climatic conditions in the winter time are very severe, so that one may feel satisfied that if electric traction proves suitable on this particular line it will be capable of meeting the requirements of any line in existence.

From the point of view of general working and convenience the electrical service has proved eminently satisfactory. Thus, between Piedmont and Donald, including a heavy gradient, the time required for passenger trains has been reduced from one hour five minutes to approximately 40 minutes. In the case of the freight service it has been found that where steam locomotives required 10 to 12 hours to cover 115 miles, the electric locomotives only require 7 to 8 hours. Also low temperatures no longer introduce difficulties. Under the old conditions, with the winter temperatures as low as —40°F. and heavy snowfalls in the Bitter Root Mountains, serious delays used to occur owing to inability of the steam locomotives to raise sufficient steam. In fact, in December, 1915, some of the Mallet locomotives were frozen up at different points of the system, and for this reason the new electric equipment was rapidly pressed into service.

As an example of main line electrification, the Chicago, Milwaukee & St. Paul Railway is more ambitious than the most enthusiastic engineer would think of in this country. As to why such progress should be made in the United States rather than in the British Isles, this may be attributed to certain special circumstances. Among these may be mentioned the hydro-electric power schemes which are available in the United States, but apart from any question of power, the severe gradients that are found on this particular line are sufficient to account for the selection of electric traction. Three mountain ranges are traversed and these result in several long gradients of 1 per cent. or more, the most severe being one of 2 per cent. over a distance of 21 miles, whilst the longest gradient is 1 per cent. over 49 miles. Conditions of this kind are difficult to meet satisfactorily by steam service, whereas they present no difficulty in electric traction. But even more important than the haulage on up-gradients is the braking of trains on down-gradients. The power then involved is something like 3,500 kw. for a 2,500-ton train when running at 17 miles per hour down a 2 per cent. gradient. Thus it is not surprising that brake-shoes often become red hot, and that a great deal of wear and tear results to both rolling stock and track. By means of regenerative braking, which is possible with the high-tension continuous-current system that has been adopted, this power becomes available for useful work and at the same time reduces wear and tear.

There must be many parts of the British Empire where similar railway problems are to be faced and where we do not doubt that electric traction would prove the most suitable solution. As to whether high-voltage continuous-current is the best to adopt may still be open to question. This system has certainly made very considerable headway in the United States during the last few years and on another page we publish a lengthy table as evidence of this. It will be noticed that most of these lines are running at a pressure of 1,200 volts and a few at 1,500 volts, which, however, is not very considerable. On the other hand, there are now four lines running at 2,400 volts, and the Chicago, Milwaukee & St. Paul Railway holds the unique position of heading the list with 3,000 volts. The difficulties in collecting the current appear to have been overcome, and for mountainous country the high-voltage continuous-current system appears to provide a more satisfactory solution than its obvious rival, the three-phase system.

REVIEWS.

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Welfare Work: Employer's Experiments for Improving Working Conditions in Factories. By Miss E. DOROTHEA PROUD, B.A. (London: G. Bell & Sons.) 7s. 6d. net.

The authoress is to be congratulated upon her industry and skill in compiling an interesting and suggestive work on a subject of considerable importance to the public, and especially to that portion of it represented by the increasing army of women workers in this country. Miss Proud must have consulted several works on factory and industrial legislation and economics, many factory inspectors' reports, works records, &c., and although there is a certain amount of repetition in her book, yet it is a remarkably good record of patient research work, and it forms a useful contribution to our sociological literature. Miss Proud is fortunate in making her literary debut at a time when, owing to the war and other causes, increasing attention is being given to the efficient administration of works, or what is sometimes termed "scientific management." Women have invaded many new industries; there are thousands of them engaged in engineering works and munition factories, where they have given satisfaction and where we think many of them will remain after the war. Though we do not agree with all the views of the authoress, yet we think that her book will prove helpful and suggestive to those who are interested in social welfare work.

The first part (Chapters I. to VI.), which occupies about 70 pages, gives a sketch of the history of industrial legislation in this country, and this is followed by an attempt to outline the scope of welfare work. The second part of the book is an elaborate plea by Miss Proud in favour of the creation of a new bureaucracy, euphemistically termed "Welfare Departments," which are to be run by "educated and highly trained women" (as welfare secretaries). In this country "welfare work" has no definite meaning at present; the term is used in widely differing senses; it is applied to social activities and various kinds of benevolent and charitable work.

In Miss Proud's view, "welfare work consists of voluntary efforts on the part of employers to improve within the existing industrial system the conditions of employment within their own factories." Therefore, she hopes to see the "welfare department" recognised as part of every large industrial undertaking. So far we are in agreement with Miss Proud, but we think that the lady is too ambitious, for, apparently, she is of opinion that the duties of the "welfare secretary" should include the arrangement of the time when holidays should be taken by workers, the duration of and conditions upon which holidays should be granted, "a satisfactory way of spending a holiday," &c. The welfare secretary must also have general supervision of works, canteens, baths, lavatories, medical and dental attendance, hours and wages, watch the returns of the work done by individual employees, and, if there are deficiencies, inquire into the physical or mental causes; she must see that breakdown is staved off by the provision of suitable rest half-hours or full holidays, she must inspect and pass all candidates for employment, and encourage the formation of works recreation clubs, games, lectures and dancing classes. Though she will not make the actual engagements, apparently, no engagements are to be made without her sanction, and Miss Proud is against undue preference being given to the relations of foremen and persons employed in the works, each individual being admitted on his or her own merits; and, apparently, it is her view that the welfare secretary can work better in this direction than departmental managers! Due regard must be had to psychological characteristics, and a welfare department might afford ample opportunity for physiological and psychological research, &c. We are surprised that Miss Proud should have placed any limits upon the activities of the welfare secretary. By going a little further, she would obtain complete control of the whole factory—employers and employed alike. We are not opposed to true welfare work, and we believe there is room for greater social activity, but we think the work can best be undertaken by committees of those immediately concerned—viz., the employers and employed. A joint committee of the managers and workers can direct and control welfare work more sympathetically and efficiently than outsiders who may know little of the actual working conditions. We yield to no one in our desire to improve the welfare of the worker, but we are not sure that the workers, and the employers too, would be better off if they were under Miss Proud's regime than they are at present. Properly organised welfare departments can confer great benefits upon the workers, but, apart from this aspect of the question, they can do much to obviate friction between capital and labour, for many disputes originate in trivial causes, and the departments could act as media of communication between the parties.

Sweden: Historical and Statistical Handbook. Edited by J. GUINCHARD. Second edition. (Stockholm: Government Printing Office.) Pp. xxvi.+781 and xi.+758.

This great handbook in the English language, prepared by order of the Swedish Government, deals exhaustively and authoritatively with the geography, the people and industries of Sweden. In its compilation the editor has been assisted by experts to the number of several hundred. The first part, in five sections, is devoted to land and people. Of the five sections, the first deals with physical geography, the second with the Swedish people, the third with constitution and administration, and in the remaining sections education and mental culture and social movements are dealt with. Many of these subjects are considered in elaborate detail.

The second part treats of the industries of Sweden. The 13 sections deal with natural resources, industries, rural husbandry, forestry, shooting and fishing, mining and metallurgical industry, manufacturing industries, commerce, shipping and navigation, internal communications, banking, credit and insurance, synopsis of trade and industrial legislation, and Sweden in foreign literature. A feature of the work is that each of the many articles comprising a section is written by an expert.

To attempt to review a book of this kind is impossible in the space at our disposal. It is sufficient to state that those having business relations with Sweden will do well to obtain the book, and to study carefully the sections in which they are interested. The study will be pleasurable as well as profitable.

The book is well-written, well-edited and well-translated, and the illustrations and printing are excellent.

Trade As a Science. By E. J. P. BENN. (London: Jarrold & Sons.) Pp. 184. 2s. 6d. net.

This handy, well-printed little book may be said to be a study of the politics of commerce. It is somewhat out of the ordinary run of books usually dealt with in these columns; it considers neither politics, as the word is ordinarily understood, nor Free Trade, nor the relations of Capital and Labour, nor many other questions that are usually discussed in connection with the dismal science of political economy. It also avoids directly, if not indirectly, the popular theme of the capture of German trade. Its main theme is the general organisation of business affairs, and the methods by which expansion can be attained by the individualistic capitalist, working socialistically in conjunction with his competitors and the State. A blind imitation of German methods is not suggested, though many changes are thought to be desirable in the direction of co-operative effort directed against the common foe. All agree that something has to be done: but it is well to bear in mind Lord Palmerston's dictum that when everybody agrees that something has got to be done, it generally means that somebody is going to do something very foolish. We commend the author's views to the reader. A Ministry of Commerce is held to be essential, and it should preferably be presided over by a Statesman rather than a business man, *i.e.*, by one whose function is the control of general principles, not having necessarily any very precise knowledge of the details of some single phase of commercialism. In conjunction with the Ministry of Commerce, but largely independent of it, in so far as action is concerned there should be trade associations, each representing some single phase of industry, and each undertaking varied activities within its own scope. These latter would include all work in connection with (1) export trade and its organisation and extension; (2) scientific research, if necessary for the nature of the trade; (3) commercial education; (4) statistics and finance; and (5) labour questions. It is hardly possible to go fully into the general scheme, which is admittedly a tentative proposal; but the book will repay study, as the author is no dry-as-dust pedant, no dogmatic preacher, and no armchair politician. The policy of *laissez-faire* is dead, but not buried: individualism seems to be yielding to an ordered form of socialism: competition gives way partially to co-operation. Yet the individualistic impulse remains and competition must be met, whether we will it or not. Altogether the book under review is a stimulating study of organised commercialism by one who has a broad grasp, and withal an intimate knowledge, of many of the details of business life. W. H. S.

NOTES ON PISTON AND SMALL-END LUBRICATION IN DIESEL ENGINES.*

BY G. B. VICKERS.

Lubricating troubles are best considered under two headings, namely, unsuitable lubricating oil and faulty design.

Lubricating Oils.—The lubricating oils should be carefully chosen. Pure mineral or hydrocarbon oils are undoubtedly the best. They contain a much smaller percentage of acid than animal or vegetable oils. The deposit from mineral oils is more easily rubbed off the bearing surface when the load comes on than animal or vegetable oil deposits. Many compound oils are good, but although they may be carefully blended originally, there is, after repeated use, sometimes evidence of disintegration, and they are liable to give a gummy deposit. It has been found by many engineers on Diesel installations that oils which are otherwise very suitable are the cause of considerable liner wear. The best test of lubricating oil is on the air compressor. If the oil causes pitting on the compressor valves and shows an acid scouring action on the valves in the air bottle heads, the main cylinder liner wear may be excessive. Regarding the amount which may be taken as average liner wear, figures taken from a number of engines give a mean wear of 0·010 in. to 0·012 in. per 1,000 hours run when the engine is heavily taxed. The lubrication requirements of the small ends and the pistons are contradictory. For pistons, an oil with a moderate viscosity of, say, 130 to 180 at 140 F. gives good results, whilst an oil with a good viscosity of, say, 400 to 500 at 140 F. is best for small end lubrication.

The lubricating oil used for pistons or small-ends should not emulsify, so that if any water drops in the crank pit, it can afterwards be separated. Most mineral oils are easily separated from the water. When a different oil is used for top-end lubrication than is used for the piston, care should be taken that the oils will blend. Some oils are impossible to compound. On average engines the quantity of lubricating oil used is kept as low as possible by using new oil on the small ends only and filtered oil on the other parts. The filtered oil has advantages, as after running and filtering the bituminous matter in the oil is eliminated. Filtered oil should not be used too often on the pistons, as its viscosity gets too low for this work.

The usual method of piston lubrication is through four or six stems or quills leading through the water jacket to the liner. The customary method has been to connect each of the quills by a common feed pipe, past a back-pressure valve to the single lubricating pump. Some engineers now insist on having a separate feed to each quill.

Many piston seizures have been caused by faulty arrangement of lubricating piping and leaky back-pressure valves. The lubricating pumps for piston lubrication are in the majority of cases driven from the cam-shaft and so are placed much higher than the quill line. The result is, after a short stoppage, the feed piping has been drained and unless there is wasteful flushing through, the piston does not receive any lubrication for a few minutes after starting. This difficulty has been overcome by curving the feed pipe so that it is unable fully to drain itself, or by fitting small valves which are shut off when the engine stops. A better plan is to have the lubricators fixed well below the lubricating belt line and worked off the indicator gear or the vertical shaft, thus ensuring that the pipes are always charged. The method of securing the quills is sometimes the cause of trouble. Some makers prepare a tapered hole in the liner, and the quill has a rounded nose and the quill is screwed home tight through a tapped hole in the water jacket. When the parts get warm and expand, these quills have been found to act as struts and have caused piston seizures immediately opposite to the lubricating holes. An improved method is to have the quill screwed into the liner, a plain hole in the water jacket and an external joint made. The telescopic quill is an improvement over either of the previous methods.

Top-End Lubrication.—Phosphor-bronze bearings are usually adopted for the top-end bearings. The pressures are too great for white-metal to be successful. The wear on phosphor-bronze bearings is seldom more than 0·001 in. per year, whilst white-metal bearings according to the quality may show more wear than this in one week. It is impossible to give a definite clearance allowable at top-ends. If white-metal is used, no clearance should be allowed; after running the engine light for a time, the bearings then run quite satisfactorily. When a phosphor-bronze split bush is used, the average clearance is 0·003 in. vertically and 0·006 in. at each side. If the bush is solid, more clearance is required, usually 0·006 in. to 0·008 in. vertically, and 0·008 in. at the sides. The gudgeon-pins should be fully case-hardened at the ends, as well as on the bearing surface.

Many of the methods adopted for lubricating the top-end bearings do not appeal to the British engineer. A good designer would only adopt them as a last extremity and then only with great diffidence. Taking first the scraper system. Two grooves are cut on the bearing surface of the piston, the top of the grooves entering the small circular groove usually turned on the piston below the lowest ring in the top nest, the grooves then take the form of a half-spiral gradually decreasing in width until they are opposite the ends of the gudgeon-pin. Holes are then led through the piston to the centre of the pin, the oil gathered in one groove leading to the large diameter end of the pin and the oil from second groove being led into the small diameter end of the gudgeon-pin. Two holes are led from the centre of the pin to the top bearing surface in the usual manner.

In the banjo system the oil is led into a banjo on the side of the crank and the centrifugal force causes the oil to flow into a small receiver having a steel ball and cage. At every revolution of the crank, the ball, having a small lift, is thrown up by its inertia and allows a small quantity of oil to pass up the pipe leading to the top end; as the ball falls on to its seating it acts as a retaining valve.

The third, and most general method of top-end lubrication is to have one or two slots in the piston which pass over the leads from the oil supply pipes and holes leading from the bottom of the slots through the piston to the centre hole in the gudgeon-pin. Several holes lead from this central hole in the pin to the bearing surface.

On medium and high speed engines, a complete service of forced lubrication solves the lubrication difficulties. Regarding the top-end lubrication, the practice of fitting a lubricating pipe leading from the bottom to the top end is to be deprecated. Any external pipes tend to come loose at the joints and get broken. It is much better to have the oil passage up the centre of the connecting rod. When a priming system of lubrication is not provided, a small ball valve fitted in a cage in the hole at the bottom end of the connecting rod acts as a retaining valve when the engine is shut down and prevents the oil from draining away from the top end.

Although the forced lubrication on all the bearings effectively solves the problem of top-end and piston lubrication, the system has disadvantages. Unless manufacturers have taken special precautions, it is probable that the piston will receive too much lubrication. The oil is thrown from the bottom end bearings on to the liner walls and when the piston is on its suction stroke, the slight pressure in the crank chamber tends to force the oil past the relaxed rings, the result being that the lubricating oil is burnt and very peaky indicator cards are obtained, showing a maximum pressure frequently 100 lb. to

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* Abstract of a Paper read before the Diesel Engine Users' Association.

150 lb. above compression pressure. The high consumption of lubricating oil has retarded the progress of the enclosed type of engine. The difficulties have been overcome first by guarding the bottom-end bearings to avoid splash on to liners; secondly, by preventing the oil from creeping from the top-end bearing along the gudgeon-pin keyway on to the piston surface; thirdly, by providing scraper-grooves on the piston with return ducts to the inside; fourthly, by dissipating the vapour in crank chamber, this vapour tending to get past the rings on suction stroke.

The common method of withdrawing the oil vapour in the crank chamber is to take the air compressor suction or the main cylinder suction from the chamber. It is found, however, that the vapour is most effectively withdrawn by a belt-driven extraction fan and the gases are led to a baffle box where they are condensed, thus recovering the oil which by other methods is burnt. The vapour is mainly caused by the oil being splashed on the inside of the piston crown, and if the crown has an oil guard fitted the vapour is considerably reduced.

CORRESPONDENCE.

PROFESSORS IN COMMERCIAL WORKS.

TO THE EDITORS OF THE ELECTRICIAN.

In his lecture on "Science and Industry," as reported in your issue of November 10th, Mr. J. Swinburne makes the statement that "no commercial works wants college professors loose in them attempting to keep up to date in practical matters." This is contrary to our experience here in America. The Westinghouse Electric Company has a teachers' summer school of five weeks' duration, specially designed to keep the teachers of electrical engineering in close touch with practice.

All the teachers of electrical engineering in the country are invited to make application for admission to this course, and the 30 chosen are assigned to the department in which they wish to gain experience, and are paid at the rate of £10 per month. The work of the course is as follows:—

On Monday, Wednesday and Friday mornings from 8 a.m. to 12 a.m. various parts of the factory are visited, and the points of interest in the design and construction of the machinery are brought out in a discussion, which is led by the engineers of the company.

On Tuesday and Thursday evenings from 7.30 p.m. to 10 p.m. meetings are held at the Westinghouse Club, at which engineering topics, such as the heating and ventilation of electrical machinery, or educational topics, such as the qualities found lacking in engineering graduates are discussed by the teachers and by the engineers and officials of the company.

On Monday evening the teachers themselves meet in conference and discuss teaching problems, such as the grading of reports, laboratory work, how to develop initiative in the students, &c.

Wednesday afternoon and Saturday morning are devoted to outside excursions to the rolling mills, glass works, power stations and other places of engineering interest in the vicinity of Pittsburg.

The remainder of the teacher's time, between the hours of 8 a.m. and 5 p.m., is devoted to the work of the department to which he has been assigned, and is generally spent on some problem of interest for the solution of which the regular engineering department has not been able to find the necessary time. The teacher also is at liberty to wander through the works to his heart's content, being given a pass to all departments.

The Westinghouse Company takes on a large number of engineering graduates each year, some of whom they retain, and others they pass on to the operating companies, and the officers of the company have felt that it was desirable to bring the teachers and the practising engineers more closely into contact, with the idea of improving the product of the universities. It is impossible to attend such a teachers' course without becoming quickened and inspired.

Cornell University, U.S.A., Nov. 23. ALEX. GRAY.

THE INSTITUTION WIRING RULES.

TO THE EDITORS OF THE ELECTRICIAN.

Although I felt that the new wiring rules issued by the I.E.E. were open to criticism, I hesitated to raise a discussion on this question, as I felt that I might be alone in my objection to them and to the way in which they were prepared. I see, however, that the Greenock Electrical Society has been dealing with this matter, and I should like to say a few words about it.

I do not propose to discuss the rules themselves, but wish to say that the Institution should have given at least one evening for a general discussion of them, instead of leaving the matter entirely in the hands of a committee.

I took the trouble to send some suggestions to the said committee, and received an official acknowledgment from the secretary, and there the matter ended.

The Institution has not given opportunities for a free expression of opinion by the members on this subject, and this tends to destroy their interest in the proceedings. A more democratic system of control would increase the activity of the members, and this is certainly to be desired.

Kingston-on-Thames, Dec. 11. F. PEAKE SEXTON.

A VISIT TO THE UNIVERSITIES OF LIVERPOOL AND MANCHESTER.

It will be recalled that in October last the Circle of Scientific, Technical and Trade Journalists was invited to form a party to visit the Universities of Leeds and Sheffield. A similar visit to Liverpool and Manchester, where the party were again the guests of the Universities, took place on December 10th to 13th. The object in view was to give an insight into the work now being carried on by the Universities and the utility of the work to the industries of this country.

UNIVERSITY OF LIVERPOOL.

On arrival at Liverpool the party were welcomed at the Adelphi Hotel by Prof. Gonner, the deputy-chairman of the Senate, who officiated in the absence of the Vice-Chancellor through indisposition, and the Registrar, Mr. Carey. On the following day Prof. Herdman received and addressed the party at the University, and expressed his appreciation of the need for closer co-operation between the universities and the technical press. Prof. Herdman referred to the national recognition of the value both of pure and applied science as exemplified by Lord Crewe's recent address to the deputation from the Board of Scientific Societies on December 1st. Liverpool differed in several respects from the great manufacturing cities of Leeds and Sheffield, being essentially a seaport town, with wide commercial interests. The University had, therefore, formed special departments to deal with modern languages and geography (the latter from the human and economic standpoints), both of which were most important in relation to commerce. Among other special sections of the University's activity were mentioned the School of Tropical Medicine, and the researches carried out in connection with sea fisheries. Although engineering was in a sense secondary, there were four departments—namely, naval, mechanical, electrical and civil. There were also four chairs in chemistry, and it was hoped that in due time there would be a department of industrial chemistry. The relations between the City and the University were most excellent, much hygienic and bacterial work being carried out at the University for the city authorities.

Dr. S. R. VASEY ("The Lancet") briefly replied for the visitors.

The party were then conducted over the engineering laboratories by Mr. J. Wemyss Anderson, where they were shown the plant for experiments in hydraulics, the transference of power by air pressure and the study of combined stresses on steel. Another experiment of interest was the study of the vibrations from reciprocating engines, the model engine being mounted on springs, so that any vibrations were readily seen. In one section of this department students were being trained in engineering work as R.F.C. mechanics.

In the electrical department, under Prof. W. E. Marchant, some experiments were in progress on the current-carrying power of buried bitumen cables, being part of the research on buried cables inaugurated by the Institution of Electrical Engineers, and on eddy current losses at very high frequencies. A considerable amount of work is also being done on magnet steels in connection with the Institution of Electrical Engineers and with the co-operation of Sir

Robert Hadfield, and the difficulties met with in the construction of magnets are being studied in detail, particularly in reference to the M.L. magnets.

Following this inspection, the visitors were entertained to lunch by the University, Mr. Alsop (chairman of the Liverpool Education Committee) presiding. Mr. Alsop gave a short address expressive of the City's interest in scientific and technical education, and Mr L. Gaster replied for the visitors.

The afternoon was devoted to visits to various other departments, including those dealing with geography, tropical medicine, zoology, bacteriology and organic chemistry. Also the well-known Muspratt Laboratory of physical chemistry, which is under the direction of Prof. W. C. McC. Lewis. Although time only permitted a short glance over each department, visitors were much struck by the variety of valuable work done. The researches of the School of Tropical Medicine, which is famous throughout Europe, being particularly interesting.

Finally, the visitors were entertained to tea at the University Club, Prof. Gonner and others of the professors being prseent. Mr. W. R. Cooper expressed the thanks of the visitors and their great interest in what they had seen, and Prof. Gonner added a few words. The party then took an evening train to Manchester.

Visit to Manchester University.

On Tuesday morning the party assembled at the University of Manchester, and were addressed by Sir Henry Miers, F.R.S. (the Vice-Chancellor), who with Prof. Harold Dixon, F.R.S., had been present to welcome the visitors at an informal reception held at the Midland Hotel on the previous evening.

Sir Henry Miers gave an address summarising the various aspects of the work of the University, and explaining how the University had originated from the Owens College, and how, later, with the colleges at Liverpool, Leeds and Sheffield, it formed part of the federal Victoria University. During recent years this federation was split up into the individual universities. Mr. L. Gaster responded for the visitors, who then proceeded to inspect the various departments.

The Librarian first conducted the party over the Christie Library, which originated through the gift of a collection by Mr. James Heywood in 1851, to which were added various other important bequests, including a gift by Mr. Christie, formerly Professor of History in the Owens College. The number of volumes now numbered over 146,000.

A short lecture was given by Prof. H. B. Dixon in the Chemical Department, who referred to his first connection with the department 40 years ago, when the influence of Bunsen was very strong through Roscoe. Bunsen had carried out some work on the explosion of gases, and had reached wrong conclusions. Prof. Dixon gave an interesting short account of his own work on this subject, showing that the velocity of the explosion wave is small at first, but becomes great and greater until finally a constant rate is obtained. This was shown by photographs obtained on rapidly moving films. This demonstration was followed by the exhibition of certain hand grenades. An experiment on picric acid demonstrated the comparative safety of this material unless a detonating ingredient such as lead oxide is added.

In the Schunck chemical library were to be seen three interesting exhibits—namely, a chair used by Dalton, a balance used by Davy, and a model ship built by Joule at the age of 14.

Passing through the chemical departments, the visitors then entered the medical school, where Prof. Elliot Smith gave an account of some of his work on "Shell-shock." In the engineering department the testing of materials was in progress.

In the physical section Prof. Sir Ernest Rutherford gave a short address on the work of the department, dealing especially with radium emanations. The subject has now become important practically, because radium in zinc sulphide is used as a luminous paint. In passing through these laboratories visitors were shown a very fine exhibition of the arc spectrum of iron, obtained from a Rowland grating. In the department of electro-chemistry we noticed a magnesia crucible which had been made in the laboratory—no small feat, considering that the melting point of magnesia is 2,800 C. It will be remembered that fused silica as an industry started in these laboratories. A visit to the Museum completed the morning's work, after which luncheon was taken at the invitation of the Lord Mayor, who in a short address expressed his belief in the future of industrial research. Sir Henry Miers also spoke, and Principal Garnett gave an account of the work at the Municipal School of Technology, to be visited in the afternoon.

The Municipal School of Technology

The extent of the work done at this institution, which forms part of the university, is so great and its nature so varied that the visitors could only pass very rapidly through a few representative departments. All were much impressed by the large area devoted to cotton spinning machinery, which, we understand, is now manufacturing various special materials for the Government. Another illustration of the "self-contained" nature of the work is provided by the fact that the programme handed to the party was printed on the premises, and on paper actually made at the School of Technology.

The electrical and engineering plant of the Municipal School of Technology has been described at different times, and is exceptionally complete, a feature being the number of relatively large units and the ease with which power can be supplied to any part of the building. A large extension is in contemplation, but is in abeyance during the war.

In the rubber laboratory we noticed an interesting new insulating material obtained by chlorinating a solution of rubber in carbon tetrachloride. The resulting compound contains 60 per cent. of chlorine and is plastic under heat.

Other departments visited included the laboratories of organic chemistry, dyes, electro-metallurgy, photography, &c. Interesting researches are being conducted on the standardisation of rubber and the high-tension testing of insulating materials. There are also many special experiments being undertaken for various Government Departments, to which reference cannot be made.

Tea was served in the School of Technology, during which Mr. Gaster expressed the thanks of the visitors to the college authorities and the Vice-Principal briefly replied.

In the evening the party was entertained to dinner by the Vice-Chancellor at Owens College. The toast of the guests was proposed by Coun. Simpson and responded to by Mr. Leon Gaster and Mr. W. R. Cooper. A vote of thanks on behalf of the visitors was proposed by Mr. H. R. Kempe. The Vice-Chancellor replied, and was followed by Prof. H. B. Dixon, Mr. J. C. M. Garnett (Principal of the School of Technology) and Sir Ernest Rutherford. The dinner was followed by a short concert, given by some of the students of the Academy of Music, whose rendering of the items was much appreciated.

All the members of the party were greatly impressed by the work, and facilities for work, which was evident at both Liverpool and Manchester. Not only was a great deal of work being done of a war character, but also work of direct interest to the local industries. At present the students are necessarily few and the staffs are depleted. At Liverpool Prof. Baly and at Manchester Prof. Dixon have been appointed Deputy Inspectors of High Explosives for certain areas, and many other members of the staffs are working for the Government in one capacity or another.

On Wednesday morning a visit was paid to the works of the British Westinghouse Electric & Mfg. Co. at Trafford Park. It is impossible to do justice to the variety of work being done, but the switchgear department and the assembling and testing of large transformers and generators were of special interest. Among the researches being conducted were noted a series of tests on the permeability of steels and on the period of break of switches. A section of the works is also given up to the making of shells of various calibres, some of the lathes for the purpose having been specially built and designed by the company since the outbreak of war.

At the conclusion of the visit a short address was given by Mr. A. P. M. Fleming on the education and training of employés. Courses of lectures are given during works hours, as it is recognised that apprentices are rarely able to study effectively at night after a hard day's work in the shops.

The concluding item of the trip was a visit to the Ford Motor Co.'s works, where visitors were much impressed by the highly ingenious method of assembling the cars, which are built up on an endless chain, so that the work comes to the operator, instead of his having to move after the work. In this way each operator becomes a specialist, and every element in the car is tested in its course through the shop. All the details are fed to the moving chain at the point where they are needed, and the erection of each car takes place with remarkable speed.

A short address was also given on the Welfare Work of the firm, which is an important feature of their method of work.

Hydro-Electric Power in Spain.—It appears that there are now 50 hydro-electric plants with an available horse-power of over one million, working in Spain. It is estimated, however, that it is practicable to produce from water-power quite 6,000,000 H.P., of which over one million could be derived from the river Ebro and its affluents. Capital for such developments has in the past been provided mainly by France and Great Britain. It is to be hoped that the interest of these countries in the matter will not be lost owing to the vast expenditure of capital during the war.

ENGINEERING INDUSTRIES AFTER THE WAR.

A meeting of representatives of the Scottish iron, steel, engineering, shipbuilding and allied industries was held in Glasgow in August last, when a "preliminary" Committee was appointed to consider and report upon certain questions. This Committee has now issued its report, in which it is said that the following general points are of outstanding importance in considering the question before them :—

1. (*a*) It is assumed that the Government will take a more active part in the future in encouraging, by every means in its power, the development of the industries of this country.

(*b*) After consideration of the various aspects of the probable post-war conditions, the Committee is of opinion that the factor that will have the greatest effect on the prosperity of the country in general, and the industries in which we are interested in particular, and that will overshadow all other factors, is the question of increased production. Unless the capacity of efficiently equipped industrial concerns is utilised to the fullest extent, and the largest available output is attained, all other measures of assistance or regulation will be of secondary value in attaining the expansion and prosperity of our industries and the comfort and well-being of those employed in them.

(*c*) Increased productivity can only be attained by a more cordial co-operation between employers and employees than has existed in the past; by efficient equipment and organisation on the one hand, and, on the other, by the abolition of all restrictions and practices limiting output.

The existing policy of limiting output, and of refusing in many cases any system of payment by results so that employment may last longer or that more men may be employed, is agreed to be economically unsound and inimical to the best interests of the Empire.

(*d*) In order to secure the foregoing, it is essential that in the remuneration of employees some form of payment by results should be adopted wherever possible, with basis rates, compatible with the productive effect of labour, fixed on such a scale as will ensure for all willing workers a good and comfortable standard of living. Once these basis rates have been equitably fixed and established, an increase in earnings, due to increased results, should be encouraged in every way; and workmen should have the security given them, that any enhancement of their earnings following increased production, will not be made a ground for rate-cutting, as the whole success of the system must inevitably rest upon mutual confidence.

(*e*) In view of the foregoing considerations, any organisation which may be instituted should be prepared to co-operate with labour, as without such co-operation and assistance the desired result will be difficult of attainment.

(*f*) An increased supply produced under the improved conditions outlined above may be confidently expected to create a correspondingly increased demand, and that quite apart from the increased demand which it is widely anticipated will arise after the war. At the same time, attention and efforts must be directed to maintaining and extending existing markets and securing additional markets.

2. Supplementing these general considerations the following is an indication, not necessarily exhaustive, of the objects that any organisation which may be instituted should have in view, viz. :—

(*a*) To direct the attention of the Government and its Departments, for their information and guidance, to matters requiring consideration and action in the interests of the industries concerned, and to initiate and review legislative proposals on commercial, industrial and economic matters.

(*b*) To deal with questions affecting the labour conditions and internal organisation and disabilities of the industries concerned, with a view to securing increased efficiency from an Imperial and national point of view.

(*c*) To educate and inform public opinion in accordance with its recommendations and findings.

3. As examples of the questions under these headings which might have to be dealt with, the following have been mentioned, but it is to be clearly understood that the preliminary Committee express no opinion on the merits of any particular point. The examples are only given as illustrating in a general way the questions which might arise for consideration, viz. :—

(*a*) Consideration of all conditions affecting trade and industry proposed to be embodied in the terms of peace, or in any treaty.

(*b*) The effect on industry of regulation of imports and exports by means of tariffs, subsidies or prohibitions.

(*c*) The effect of existing banking methods on industrial enterprise.

(*d*) The question of facilities and rates for transport by rail, road, or water.

(*e*) The safeguarding of existing and the securing of additional markets.

(*f*) The establishment of efficient consular services in relation to foreign trade.

(*g*) Questions relating to sickness and unemployment, insurance and pensions.

(*h*) Means of giving workpeople a continuing interest in the prosperity of the industry in which they are employed.

(*i*) Remuneration of workpeople according to output by piecework, premium bonus, or other system of remuneration, and the grading of labour according to skill and ability.

(*k*) Rates of wages, working hours and demarcation of work between skilled and unskilled workpeople, between men and women, and between different skilled trades.

(*l*) To consider present promiscuous methods and times of making general advances or reductions of wages.

(*m*) The apprenticeship question—how affected by the experiences of the war, and from all points of view.

(*n*) Questions affecting the employment of women workers.

(*o*) Social amenities of workshops, and the well-being of young people engaged in industries.

(*p*) The effect on the industrial efficiency of the country of existing or pre-war restrictions of freedom of management and control.

(*q*) The provision of machinery for avoiding strikes and lock-outs, and for settling questions which arise between employers and employed.

(*r*) The review of the procedure of employers' associations, trade unions or other combinations of employers, or workpeople where such tends to interfere with the liberty of the subject without national benefit.

(*s*) Questions of scientific and technical education.

(*t*) Industrial research and experimental investigation.

(*u*) Whether it is desirable in view of the grave disadvantages which have arisen in the past from the failure of individual employers and individual workmen to carry out agreements made on their behalf by their accredited representatives, that some method of making the associations of employers and employees responsible for their members should be adopted.

4. The questions to be dealt with fall into two divisions :—

(*a*) Such questions affecting labour as are best dealt with directly between specific classes of employers and their employees.

(*b*) Questions in which labour is only indirectly interested and which can be dealt with separately by employers.

5. Questions which fall under the first category have in the past been dealt with between employers' associations and trade unions with a fair measure of success. In view of the undesirability of multiplying organisations, and of the value of the existing staffs with their experience, knowledge and records, it appears most natural and practicable to take advantage of existing organisations and improve and extend them to deal with such questions.

With this object, existing employers' organisations should include all employers engaged in the industry and within the district.

Where, in any district or industry, no association exists an association should be formed.

6. As regards questions which fall under the second category, it is considered that employers who belong to associations with constitutions which enable them to deal with such questions are (subject to the proposal dealt with later) already provided for. In other cases either the existing associations should extend their constitutions to cover such questions or employers should join some existing association (for which they are eligible) which covers the ground, or, as an alternative only to be adopted in the last resort, a new association should be formed with an appropriate constitution. In the foregoing arrangement it is felt that associations should neither as regards the industries or areas covered be so large as to be unwieldy nor so small as to be parochial.

7. In order to co-ordinate the activities of the various organisations, to obtain due recognition of properly constituted employers' and employees' associations, to confirm in or endorse voluntary agreements between employers and employees, and, where desirable, to give legal effect to the recommendations of these associations, it is considered that some central organisation is necessary which should have Governmental recognition to give it weight and authority.

8. It is suggested that the central organisation should take the form of a National Advisory Council of Industry consisting of two bodies, viz., representatives of employers and representatives of employees, who would meet either separately or together, as the nature of the questions to be considered might require—the joint meeting being always (and the meetings of the separate bodies as required) presided over by the Minister of Industry mentioned hereafter. The employers' representatives should be elected by the various employers' organisations, in number and proportions to be determined, with possibly additional employers' representatives nominated directly by the Government. The employers' representation should be similarly determined. Government departments might also be represented at the joint or separate meetings, or might, if thought desirable, constitute a separate body available for joint meetings. This Governmental representation would safeguard the interests of the State and the community as against the personal interests of the employers and the employees.

9. In actual practice it might be found desirable that the National Advisory Council should be chosen from amongst local councils formed for large industrial areas; for example, Scotland could form one such area. As some industries are federated over the whole country, and others are only associated locally, this point requires careful consideration. In any case, it appears desirable that local associations should federate with other associations in the same industry for certain purposes at least, over as large an area as possible.

10. It is suggested that a Minister of Industry should be appointed, and in this connection the appointment of an individual retaining a connection with either the employers' or the employees' side of industry is undesirable, as is the appointment of an individual having only a political or a legal qualification. It is suggested that while a Minister of Industry should not be a permanent official, neither should his appointment nor retiral be dependent on a change of Government. Such a Minister would form the connecting link between the Government and the central organisation described in the eighth paragraph.

The Preliminary Committee also suggests that a Temporary Committee be appointed, representative of the industries concerned in Scotland, to take steps to put into practical effect the general principles enunciated.

LEGAL INTELLIGENCE.

British Thomson-Houston Co. v. Duram (Ltd.)

The hearing of this patent action was continued during the week.

Mr. JAMES SWINBURNE said he had made himself acquainted with the specifications in the case. Tungsten was an element, but he had never heard that it was found in the form of tungsten in nature. It was combined with oxygen or sulphur. It had come into large use of recent years in connection with the manufacture of filaments for incandescent electric lighting. The carbon filament held the field from about 1879 to about 1900. Then Dr. Welsbach made osmium filaments. The next lamp was the Nernst, and then came Just and Hannaman. The metal there was tungsten: it was squirted with an organic binder, and the carbon resulting from the organic binder was removed. Witness described certain experiments of his own in connection with the Nernst lamp in 1900 or 1901 when he was making heaters for the lamps. In regard to Siemens' German specification of 1902, that dealt with tantalum, niobium and vanadium. Any knowledge about those metals would tell them nothing as regards the working of tungsten. The same applied to the Abel specification of 1902. The specification of the British Thomson-Houston Co. of 1906 stated that "the metal tungsten has been proposed as suitable material for the manufacture of incandescent lamp filaments and other conductors operating at high temperatures, but difficulty has been encountered in drawing or rolling filaments from tungsten because of its non-ductile character as ordinarily obtained." He had not seen any publication which referred at all to the ductility of tungsten. "We have discovered that when tungsten is heated it undergoes remarkable molecular changes, and, in fact, becomes so ductile that it may be easily worked when hot." Working on iron meant really hammering, sweating and drawing. "The metal becomes so ductile that it may be hammered into bars, rolled into sheets or drawn through dies into wire." The process was described in the specification, and he had seen the process actually carried out. There was no information that he could obtain tungsten which would be ductile by the process before the date of that patent. It was an important process for lamp filaments, and was practically replacing all the others, and the metal was also coming into use for other purposes, such as making electric spark contacts. He had not found in any of the earlier documents pleaded in the case instructions which would enable him to know how to work tungsten.

Witness was cross-examined by Mr. Terrell as to increasing the malleability, and as to the ductibility of certain metals. Built-up tungsten filaments first got on the market about 1907 and the drawn wire filament much later. Asked to account for the fact that the filament was not on the market between 1906 and 1911-12, witness said the period (five years) was not out of the way for developing a process like that into a commercial one. It was not that one had to draw the wire and make a new lamp to compete with gas or something of that sort; one had to compete with an existing lamp, and one could not get it into commercial use till it was better than the existing lamp. In his (witness's) opinion ductibility involved malleability plus tensile strength. That specification did not talk of malleability.

When you heat metal and start hammering it, there is no more ductibility in the metal than there was before you began in the sense of differentiating it from malleability?—I think there is; I think the hammering generates ductility. Mr. Swinburne also said that in his opinion the word "ductility" was used loosely to mean workable.

Prof. C. VERNON BOYS, F.R.S., said he had read and considered the specification of plaintiffs, and took part in certain experiments with reference to the subject matter of the patent. The information on the subject of tungsten at September, 1906 (the date of plaintiffs' patent) consisted of Moissan's experiments; the tungsten powder, which was well known at that time; and possibly the squirted filaments of tungsten, but he was not sure that they were on the market then. It was possible to repeat the experiments of Moissan, and to get that result. As to the filaments, they were a finished product, and owing to its brittleness and hardness he would never think of drawing it. He did not know of any tungsten which could be put into the form of rods. They could gather nothing about tungsten from other metals; the Siemens' specification told them nothing in words and nothing by inference.

His LORDSHIP: Suppose you take a fritted tungsten rod, and expose it to further prolonged heating, do you increase its malleability apart from any subsequent working or heating?—I think that is the case; the greater the temperature and the greater the length of time you maintain it, the more coherent and compact the metal becomes.

Mr. KERLY, K.C., asked what directions the plaintiffs' specification gave for working tungsten for other purposes than wire drawing, and witness said they would roll it into sheets, not necessarily as a preliminary to wire drawing. It said it might be hammered into bars, but the patentee did not give directions. He had never hammered it into bars; he believed he could hammer it by doing it very carefully, but he thought rolling was much better and quicker.

In September, 1906, was there a difficulty in producing a built up tungsten rod?—I do not know. I do not know of its being done, but if it had been tried it would have succeeded.

As to the patent in question, at what stage in the process of rolling or drawing do you say the thing becomes ductile?—It may be that it is ductile before you roll it at all. I have not tried that, but as ductility requires a greater degree of strength and coherence than mere malleability, and you roll before you can draw, the process may be a gradual one.

On Thursday last Mr. SWINBURNE was re-examined. In reply to Mr. WALTER, K.C., who asked what the common treatment of metals to be drawn into wire was at the date of plaintiffs' specification, witness said the common treatment was to roll them hot till one got rods of convenient size to draw, and then to draw them cold. They never drew wire direct from an ingot. As regarded the ordinary metals that had been treated by rolling, drawing and things of that kind, they had all been melted or substantially melted, and then they were practically solid and all got into a final density. From all the literature he knew until the instructions that were contained in that specification he did not know of any coherent form of tungsten. In the treatment of the powder which has been carried up to a thousand degrees in the manner indicated in the specification it produced a different physical condition in the rod. A reduction of the dimensions of the body took place—that was to say, it got smaller and the particles came together, so that they appeared to be quite solid. He did not know of any method by which tungsten could be obtained in a molten form so that it could be formed into rods. In modern days all the metals used had been melted first. Such experiments could not have been carried out with tungsten up to the date of that specification; you could not get tungsten, to start with, into the regular condition. The prior specifications relied on by defendants dealing with the treatment of other metals, afforded no instruction as to the treatment of tungsten.

His LORDSHIP: Having read plaintiffs' specification from a scientific point of view, either as metallurgist or chemist, do you understand that it is ever intended to refer to molten or melted tungsten at all?—I read it as if the writer had no idea of molten tungsten in his head in writing the specification.

Does it convey to you as a metallurgist that he is disclosing a method for dealing with a molten tungsten?—No; it conveys this idea, that you can take a powder and make it into a sufficiently coherent and solid form for working.

Dr. PASSMORE said he gathered from plaintiffs' specification that the invention was essentially to make drawn wires of tungsten, but that the coherent product obtained was also capable of being hammered hot, and, in order to check that, the first experiment he made was to satisfy himself that the coherent product, as described in the specification, was heated to a red heat and only oxidised to the extent of blueing on the surface. That was to him, as a chemist, the most remarkable statement of the whole specification. He found that was true, and that was a great novelty to him as a chemist, because with the tungsten that he had hitherto—and he had had a great many samples of tungsten—immediately on heating, long before red heat, it oxidised absolutely throughout, became red hot; in fact, the first specimen of tungsten had even oxidised at the warmth of the hand. When he read the statement that tungsten could be heated to a red heat and still only blue upon the surface, like steel, that was the first thing that struck him as a chemist. Having satisfied himself on that, then he tried the effect of hammering. He took a sheet of thin plate iron, put it upon a sheet of asbestos so as to make a non-conducting bed or anvil, and put a piece of coherent tungsten rod upon it. He turned a blowpipe flame upon it until it was red hot, and then he took a hammer and flattened it out. He obtained some of the material which was actually used for the manufacture of filaments. He tried to work tantalum by the process indicated for working tungsten, except that he did not perform the first stage, make the tantalum by reduction of the oxide. He took the tantalum metal given him as a powder, then he mixed it with an agglutinant, shaped it into a rod and heated it to 1,000 deg. or thereabouts, and then he hung it up to try and pass an electric current through it, but he failed to do it. Then he tried to shape it without an agglutinant, and he made a rod in that way with the same result—that he could not pass a current through, the reason being (he believed) that the metal contained some oxide. Taking the material described in Moissan's Paper, he should expect a porous material as described. "Porous" was an apt description, as there would be more or less a bubbling mass. If we heated the porous material in the air it would be oxidised, and it would fall to powder. He was present at the carrying out of the actual manufacture, and he also made some wire himself.

Cross-examined, he said he had given evidence in the "Z" lamp case and another, and he was familiar with the manufacture of tungsten filaments since 1910 or 1911. As far as he recollected, the Welsbach process was for obtaining filaments, not rods, except that the removal of the carbon in the Welsbach process was effected by chemical means. He agreed that when one had once got the Welsbach invention for osmium one could get squirted filaments of any of the metals mentioned (molybdenum, osmium, tungsten), assuming there were no chemical difficulties owing to differences in the metals. From a chemical point of view, the great difference between osmium and tungsten and molybdenum was with reference to their chemical properties. One could not predict because this process worked with osmium that therefore it would work with tungsten or molybdenum. The chemical processes involved in the baking of a rod and of a filament were the same, but there might be mechanical differences. The specification only stated in general terms what was perfectly well known—that pure tungsten was produced by reduction of the oxide with carbon or with hydrogen; one must use pure tungsten oxide if one were going to obtain pure metal. One expected tungsten which might contain traces of carbon and oxide of tungsten. The witness was cross-examined on the construction of the specification, and after re-examination by Mr. Walter plaintiffs' case was closed.

Mr. WALTER said that was as far as it was necessary to carry the case on the issue, subject to any questions that might arise hereafter. He wanted to put in the admission by defendants that, for the purposes of the action, "they in the course of their manufacture of tungsten can subject the metal in a coherent form to the action of heat while it is being operated upon or manipulated."

On Friday Mr. T. Terrell, K.C., opened defendants' case, and said the fair reading of the evidence was that there had never been made a tungsten rod of anything like $\frac{3}{16}$ in. diameter.

His Lordship said he was not prepared on the evidence to say that making that was not an invented novelty.

Mr. Terrell said they presented their case on the footing that the patentees only put into practice a discovery, which discovery it was the business of the ordinary metallurgist to make in connection with either a new alloy or a new metal. That being so, and there being no difficulty and no suggested invention in carrying it into operation, there being no special apparatus necessary to do it, the only invention could be the bare application of the discovery that was alleged to be made. That discovery was the business of the ordinary metallurgist, and was not invention. The evidence of Mr. Swinburne established that, given a chunk of tungsten, a metallurgical engineer, being told to investigate its properties, would as a matter of ordinary business try it cold and try it hot to find out its properties. He might be deceived about the tungsten but he would find out as part of his business that it was malleable hot. There was no subject matter in the patent, because a so-called discovery could not be subject matter, and there was no invention or pretended invention in the application of a discovery. All that was said to flow from the discovery was that which flowed admittedly from the same fact with other metals.

On Monday Mr Ballantyne gave evidence for defendants. He said before the making of the tungsten filament lamp he was not aware of any use for tungsten except in the form of powder. Of recent years other uses for metallic tungsten than making wire for globular bodies had come into notice. Tungsten was a fusible metal, and in many cases was used as a substitute for platinum. In 1904 the tungsten wire built-up filament was known to be a success. Squirted filaments were made under a Just and Hanaman patent of 1901 and succeeding patents. He had a little difficulty at first in understanding what the point of the inventor was in the specification in this present action. At first he understood it was to get ductility by a process of heating, but he gathered afterwards that it was the working of a metal by melting. Asked what material he understood to be referred to, he said he understood it to be tungsten, which was started in the form of powder and was converted into a coherent. He could not say as an actual fact that melted tungsten was on the market, but he believed it had been used on the market in a form suitable for making filaments. He had tested the slugs which were made according to the patentees' process, and found in one test a density of 16·7 and in the second of 16·0.

The hearing had not been concluded when we went to press.

Nordman v. Rayner & Sturges.

Judgment in this action, which raised the question of the effect of internment on a contract, was recently given by Mr. Justice McCardie. Plaintiff sought to recover damages for alleged breach of a contract to pay commission. It appeared that in July, 1914, a contract was entered into between plaintiff and defendants by which plaintiff became London agent for certain parts of defendants' shipping business and was to receive an agreed commission. The contract was to be for 12 months and if not then terminated in the way provided it was to run for five years certain from the end of the preliminary period. The contract was made just before the outbreak of the war. Plaintiff was born in Germany, his wife was a German, and he was registered here as an alien enemy; in September, 1914, he was interned. As he was an Alsatian, of French extraction, with anti-German views he was released in October, 1914. It was contended for defendants that the mere fact that war had broken out dissolved the contract, but the Judge said he could not accept that contention. Both plaintiff and defendants were resident in this country, the contract was to be fulfilled here, and plaintiff remained within the jurisdiction throughout and was entitled to the protection of British law. Then it was contended that even if the outbreak of war did not destroy the contract, yet the contract was at an end because the personality of plaintiff would make it impossible for him to carry out his part. But the contract was one for several years, and any interference with it likely to be caused by the outbreak of war was not, in his opinion, enough to destroy the basis of the contract. Finally it was argued that plaintiff had lost his rights under the contract owing to the internment, but internment was not due to any moral default of plaintiff and could not be held to have operated to destroy his civil rights, and in such a contract as that internment for a period of one month was not, in his opinion, sufficient to cause a substantial frustration of the business engagement. Authorities showed that the interruption of business must be serious before the contract failed. His Lordship, who referred to the analogy of the effect of sickness in master and servant cases, held that the contract was still valid and subsisting. There had not been any rescission of the contract by mutual consent, and there had been wrongful repudiation by defendants. He accordingly gave judgment for plaintiff, assessing the damages on the principle of Faulkner *v.* Cooper.

A. P. Lundberg & Sons v. Witting & Partners.

Last week a Divisional Court (Justices Ridley and Avory) heard an appeal by defendants against a decision of the judge at the Clerkenwell County Court in respect of a disputed contract for 180,000 mild steel grub screws.

Mr. Fortescue (for appellants) said the appeal arose out of an action respecting an order for 180,000 screws $\frac{1}{2}$ in. long, $\frac{1}{4}$ in. Whitworth thread, to be delivered by plaintiffs to defendants, at the rate of 22,000 weekly. The action was brought to recover £42. 5s., the price of certain of the screws. In the court below the defence was that the screws were not in accordance with the contract, and defendants contended that they were entitled to regard them as worthless. There was a counterclaim for loss of profits and costs of stacking up machinery. The judge found that there was a breach of contract, and that the screws were not in accordance with the sample. But he held that in the circumstances the people to whom the screws were to be delivered did not reject them within a reasonable time, and, therefore, they must pay the full purchase price of the screws. He also dismissed the counterclaim.

Mr. Palmer (for respondents) argued in favour of the judge's finding.

The Court allowed the appeal, with costs, and ordered a new trial. There was no doubt the screws were to be made to a certain pattern, and that they were not according to that pattern. The Court said the learned judge was right in his first finding, but was not correct in the second.

H. K. Frood v. Lanarkshire Tramways Co.

At Hamilton last week Sheriff Shennan delivered judgment in this action for damages arising out of pursuer's motor car colliding with an unlit tramway pole in the centre of a street in Motherwell.

In his judgment, the Sheriff stated that the poles were in the centre of of the roadway by the authority of Parliament. They were no more a legal obstruction than were the houses in the street or the kerbs in the footway, and defenders had no duty to the public imposed on them to give warning of the existence of the poles. As to the pursuer's further contention that it was the duty of the defenders to take special measures to obviate difficulties under the lighting restrictions by painting the poles white, his Lordship stated that that also was negatived. Defenders' argument was conclusive that the pursuer, being one of the public, had no title to found on clause 13 of defenders' Order of 1903 an obligation to light all centre poles in the street in which the accident occurred. That clause was described as containing certain provisions for the protection of the Provost, Magistrates and Councillors of the burgh of Motherwell. Being in a private Act, it embodied a contract between the two parties to it, and no one else could enforce that contract. On the question of deficient lighting the lighting authority was responsible—viz., the burgh authorities. Therefore, he found that pursuer's averments were irrelevant, and insufficient to support the conclusions of the writ, and dismissed the action, with expenses.

Re Edison Swan Electric Co. (Ltd.)—On Tuesday Mr. Justice Neville granted the petition of the company for sanction to special resolutions altering the objects of the company.

Mr. Jenkins, K.C. (for the petitioners), said that his clients had very large and complete plant and they desired to extend their powers by entering into arrangements with the Government and municipal and other authorities, and doing any engineering work that was submitted to them. They also desired powers to acquire patents for inventions relating to mechanical engineering, chemical engineering, chemistry, and anything of a like character in addition to their electrical patents.

EDUCATIONAL.

City and Guilds of London Institute.—The report on the work of the department for the 1915-16 session has been issued.

The work of the technology department is stated to have been carried on with some difficulty during the past year. Half of the office staff has joined the Army, and Mr. Killby (secretary to the Technology Committee) is serving in the Army in France. The number of classes registered in technological subjects was 3,961, against 4,995 in 1914-15 and 5,049 in 1913-14; the number of students in attendance was 35,203 (55,996 and 47,050); the number of candidates presented for examination was 8,508 (23,119 and 15,623); and the number of passes was 5,239 (14,570 and 9,866) respectively. Many students after commencing their studies were unable to continue their full time. Recognition is due to the authorities and teachers of technical schools for the successful efforts which they have made to carry on the work of their classes uninterruptedly, notwithstanding the absence of members of their staffs on active service, and many other difficulties due to the war. Valuable help has been given to the Ministry of Munitions by the technical schools in general, either by directly manufacturing articles and gauges for munitions of war or by undertaking special work and training men in it.

Examinations.—In spite of war conditions, the examinations were conducted throughout the country. For the first time in its history the examinations of the Institute were this year held on foreign soil, 12 candidates being examined in telegraphy and three in telephony at Havre, under the supervision of Capt. G. T. W. Olver, R.E., O.C. Signals. It is also worthy of note that a candidate in telegraphy was examined on board H.M.S. "Queen Mary," under the supervision of the late Lieut.-Commander R. L. Clayton, who lost his life subsequently in the naval battle of May 31. The candidate himself had been invalided home before the action took place. The number of subjects in which examinations were held was one less than last year; further, the proportion of subjects in which one or other grade of examination was not held owing to the small number of entries was larger than usual. In all of the chief industries—textiles, engineering, whether mechanical, electrical or structural, telegraphy and telephony, carpentry and joinery, plumbers' work, &c.—there was almost without exception a more or less uniform in decrease the number of candidates. The number of candidates in the United Kingdom for grades I. and II. was 51·6 per cent., but for the final examinations only 43 per cent. of those for the same examinations in 1915. The percentage decrease in the number of older candidates was thus, as might have been expected, greater than in the case of those entering for the lower grades, and the total number of final candidates was but little over 14 per cent. of those entering for all grades. The percentage of successful candidates was 61·5, against 63·2 in 1915. In many individual subjects and grades the numbers examined were so small that no general conclusions can be drawn from the percentage results. Although not uniformly the case, it may be said that the falling off in the quality of the work done has been more marked in the grade 1. than in the final papers. It would appear that there has been more difficulty in maintaining under present conditions the regular attendances and habits of study of the younger than of the older students. In one or two subjects the examiners' reports state that there is evidence of some disorganisation of the teaching. The percentage reduction in the numbers of candidates is greater in Scotland than in England and Wales, and in the numbers both of students and of candidates is least marked in Ireland. The centre that presented the largest number of candidates—238 in all, of whom 163 were successful—was the Municipal School of Technology, Manchester. It is followed closely by the Municipal Technical Schools of Bolton and Birmingham with 229 (142 successful) and 228 (130 successful) candidates respectively. From the whole of the schools under the authority of the London County Council, the total number of candidates presented was 232, of whom 172 were successful.

During the past session the institute has again held its examination in India and the Overseas Dominions—New Zealand, South Africa and Malta having each contributed their contingent of candidates. The examinations were held at two new centres in India—at Cawnpore and at the Amar Singh Technical Institute at Srinagar, in Kashmir. Candidates from the Victoria Jubilee Technical Institute, Bombay, were successful in winning three medals. Owing to the greater number of candidates at Bombay and in New Zealand, the total number in India and the Overseas Dominions increased from 634 to 724.

For the special examination in magnetism and electricity, which the Institute holds by arrangement with the Postmaster-General, only 385 candidates presented themselves, against 664 last year. Seventy candidates passed in the first class and 113 in the second class. In four cases the candidates were successful in obtaining over 95 per cent. of the full marks.

With the inclusion of the candidates from India and other parts of the British Empire, the candidates for teachers' certificates, and also those for the special examinations in magnetism and electricity and in cookery the total number examined by the department in the session 1915-16 was 10,184, compared with 18,327 in the preceding session.

Some suggestions and criticisms having been made in regard to the syllabus in electric wiremen's work, a conference was arranged between Mr. W. R. Rawlings and Mr. W. Ellerd Styles, representing the Electrical Contractors' Association, and Prof. T. Mather, F.R.S., and Mr. Hawkins, representing the Institute, as the outcome of which a revised syllabus under the modified title of "Electrical Installation Work" has been adopted and now appears in the programme for the next session.

The programme for the session 1916-1917 was issued through Mr. John Murray in July last. It contains syllabuses and regulations with respect to the Institute's examinations and the registration of classes, a list of teachers registered by the Institute as qualified teachers in technology and the prizes and medals offered on the results of the examinations by the Livery Companies, the Institute, and other bodies. No new subjects of examinations have been included.

In view of the shortage of paper and the requirement that all forms of expenditure should as far as possible be curtailed, the questions set at the examinations of 1916 are not reprinted as an appendix to the report, and for the same reasons the publication in extenso of extracts from the examiners' reports on the examinations in individual subjects has been suspended. The importance of clear sketches of apparatus or machine details, whether the subject be coal-tar distillation, electro-metallurgy, iron and steel shipbuilders' work or calico and linen printing, needs to be emphasised, and continual exercises in freehand sketching or scale drawing, according to the circumstances of the case, should be insisted upon by teachers; facility in this art will prove of quite as much value to the student as a means of saving time in his future practical work as in the examination room. The verification of answers by common-sense methods should also be inculcated. "It may be doubted (says the report) whether even now the nation in general is alive to the full importance which the technical instruction of its artisans will have in the near future when it is to be hoped that war conditions will have passed away. Much has been said and written by way of forecast of the keen industrial struggle that will begin upon the conclusion of war, and at the present time in certain trades there are signs of an awakening of greater interest on the part of masters and trade bodies in the training of their apprentices. A vague opinion that all is not well with the technical training of our working population is no doubt widely held, but much more is necessary, and the time for mere discussion of the problem is past. Speaking generally, employers must change their attitude towards technical training, so that those who foster the education of their younger employés should become the great majority instead of the minority, and so that attendance at continuation schools and day schools, or if this be too much to expect, at least at evening technical classes, should become the rule. Nothing short of a strong national movement in this direction can prove adequate to meet the requirements of the case. What has been said above is sufficient to show that there is need for reform in the primary school, in the secondary school, in the technical school and in the university, not with a view to turning men into machines, but to provide them with the raw material of knowledge, which they need for intellectual development."

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mawburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

14,111 Zoelly. Electromagnetic power-transmission gearing. (6/10/14.)

14,742 Marr. Telephone exchange and like plugs. (19/4/16.)

15,448 B.T.-H. Co. (G.E. Co.) Circuit connections of electron discharge apparatus.

Relates to a circuit arrangement for an electron discharge device or the like having therein a filamentary cathode and a co-operating anode, in which a source of alternating potential is applied to said cathode for heating it to incandescence, and the external connections between said cathode and anode are so arranged that the average potential difference between cathode and anode at any instant is independent of the potential applied to the cathode for heating purposes.

15,579 Mellersh-Jackson. (Western Union Telegraph Co.) Telegraph apparatus.

15,762 Langdon-Davies, Soames & Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Electrically-controlled clutches.

16,058 Marks. (Bancken). Lightning arresters.

16,290 Pordes. Portable electric battery lamps.

16,854 Walker. Dynamo-electric machines of the commutator type.

Relates to a dynamo-electric machine provided with two commutators and having brushes of the same polarity divided into two parts—namely, a forward part and a backward part—distributed on the two commutators, the forward part of the brushes being so connected to the commutating pole winding or apparatus controlling the excitation of the commutating pole that the current collected by the forward part strengthens the commutating pole, and in so doing tends to equalise the currents collected from the two commutators.

17,060 Fildes. Connection between electric incandescent lamps and holders.

17,128 B.T.-H. Co. (G.E. Co.) Electrically-driven vehicles.

17,166 Campbell. Electric regulating systems.

17,570 Parsons & Ball. Reversible electric step-by-step ratchet mechanism.

1916 Specifications.

358 Wrigley. Electric lighting system or circuits. (3/1/16.) 101,983.

2,242 Williams & Williams. Telephonic receiver. (15/2/16.) 101,996.

2,328 Dushman. Electric discharge vacuum tubes. (20/2/15) 100,104.

An electrical discharge device comprising an enclosing envelope evacuated so highly that evidences of positive ionisation are substantially absent even at very high voltages, said envelope containing a cathode adapted to operate at incandescence and an anode the parts of which are arranged substantially symmetrically with respect to the cathode.

2,552 Railing & Angold. Miners' electric hand lamps. (21/2/16.) 102,001.

2,584 Wrighton. Electric furnace. (19/2/15.) 100,093.

4,752 Donovan. Combined electric lamp-holders and switches. (31/3/16.) 102,012.

6,260 Collie. Troughing or trays for electric conductors, conduits, pipes and the like. (2/5/16.) 102,015.

7,275 Erichsen. Electric heating apparatus. (22/5/16.) 102,020.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

November 9, 1916.

16,041 Green. Elec. signalling.

16,065 Fowler & Benjamin Electric (Ltd.) Supporting elec. lamps.

16,067 Clapp & Simpson. Incandescent elec. lamps.

16,077 Canadian-American Machinery Co. (Toronto Type Foundry Co.) Elec portable grinding attachment for lathes, &c.

16,090 Pugh. Elec. operated striking device for clocks.

November 10, 1916.

16,106 Ellefsen & Electric Control (Ltd.) Dashpot retarding and time-limit devices.

16,144 Cooke. Magneto elec. machines.

16,145 Cooke. Elec. contact breakers.

16,155 Boulton. Ignition magnetos.

16,157 British Westinghouse Elec. & Mfg. Co. Mechanical arrangement to make elec. meters differential

16,159 Pullinger & Beardmore. Securing sparking plugs.

16,170, 16,171 Scouler. Manufacture of elec. lamp caps or bases, and apparatus for.

November 11, 1916.

16,175 Hayes. Sparking plugs.

16,201 Cooke. Armatures of magneto elec. machines.

16,202 Cooke. Elec. contact breakers.

16,206 Lumb. Elec. heating appliances.

November 13, 1916.

16,215 Clark, Longford & Sphinx Mfg. Co. Sparking plugs.

16,248 Soc. Clarget, Bein & Cie. Sparking plugs. (13/11/15. France.)

16,250 B.T.-H. Co. (G.E. Co.) Motor speed control regulation.

November 14, 1916.

16,272 Leitner. Elec. regulators, &c.

16,284 Ackery. Elec. connections and terminals.

16,291 Bergmann & Igranic Elec. Co. Reversing switch.

16,294 Astley. Packing boxes for lamp bulbs.

16,308 Lawton. Secondary batteries.

November 15, 1916.

16,332 Cox & Elec. Ignition Co. Contact breakers of magnetos.

16,348 Roberts. Elec. wire gas lighting appliances.

16,359 & 16,360 Crawford, Preston & Sanders. Elec. contacts, &c.

16,370 Bruce. Telegraphy.

16,377 Chadburn. Ships' telegraphs.

16,382 Clothier & Reyrolle. Elec. switchgear

November 16, 1916.

16,395 Stobie. Elec. furnaces.

16,393 Burney. Elec. heaters.

16,413 Ringrose. Switchboards.

16,423 Henry & Hermann. Sparking plugs. (2/12/15. France.)

16,427 B.T.-H. Co. (G.E. Co.) Elec. arc devices.

16,434 Baker, & Mackenzie, Holland & Westinghouse, &c., Co. Signalling by elec. lamps.

16,452 Bigge & Butt. Mercury breaks or interrupters.

16,453 Mellersh. (Baruch Elec. Controller Corpn.) Protective devices for elec. circuits.

16,457 Dixon. Reflectors for submarine telegraphy.

November 17, 1916.

16,461 James. Attachment for trolley poles of elec. cars.

16,492 Kunoman. Spark gaps.

16,494 Atherton & Jones. Intermittently illuminated signs.

16,512, 16,513 & 16,514 Mason. Ignition dynamos. (19/6/15. U.S.)

16,515 London Elec. Supply Corpn. Furnaces.

16,518 Mason. Ignition dynamos. (19/6/15, U.S.)

16,521 Birkbeck. (Thierry.) Sparking plugs.

16,536 Oldham. Miners' elec. safety lamps.

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

The Parliamentary Schemes of 1917 Session.

Though the number of bills and provisional orders, of which notice has been given for the 1917 Session of Parliament is only a small percentage of the usual number, yet there is a substantial increase over the past session. Naturally, the war overshadows everything else at present, and new electricity supply schemes or other works of public utility which might arouse public controversy have had to be postponed. Notwithstanding the restrictions upon capital expenditure notices of eleven provisional electric lighting orders have been given, and there are five bills in which electric supply or traction powers are sought. In many of these cases the laudable intention is to be ready with schemes immediately the war is over, but in some instances extension orders are being sought with the sanction of the Board of Trade. One of the most interesting projects is that of the Electrical Distribution of Yorkshire, which is seeking powers of supply in a number of districts in Yorkshire. The company is a subsidiary undertaking of the Yorkshire Electric Power Co., and the present applications are being made in consequence of the rejection of the Yorkshire Electric Power Bill in the 1914 session. Another interesting scheme is that of the Sheffield Corporation which desires to have authority to acquire land for erecting another electric generating station, to extend the limits of the supply of electricity and water, &c. The demand for electric current for power purposes has been increasing by leaps and bounds in Sheffield, and the able and progressive manager of the municipal electric supply department wants to be in a position to meet all future requirements. Ashton-under-Lyne Corporation desires to purchase the local tramways; Blackpool Corporation seeks to extend their electric supply, gas and other powers; the Nottinghamshire and Derbyshire Tramways Co. is applying for sanction to their purchase of the Ilkeston Corporation tramways; and the West Kent Electric Co. is promoting a bill to amend its capital powers, &c. An interesting sign is that some four or five provincial and Urban Councils are anxious to obtain authority to run motor omnibuses. There are no new electric railway or tramway schemes. The South-Eastern and Chatham companies are again promoting a bill to facilitate the strengthening of the Charing Cross bridge, and the Port of London Authority are asking for powers to enlarge the Old Shadwell Basin and to extend and improve the West India Docks. also to make dry dock near the South Dock Basin and a new cut between the South Dock and Millwall Inner Dock.

* * * *

Control of Copper Supplies.

The Minister of Munitions has made an Order under the Defence of the Realm Act which provides as follows:—

(1) No person shall as from the date hereof buy, sell, or, except for the purpose of carrying out a contract in writing existing prior to such date, enter into any transaction or negotiation in relation to the sale or purchase of copper of any class whether wrought or unwrought situated outside the United Kingdom unless such person is authorised by a special permit from the Minister of Munitions to purchase or sell the same.

(2) All persons shall, except as below mentioned, not later than the 16th day of Dec., 1916, send in to the Director of Materials, Armament Buildings, Whitehall-place, London, S.W., returns of:—(*a*) All unwrought copper at the date hereof held by them in stock or otherwise under their control; (*b*) all unwrought copper due at the date hereof for future delivery to them; (*c*) all contracts existing at date hereof for sale to or purchase by them of unwrought copper.

Notwithstanding the above, no return is required from (1) any manufacturer or smelter of stock in hand or due for future delivery for the sole purpose of manufacture or smelting at his works; (2) any person whose total stock in hand and due for future delivery does not exceed two tons. Applications for special permits may be made to the Director of Materials.

The Minister of Munitions has made a further Order prohibiting the use of copper, whether wrought or unwrought, in any kind of manufacture except for the purpose of a contract or orders for the time being in existence certified to be within Classes "A" or "B" of circular L.33 of 31st March, 1916, as to control of output. The Order of the Minister of Munitions of Nov. 6, 1916, relating to the manufacture of copper wire and cable containing copper is cancelled.

Applications in reference to this order should be addressed to the Ministry of Munitions (Priority Branch), 1, Caxton-st., Westminster, S.W.

The Ministry of Munitions have appointed Mr. Cecil Budd (Messrs. Vivian Younger & Co.) and Mr. R. Rucker (Messrs. Henry Rodgers, Sons & Co.) as a committee to advise the Ministry on the purchase and distribution of copper. Mr. Stroud, of Messrs. Charles Tennant & Co., will act as secretary to the committee.

* * * *

Enemy Property in Great Britain.

In a lecture on "The Public Trustee and the War," Mr. C. J. Stewart stated that recent returns showed that about 32 millions of enemy capital was in British companies; there was about 71 millions of property in this country held and managed on behalf of the enemy, and about 19 millions of debts over £50 and bank balances were also due to them, making a total of £122,000,000.

It was most important that persons having any claim against the enemy, or any property in enemy countries, should register it. They had received 30,000 claims, and they were coming in at the rate of about 150 a day. Having given particulars of the position of the German banks, he said that each of the banks held large blocks of securities on behalf of enemy customers or its own head office or foreign branches—the value of such securities held by the three German banks being roughly £20,000,000. It had hitherto been found impossible to determine whether any particular part of the securities held on account of the head offices and foreign branches did, in fact, belong to the banks, but it was known that the great bulk of those securities, if not the whole, was really the property of the banks. All securities were now about to be vested in the Public Trustee by orders to be made by the Board of Trade. After the securities had become vested it would then be open to creditors of a particular enemy customer, for whose account any of the securities were held, to apply to the Court for directions for the sale of securities and payment of the debts owing by such customer to British subjects.

With regard to the sale of businesses or shares to persons of British nationality, Mr. Stewart said that the moneys would not find their way to enemy countries if, by the exercise of the powers he possessed, he could prevent them, until they were satisfied as to what the enemy proposed as regards the large claims we had against them. There had been 223 orders with a view to sale since April. Eighty-five per cent. of the enemy companies were very good paying concerns, cleverly managed, and in one case £5 shares realised £8 each.

* * * *

Excess Profits Duty Decisions.

The "London Gazette" for December 8th contains further decisions given by the Board of Referees in appeals under the excess profits duty provisions of the Finance (No. 2) Act, 1915.

In the case of the manufacture of explosives, the Board has raised the statutory percentage to 8 per cent. for companies and to 9 per cent. for private firms.

In the case of tramways in New Zealand (on the application of the Auckland Electric Tramways Co., Ltd.), the statutory percentage is increased to $7\frac{1}{2}$ per cent. for companies and other corporate bodies, and $8\frac{1}{2}$ per cent. for private firms.

* * * *

Australian Trade with the U.S.A.

The Trade Commissioner for N.S.W. in the U.S.A. (Mr. Melson) reports that during the last three years the Australian trade with America has increased over 500 per cent., or, in money value, by about £9,000,000.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 4, 1916, *to* Dec. 8, 1916.

IMPORTS.

London.—*U.S.A.:* Wire and cable, £2,497; elec. machinery, £2,864; carbon candles, £40; unenumerated, £8,190. *Holland:* Elec. glow lamps, £2,031; elec. machinery, £90; unenumerated, £940. *Japan:* Unenumerated, £6,005. *Switzerland:* Carbon candles, £164; elec. machinery, £107; unenumerated, £330. *France:* Glow lamps, £15; unenumerated, £108. *Canada:* Unenumerated, £435. *Sweden:* Unenumerated, £1,539.

EXPORTS.

To Australasia.—*Auckland:* Unenumerated, £388. *Melbourne:* Unenumerated, £1,601. *Sydney:* Elec. machinery, £686; telephone material, £625; elec. lamps, 6,375 n.o.; unenumerated, £533. *Wellington:* Unenumerated, £327. *Lyttelton:* Elec. machinery, £98; unenumerated, £211. *Adelaide:* Unenumerated, £122. *Christchurch:* Unenumerated, £97. *Brisbane:* Elec. machinery, £100; telephone material, £63; unenumerated, £20. *Dunedin:* Elec. lamps, 1,900 n.o. *Napier:* Wire and cable, £40; unenumerated, £20. *Perth:* Unenumerated, £20. *Freemantle:* Unenumerated, £37. *Wanganui:* Elec. machinery, £102.

Africa.—*Durban:* Unenumerated, £462. *Cape Town:* Elec. machinery, £152; unenumerated, £197. *Port Elizabeth:* Unenumerated, £108. *East London:* Elec. machinery, £51; unenumerated, £14. *Beira:* Elec. machinery, £414. *Quilimane:* Unenumerated, £10.

Gibraltar.—Unenumerated, £10.

Egypt.—*Alexandria:* Unenumerated, £29. *Port Said:* Unenumerated, £42.

Spain.—*Barcelona:* Unenumerated, £376.

Portugal.—*Lisbon:* Telephone material, £50.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Wire and cable, £203; elec. lamps, 3,378 n.o.; unenumerated, £357. *Calcutta:* Elec. machinery, £232; unenumerated, £882. *Madras:* Unenumerated, £13. *Ceylon:* Elec. machinery, £49; unenumerated, £83. *Singapore:* Wire and cable, £12; unenumerated, £52. *Bangkok:* Elec. machinery, £291. *Penang:* Unenumerated, £31. *Karachi:* Elec. machinery, £285. *Port Swettenham:* Unenumerated, £340. *Kilindini:* Unenumerated, £180. *Rangoon:* Unenumerated, £15.

China.—*Shanghai:* Wire and cable, £117; unenumerated, £372. *Tientsin:* Elec. machinery, £156.

South and Central America.—*Buenos Ayres:* Elec. lamps, 1,200 n.o.; elec. machinery, £954; unenumerated, £253. *Rosario:* Elec. machinery, £70. *Rio de Janeiro:* Wire and cable, £20; unenumerated, £29. *Santos:* Unenumerated, £83. *Antigua:* Telephone material, £10. *Tampico:* Unenumerated, £116.

West Indies.—*Demerara:* Unenumerated, £7. *St. Vincent:* Unenumerated, £84. *Trinidad:* Unenumerated, £9. *Rabat:* Unenumerated, £56.

Java.—*Batavia:* Elec. machinery, £312; unenumerated, £125.

Holland.—*Amsterdam:* Wire and cable, £2,082; elec. machinery, £49. *Rotterdam:* Wire and cable, £1,109.

France.—*Paris:* Wire and cable, £178; unenumerated, £260. *Calais:* Unenumerated, £92. *Dieppe:* Unenumerated, £361.

Norway.—*Trondhjem:* Wire and cable, £725.

Russia.—*Archangel:* Unenumerated, £742.

Denmark.—*Copenhagen:* Unenumerated, £105.

Canada.—*Montreal:* Elec. machinery, £303; unenumerated, £17. *St. Johns:* Unenumerated, £18.

U.S.A.—*New York:* Wire and cable, £6,175; unenumerated, £247.

FOREIGN GOODS (duty paid and free).

Calcutta: Elec. lamps, 400 n.o.; unenumerated, £38. *Melbourne:* Unenumerated, £13. *Cape Town:* Unenumerated, £12. *Bangkok:* Unenumerated, £290. *Havre:* Unenumerated, £78. *Hankow:* Glow lamps, £99. *Paris:* Unenumerated, £744. *Perth:* Unenumerated, £10. *Alexandria:* Elec. lamps, 544 n.o.; unenumerated, £81. *Buenos Ayres:* Unenumerated, £69. *Petrograd:* Unenumerated, £72. *Wellington:* Unenumerated, £7. *Adelaide:* Elec. lamps, £310. *Melbourne:* Elec. lamps, £320.

IN TRANSIT.

Perth: Elec. lamps, £219. *Sydney:* Elec. lamps, £1,203.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The Tramways & Light Railways Association and the Incorporated Association of Electric Power Companies have removed to Sanctuary House, 33, Tothill-street, Westminster, S.W.

It is announced that the British Dominions General Insurance Co. and the Eagle Insurance Co. have been amalgamated.

Plant for Sale.—Messrs. Marshall, Sons & Co. (Ltd.), 79, Farringdon-road, London, E.C., advertise for sale a Willans high-speed enclosed engine direct coupled to Siemens c.c. dynamo, 230 v., 500 amperes, 350 revs.

The North British Railway Co. advertise for sale two used steam generating sets. Particulars from the Secretary, 23, Waterloo-place, Edinburgh.

The City of Aberdeen electricity department advertise for sale a 120-kw. d.c. 440-500 volt direct coupled Willans-Johnson Lundell set. Offers by 24th inst. to the city electrical engineer, Mr. J. Alex. Bell.

BANKRUPTCIES, &c.

A receiving order has been made against Edward W. B. Wright, electrical therapeutic expert, formerly of 133, Oxford-street, London, W.

A second and final dividend ([illegible]) will be payable at the offices of Messrs. Corfield & [illegible], 119, Finsbury-pavement, London, E.C., to creditors of Russell Ernest Connold, late electrician, of 6A, The Parade, Canterbury.

ELECTRICITY SUPPLY.

EXTENSIONS.

Battersea (London).—Tenders are to be invited for extensions and additional works (estimated to cost £3,400) to increase the supply of energy in the Nine Elms district.

Belfast.—The City Council had before them last week certain communications relating to the acquisition of the site for the new electricity works decided upon in 1914.

The Town Solicitor recommended that as soon as the Corporation finally determined to proceed with the erection of the station, application should be made to the Board of Trade for their consent to the erection of the station as provided by the Electric Lighting Act, 1909, and with this recommendation the Tramways and Electricity Committee agreed.

The committee's minutes also stated that Sir John Snell and Mr. W. J. Pratten had been communicated with as to any modification they might desire to make in their reports given in 1914 as to a new station. Mr. Pratten said he could add little to his report, and Sir John Snell said practically the same, but added that if the City Electrical Engineer desired to consult him he would meet him in London and would charge his usual fee of £3. 3s. per hour, with a limit of 100 guineas for consultation. The committee advised the Council to consult Sir John Snell in the manner suggested.

Councillor M'Caughey, in moving the adoption of the minutes, called attention to a report by the City electrical engineer (Mr. T. W. Bloxam), which stated that: "Having regard to the very small margin of plant available at the station, I am unable to recommend further connections, but in the event of the committee deciding to authorise these being made, subject to the consumer paying the capital charges involved, I can assure them that all possible steps will be taken to secure the continuity of the supply." He said they ought to have at least 25 per cent. of spare plant, but they had only 11 per cent. They were, therefore, in a serious position. They had decided to grant certain applications for connections received during the month, but they would be unable to grant any more except under very special circumstances. There seemed nothing for it but to go on with their new station if they could get permission from the Government to spend the money. It was a very serious thing to hamper industrial and other development in the city by inability to grant electricity supplies. The extended use of electricity was doing a great deal of good in facilitating many of their manufacturing industries, and in addition it was doing good from a health standpoint in reducing the number of smaller chimneys. They had made a great mistake a few years ago in not going on with the extension scheme, but they stayed their hand largely in consequence of pressure put upon them by a large and influential deputation of the ratepayers. It was thought money was too dear then, but the consequence of their delay would be that they would have to pay a good deal more both for the money and for the work and equipment.

On the motion of Councillor Alexander it was resolved that two members of the committee be appointed to accompany the Electrical Engineer to visit London in order to consult Sir John Snell.

The minutes were then passed.

Dundalk.—The Council are sending a deputation to interview the L.G. Board with a view to a further loan for the electric supply undertaking.

Sheffield.—The Parliamentary Committee has resolved to promote a Bill to enable the Council to erect and equip a new generating station and for other purposes.

The general manager (Mr. S. Edgar Fedden) estimates the revenue of the electric supply department for the year ending March 25, 1917, at £431,000, and for the following year at £525,250, while the expenditure for the year 1917 would be £228,527 and for 1918 £292,812, leaving a gross profit of £202,473 and £232,438 respectively.

A piece of land is to be purchased from the Duke of Norfolk as a site for a converter sub-station, and plans have been passed for a transformer sub-station for Messrs. T. Firth & Sons. Two e.h.t. feeder cables are to be laid between Neepsend station and a sub-station, a distance of 5,920 yds. at an estimated cost of £23,770. Other extensions at a cost of about £2,000 have been authorised.

Worcester.—The Council recently authorised provision being made for giving an additional supply of electrical energy to Messrs. Heenan & Froude, the Vulcan Works and Messrs. McKenzie & Holland.

GENERAL.

Barrow.—A proposal to increase the salary of the borough electrical engineer (Mr. H. R. Barnett) has been referred to the General Purposes Committee.

Bath.—There was a long discussion at the last meeting of the Council on the repairs to the Diesel engine at the electricity works.

Mr. G. J. Long said that nearly £5,000 had been spent upon the engine and its accessories, and now £451 had been spent in repairs, though the Council only voted £150. He wished the Council to ask an independent engineer to test the engine properly and report to the Council. Ever since the engine was passed at Ghent in May, 1912, nearly every excuse given for its not running had proved unsatisfactory and unreliable, from the mythical hardening and grinding of the gudgeon pins, which could not be made anywhere except in Switzerland, to the excessive price of fuel oil. Now the engine was proclaimed as fit and satisfactory, and they were told that it was carrying the light they were enjoying. The engine was run when it was new for 695½ hours, and the run ended with explosions, and the engine was dismantled. The main cause of the explosion was improper combustion in the engine and that was the essential factor of safety. He had been into the works during the past fortnight, and found there had been an accident to the engine, the top of one of the pistons had come off. In fairness to the committee it should be said that they never had the terms of Messrs. Belliss & Morcom's report, and they did not know that the estimate had been exceeded until he asked on May 24, and then they were told they had spent £451. Mr. Teague had frankly said in his report, "This case has proved that a life-long experience of steam engines was useless upon this type of engine. They had a greater degree of safety than before the repairs." That was the crumb of comfort for £541. That report should have gone to the full committee and the Council. He was not alarmed at the recent accident, but he said it pointed to the fact that they had not discovered the cause of the previous breakdown. He moved "That the Electric Lighting Committee be instructed to obtain a report from an engineer of standing, and with experience in Diesel engines upon the Bath Diesel engine before all the fuel oil was used; and (*b*) that the committee be also instructed to obtain a report upon the cost of insuring the Diesel engine."

Ald. Bush said the matter must be faced squarely and the committee should say without any reservations whether they believed in the engineer.

After some discussion, the chairman of the committee (Ald. Hatt) said he was quite prepared to accept the amendment. He did not remember giving a definite promise that the engine would be insured, but he undertook to have it considered. Their engineer was satisfied that the engine did work on the Diesel cycle, the opinion of the expert as opposed to the amateur. He desired to disabuse the Council's mind entirely of the absolute mis-statement made by Mr. Long when he alleged that the committee forced their views and their opinions upon the engineer. That was absolutely unfounded. The initial responsibility, of course, must rest with the engineer who advised the committee. He had no desire to gloss over the insurance question. He was held up to ridicule for having announced that the Diesel engine ran for 13 hours, and the bearings were in absolutely as good a condition as when it started. Mr. Long brought a variety of charges a number of which he was unable to substantiate, against the committee and the engineer, and then shuffled off behind an innocuous amendment that did not deal with many of the points raised. Expert advice they had got already. It was their own engineer who saved them from disaster, not someone from outside. Instead of paying £5,450 for the engine they paid £1,570, to which they must add the cost of repairs. It had had an accident during the last few days, which was uncommon to the Diesel engine. The water box of the piston had come away; it might have been a flaw in the casting, but nobody knew. If a similar accident had occurred to one of the other engines the bill would have been paid and nothing said. The accident in question was not peculiar to the Diesel, and apart from that the position was they asked the Coucil, having regard to the money spent on repairs, to allow it to be run for use as required for 12 months.

With the accepted amendment, the report was then passed.

Casteblaney.—At a recent meeting of the Rural Council it was reported that public electric lighting would be soon available.

Deal and Walmer Gas and Electricity Act.—The Board of Trade has extended for one year from Dec. 1, 1916, the period limited by the Deal and Walmer Gas and Electricity Act, 1914, for laying mains in the streets named in the schedule to the Act.

Hackney (London).—The Electricity Committee anticipate a liability of £500 will be incurred during the current year in defending the action brought by the Gas Light & Coke Co. as to the system of charging for electric current.

Hebburn.—At the meeting of the Urban Council on Tuesday the General Purposes Committee reported that a letter was received from the Board of Trade on Nov. 25 enclosing an order which they had made reciting that it had been proved to the satisfaction of the Board that the supply of electricity to the public lamps of Hebburn was attended with danger to the public safety, and directing the Committee to discontinue such supply within 13 weeks from Nov. 25 last.

Hospital X-Ray Equipment.—Mr. James Hoult, has given an installation of X-ray apparatus to the Penrith Military hospital.

Income Tax and Municipal Trading.—At the last meeting of Stockport Council Mr. Ferns moved that, having regard to the present high rate of income tax and to the liability thereto of the profits of the trading departments of the Corporation, a special committee be appointed to review the basis on which the Gas, Electricity and Tramways Committees respectively have hitherto made annual contributions out of their profits in aid of the rates.

Mr. Ferns said he was merely asking for inquiry. It was necessary that they should go very carefully into financial affairs, because the most rigid economy would have to be exercised. He was not going to say that the profits of the commercial undertakings ought not in some measure to go in relief of rates, but he did think it should be considered whether the commercial undertakings should be run with the idea of relieving the rates or with the idea of supplying the commodities required by the town and putting the concerns in a good and prosperous position. The basis on which they had worked before had been the basis of expediency. He wanted to get away from that in future, and work upon a sound commercial basis. During the last 10 years they had taken from the gas, tramways and electricity departments £251,000 in aid of rates. Assuming that the amount taken in the next 10 years in aid of rates from the profit-earaing undertakings came to the same, and assuming that the income tax remained the same as at present, and there was a possibility of it being higher, it would mean that over £62,000 would have to go to an outside authority *i.e.*, to the Inland Revenue Commissioners—and the town would not benefit a penny so far as that money was concerned. Prior to the war, L.G. Board inspectors had stated that the Board might at some time or other object to new loans unless the profits were used to a greater extent for the needs of the works, and it was also suggested that new machinery and other things should be met out of revenue.

Ald. Graham, in seconding, said he hoped the L.G. Board would refuse to sanction further loans unless only a fixed proportion was used for relieving the rates and the balance for wiping off outstanding loans and meeting the cost of new machinery, extensions, &c.

Councillor McGregor said that since his connection with the Council in 1901 they had pursued an unbroken policy with regard to the profit-earning departments, and that was that, after making provision for sinking fund and interest and other contingencies, the remainder of the profits should be handed over for relief of the rates. That was their present policy, and it had the sanction of some of the leading business men who had taken part in the business of the Council. If there were any adequate reasons for making the change suggested he would support an inquiry, but there were only two things they could do. They could hand over the profits, after making provision for depreciation and sinking fund and other contingencies, in aid of the rates, or they could cut down the price at which commodities from the undertakings were supplied to the public. The majority of the inhabitants belonged to the working classes, and there was only one undertaking from which the working man could hope to get a reduction. That was from the gas undertaking. Electricity was not used in working class houses at present, and, so far as the trams were concerned, the majority of the working classes lived within walking distance of the place where they worked. The amount handed over last year from the gas department in aid of rates was about £10,000. A penny in the £ produced about £1,750. If they were to take away the money voted in aid of the rates (say £20,000 per annum) it would mean that the rates would go up at least 1s. in the £. The average assessment of a workman's house (of a rental of £15. 10s.) was about £10. 10s., and that was generally paid by the landlord, who, if the rates were increased by 1s. in the £, would have to find 10s. 6d. extra per house per annum, and the probability was that he would increase the rent by 6d. per week, or 26s. per annum. The income tax (5s. in the £) was to help to pay for the war, and were they so unpatriotic as to think of shuffling their cards and getting out of their responsibility in that matter? They ought to help towards doing their share for the payment of the war gladly and without cavil. The ratepayers ought to have a return on their capital, and no business man would be satisfied with less than their return—2½ per cent. If they put 1s. on the rates it would be detrimental to the growth and prosperity of the town. During the last 10 years there had been an exodus of business concerns from Manchester owing to the heavy rates, and many very big concerns had come to Stockport because the rates were lower and the facilities equal in the matter of railways, canals, gas, water and electricity. It was their duty to use every endeavour to keep the rates down, so that large industrial concerns might be induced to come to the town and help in its development and prosperity.

Ald. Sharpden said there was no reason for reducing the tram fares, which were among the lowest in the country. A workman travelled 3 miles for a penny, and with a return 6 miles for twopence. The present position had only been obtained after continued and earnest consideration on the part of the Committee and long experience in managing the undertaking.

The motion was negatived by 30 votes to 22.

Increased Charges for Electrical Energy.—The following increases are being made:—

Wrexham Council is increasing its charges for electrical energy for all purposes by 10 per cent.

Bath Electric Lighting Committee is increasing its charge for current for lighting by another ½d., making it 6d. per unit.

Bray (co. Wicklow) Council has, on the recommendation of the Electric Lighting Committee, adopted the following charges for electricity as from Jan. 1 next. Private residencies, shops (closing at 8 p.m.), meeting halls, &c., 6½d. per unit (increase ½d.), shops open after 8 p.m., clubs, hotels and other long-hour consumers, 5½d. (increase ½d.). Consumers using over 6,000 units per annum, 3½d. (increase ½d.), flat rate for other consumers 6½d. (increase ½d.); motive power, heating, &c., first 50 units per quarter per kilowatt connected, 3d. per unit (increase ½d.), exceeding 50 units 1½d. per unit.

Market Drayton.—The Blore Heath Rural Council has authorised the Market Drayton Electric Light & Power Co. to supply electric current in certain parts of its area.

Marylebone (London).—Ald. Duncan Watson has been appointed chairman of the Electric Supply Committee for the ensuing year.

Newport (Mon.).—The Finance Committee is to report upon the question of charging to the account of various departments and trading undertakings for the services rendered and work done by other departments of the Corporation.

The L.G. Board has sanctioned the borrowing of £444 required for plant to give a bulk supply to Messrs. Smith (Newport) (Ltd.). The British Mannesmann Tube Co. is proceeding with work on the site for the erection of works, and though it was originally contemplated to put down independent electrical plant, negotiations in regard to a supply are now proceeding with the Electricity Committee.

The total income of the electric supply department for the half-year ended Sept. 30 was £21,506, increase of £1,893 over the corresponding period of 1915.

The following increases of salary have been granted upon the recommendation of the Borough Electrical Engineer, to take effect as from April 1, 1917: A. H. Felton, works superintendent, £166 to £175, W. H. Clarke, installations assistant, £140 to £150; E. G. Illingworth, sub-stations engineer, £130 to £140; F. B. Briggs and W. A. Borrowdale, senior engineers-in-charge, £123. 10s. to £135.

Councillor Moxon has been appointed chairman and Ald. F. Phillips deputy chairman of the Electricity and Tramways Committee for the ensuing year.

Queensbury (Yorks).—The Council has assented to the application of the Electrical Distribution of Yorkshire for a provisional electric lighting order.

Ripon.—The Council recently decided to apply to the Board of Trade for a provisional order for the supply of electricity in Ripon and certain adjoining parishes, but the Board has intimated to the Council that their case did not disclose any special circumstances which would justify the Board in holding that a prima facie case existed for the promotion of a provisional order at present. The Council are, however, asking the Board of Trade to reconsider the matter.

Torquay.—Correspondence has passed between the Town Council and Mr. W. B. Cownie, managing director of the local tramway company, in regard to the charge for electric current, &c. An inquiry by Mr. Cownie as to the possibility of the Corporation entertaining an offer for the purchase of the undertaking has been answered by an intimation that the Council do not contemplate selling their undertaking.

Walsall.—The Electricity Supply Committee report that the delay in getting the plant at the new station into commission has increased the difficulty of maintaining the heavy winter loads with the plant at the other station, and during the past month several breakdowns have occurred.

Directions have been given the engineer that the supply to factories and works must have priority, and that if necessary the tramway supply be shut down or curtailed to enable this supply to be maintained. Consumers are asked to restrict their use of electricity as much as possible between 4 p.m. and 6 p.m. each day.

The chairman of the Electricity Committee stated at the meeting of the Council on Monday that the demand for current was increasing every day, and as the whole of the available machinery at the old power station was in use a breakdown would prove serious. To make matetrs worse, the committee had now received an intimation that as a rotor which was ordered for the new works had proved faulty, but the Government were considering the commandeering of the rotor which had been sent to be repaired. Representations had been made as to the serious position this would create. He appealed to the public to assist the department as much as possible.

Wimbledon.—Ald. Stuart and Ald. Abbott have been elected chairman and vice-chairman respectively of the Electric Lighting Committee for the current municipal year.

The Board of Trade consider that a prima facia case has been made out for the application of a provisional order to supply energy in the Parish of Cuddington, and Epsom Rural Council is to be asked to waive its right to receive notice of the Council's intention to apply for the order.

The L.G. Board have sanctioned the borrowing of £727 for defraying expenses on transformer sub-stations in the Malden and Coombe area of supply, but as the expenditure was incurred several years ago the Board have reduced the period for payment of the loan to 10 years.

The Borough Surveyor is to remove the ashes taken from the furnaces at the electricity works at 1s. per cubic yard.

A final certificate for the payment to the British Thomson-Houston Co. of £863 in connection with their contract for the 1,500 kw. turbo-alternator has been passed.

TRACTION NOTES.

Ashton-under-Lyne.—The Corporation, in conjunction with Waterloo and Bardsley Parish Councils, have taken definite steps to acquire the undertaking of the Oldham, Ashton & Hyde Electric Tramway (Ltd.).

Ashton Council is promoting a bill to make provision for the purchase, and agreements have been made with the Parish Councils of Waterloo and Bardsley for the transfer of their powers to the Corporation. In addition to the Works, the bill seeks to authorise the construction of additional tramways in the borough, to provide and run omnibuses, &c. Should the bill go through there will be through inter running between Ashton and Oldham eventually.

Bolton.—On Dec. 8 the Tramways Committee received a letter from the District Secretary of the Lancashire District Council of the Amalgamated Association of Tramway Workers, giving 21 days' notice on behalf of members of the Association in the employ of the Tramways Department to withdraw their labour unless their recent application for an advance of wages and better conditions of labour were agreed to by the Corporation. The matter has now been referred to the Board of Trade Committee on Production.

A special sub-committee has been asked to report upon the question of purchasing electrically-propelled vehicles.

Darlington.—The Council have decided to suspend temporarily the half-penny fares on the tramcars after 1 p.m. on Saturdays.

Edinburgh Queensferry Tramway.—The question of the possibility of extending the tramways from Edinburgh to Queensferry in connection with the development of Rosyth has been discussed by a subcommittee of the Tramway Committee.

Councillor Deas, on whose motion the question has been raised, suggested how an overhead electric system from the city could be extended to Queensferry and linked with the Rosyth area and Fife towns by ferry boats, on which the trams could be taken across the Forth. It was agreed to submit the matter to the tramway Committee with a view to the matter being further considered.

Hull.—The Chairman of the Tramways Committee (Councillor Wheatley) recently announced that the profit earned by the tramways in the year 1915-16 was £12,469, compared with £19,099 in the previous year. The Council have referred back a proposal of the Tramways Committee to charge soldiers and sailors a flat rate of one half-penny for tram rides after Jan. 1. At present the service travel free of charge on the system.

Keighley.—At the last meeting of the Council, Ald. Midgley, chairman of the Health Committee, said the Health Committee had been considering the desirability of purchasing an electrically-driven vehicle to assist in the removal of ashes.

The scavenging and cleansing charges at present were a serious item. Team labour was costing them 25 per cent. over pre-war rates, and there was an application for another increase, which, if granted, would mean an additional £460 a year. The Committee asked for an expression of opinion from the Council as to whether they would sanction the purchase of a vehicle such as he had mentioned for £1,100 if after careful investigation it was fairly clear that it would be a paying investment. The Council have asked the Health Committee to pursue its investigations.

Leeds.—The new tramway route, along Nippet-lane, Burmantofts, to Compton-road was opened for traffic last week.

London County Council.—Tenders are to be invited from selected firms for the supply of 100 pony-wheel axle forgings for the tramways department.

L.C.C. Tramway Employes.—The application of the employés in the traffic section of the London County Council tramways department for an increase of 15 per cent. on all current rates of wages formed the subject of arbitration proceedings at the Chief Industrial Commissioner's Department, Westminster, on Monday.

The claim was based on the ground of the higher cost of living, and over 5,000 workers, including drivers, male and female conductors, and pointsmen will be effected by the decision, which was reserved.

Nelson.—Arrangements have been made between Nelson and Colne Corporations for a curtailed tramway service, and during the winter months the cars will cease running one hour earlier, except on Saturdays.

Newcastle-on-Tyne.—Owing to the increased traffic, a junction will be made between the tramway lines in Union-road and Miller's-lane, and to connect the sheds in Miller's-lane with the Shields-road route. The total cost is estimated at £6,500.

Preston.—A proposal to stop the tram-cars at 10.30 each evening has led to a protest by the Postmaster.

In his letter the Postmaster pointed out that a million letters were dealt with daily at the local sorting offices between 10 and 11 o'clock each night by a staff largely composed of women. If the trams were stopped at 10.30 those women could not be kept on duty later than 10.15, which would mean the failure of the despatch of a large number of letters.

The chairman of the Tramways Committee (Ald. Ormrod) withdrew the recommendation and the matter will be reconsidered.

Sheffield.—Employees in the tramways and motor department are to receive additional allowances estimated to cost £15,120 a year, making the total estimated cost of war allowances granted £30,610 per annum.

The Architect has been instructed to prepare specifications and quantities and obtain tenders for the new car depot in the Crookes district. The total estimated receipts from the tramways for the year ended March 25, 1917, is £509,857, and the the year ending March, 1918, £523,683, the total estimated expenditure for the two years being £573,632 and £505,938 respectively.

Stretford.—The chairman of the Electricity and Tramways Committee (Coun. Whiteside) has been authorised to secure the option on a suitable site for a sub station.

Wages of Electricity Works' Employees.—Marylebone (London) Borough Council has decided to call a conference for the purpose of discussing wages and labour conditions in electricity supply works.

Wolverhampton.—A payment of £15 is to be made to the tramways manager (Mr. C. Owen Silvers) by way of royalty in respect of each car fitted with "Silvers dynamic pickup," provided that the Corporation shall have the option at any time of fitting any number of cars with such apparatus for the sum of £750, less such amounts already paid by way of royalty.

TELEGRAPH AND TELEPHONE NOTES.

Italian Wireless Telegraph Regulations. The "Gazzetta Ufficiale" contains the text of a Decree (No. 1,587) relative to wireless installations on board merchant ships. Merchant vessels carrying 50 or more persons on board must, unless they are specially exempted, be provided with radiotelegraphic installations.

Radiotelephony in Argentina.- A laboratory is being fitted up at the Radiographic station at the Darsena Norte, for the purpose of making experiments in radiotelephony. It is hoped to be able to effect communication over a distance of 200 miles.

Telephony in Argentina.—The Minister of Public Works of the Province of Cordoba has authorised the Rio Cuarto Telephone Co. to exploit the telephone systems connecting that city with Sampacho, La Carlota, Pascanas, Dalmacio Vélez, Rio Tercero, Los Reartes and Achiras.

EMPIRE NOTES.

Australasia.—The "British Australasian" says negotiations for the development of Tasmanian iron deposits have been opened with the State Attorney-General by the Australian Electric Steel Co., which is erecting works in New South Wales.

Directors of the company state that the company intend to use an electrolytic process for producing steel direct from the ore and have asked whether the Tasmanian Government would supply power for working the iron deposits in the north-western part of the State. On behalf of the Government an undertaking was given to supply power subject to an agreement as to terms. The Government is investigating the power possibilities of the Lake River and the Arthur Lakes, which may provide a large supply of power for the northern part of the island.

A motor and compressor are being installed at the Mount Lyell Mine (Tasmania) for the new electrically-driven air-compressor plant. When this plant is in operation the whole of the machinery at the company's mines and reduction works will be operated by electric power derived from the company's own Lake Margaret hydro-electric plant.

Canada.—The Dominion Government have taken over the control of the electric power plants on the Canadian side of Niagara Falls in order to expedite munition work and to prevent the exportation of the power to the United States, which is badly needed by Canadian factories.

American works and mills have taken a supply of electrical energy from the Canadian plants in addition to the electrical energy derived from their own power plants. The Canadian plants selling power to the States will now be obliged to cancel contracts or shut down, when the authorities will operate their plants. The action will, probably, also affect the mills, tramways and street lighting of certain towns in Ontario, for current is supplied from Niagara to places within a radius of 150 miles.

South Africa.—The "African World" states that the project for constructing an electric tramway from the Rand to Pretoria has been revived

The electrification of certain urban sections of the railways is being considered.

FOREIGN NOTES.

American Inquiries.—H.B.M. Consul-General in New York (Mr. C. Clive Bayley) requests United Kingdom manufacturers who have branches, agents or other representatives in the United States to forward to him the addresses of such representatives, as these will be of assistance to him in dealing with the frequent inquiries he receives from American merchants.

Colombia.—The Government has given sanction to the Municipal Council of Remedios (Department of Antioquia) to borrow £5,360 for electric lighting and aqueduct works, to the Municipal Council of San Jeronimo (Department of Antioquia) to borrow £800 for the installation of an electric power plant, and to the Municipal Council of Quibdo (capital of Choco Intendency) to borrow £2,000 for electric lighting works. The Government has also authorised the Municipal Council of Pensilvania (Department of Caldas) to borrow 15,000 pesos gold (3,000) for the installation of an electric power plant; and the Municipalities of Angostura and Venecia (Department of Antioquia) to borrow 4,000 pesos (£800); and 5,000 pesos (£1,000) respectively for similar purposes.

U.S.A.-Argentine Telegraph Project.—The "Review of the River Plate" states that the Western Union Telegraph Co., in combination with the American International Corpn., has decided to construct two telegraph lines between the United States and Buenos Ayres, and that a commission will shortly leave New York to study the matter.

Venezuela. An American consular report from Maracaibo states that since the local electric light company decided to supply power during the day increasing interest has been shown in electric power and heating devices.

There is a good opening for all kinds of electrical appliances for domestic and industrial use, such as fans, stoves, irons, large ovens for bakeries, motor-driven pumping outfits for private houses, motors of 1 H.P. to 25 H.P. Catalogues and prices might be sent to the Maracaibo Electric Light Co.

A company was organised in Barinas, Venezuela, to build an electric plant in that city. Sr. J. M. Rodriguez is president, and Sr. S. Jiménez, secretary.

MISCELLANEOUS NOTES.

Blackmail Charge.—At the Central Criminal Court last week Thomas Absalom Jackson was found guilty of having demanded money with menaces from Marconi's Wireless Telegraph Co. (Ltd.) and from Mr. Godfrey Isaacs (managing director of the company) and of offering to prevent the publication of certain matters with intent to extort money. The accused was sentenced to three years' penal servitude.

Enemy Firms in Foreign Countries.—The "London Gazette" of Dec. 8 contains further lists of additions to, removals from and alterations in the list of persons and firms with whom all business relations are prohibited.

Amongst the additions are: *Portugal.*—Thomson-Houston Iberica (*see* Allgemeine Elektricitâs Ges.); *Spain.*—Orenstein & Koppel—Arthur Koppel—Soc. Anon, Barcelona, and all other branches in Spain.

Enemy Firms Wound-up.—The Board of Trade has ordered the winding-up of 377 businesses controlled by alien enemies.

The latest list includes Hills, Menke & Co. (Ltd.), 154, Great Charles-street, Birmingham, general export merchants (Controller: H. A. Sharp, 120, Colmore-row, Birmingham); Greenwich Time (Ltd.), 106, Albany-street, London, N.W., selling and letting out on hire clocks (Controller: S. F. Stephens, 12-14, Arthur-street, E.C.).

Claims against Vincit (Ltd.), 21, South-road, New Southgate, London, N., are to be sent to Mr. C. Eves, 62, New Broad-street, E.C., by Jan. 16.

Claims against the New York-Hamburg India Rubber Co., (Ltd.) are to be sent to Mr. H. E. Clark, 7, St. Mildred-street., E.C. by Dec. 28.

Inquest.—At Coxledge last week an inquest was held on Geo. Soulsby, an apprentice fitter and electrician, employed by the Burradon & Coxledge Coal Co., at Hazelrigg Colliery.

M. Dickinson, an engineman, stated that about 11 a.m. on the 3rd inst. deceased went into the engine-house. After an absence from the engine-house of about two minutes he found deceased lying on his back on the floor. Artificial respiration was tried without effect. On examining the place witness found that deceased had been tampering with the electric controller. He had opened the box and come into contact with the electric-current.

M. Richardson, enginewright, stated that he gave deceased instructions to "blow out" the motor. He did not intend that he should clean the contacts, because he knew that he would not have time, although he was quite capable of doing so.

A verdict of "accidentally electrocuted whilst attempting to open the electric controller before 'cutting' the main switch," was returned.

Municipal Tribunal Case.—Two electrical engineers of the Islington (London) Borough Council asked the London Munitions Tribunal to grant leaving certificates because they had been refused the 3s. war rate granted to engineers on Nov. 7. Unless they obtained the extra 3s. or left the employ of the Council they would be turned out of their trade union.

For the Council, Ald. SAINT stated that each man was getting an average wage of £2. 10s. per week, and the Council desired to pay fair wages. The Council were supplying electrical energy at 1d. per unit, and were making no huge war profits. Neither did the men have to work under high pressure. If the wages were raised the increased working costs would mean that the rates would have to bear part of the cost of running the undertaking.

The case was adjourned in order that representatives of the men's trade unions might be called.

Prohibited Goods Forfeited.—At Liverpool last week the Excise authorities claimed the forfeiture of certain goods which had been seized at that port on arrival from the United States.

In one case a large quantity of motor-car parts, consisting of carburettors, were claimed by the Anzac Motor Co., of London, having been consigned to them by the Marvel Carburettor Co. (of Michigan, U.S.A.). For the prosecution it was stated that these had been imported in contravention of the Prohibition of Imports (No. 3) Proclamation, 1916, and were therefore liable to forfeiture.

In the second case a consignment of electric light reflectors for Gaston Williams & Wigmore (Ltd.), of London, were similarly seized, they being prohibited goods under the No. 4, Proclamation. It was stated that the goods were ordered before the Proclamation came into force, but owing to congestion of traffic they were not delivered in this country in time to escape the operation of the Proclamation.

In both cases the Stipendiary Magistrate made an order forfeiting the goods with five guineas costs.

Prohibition and Restriction of Exports.—On Dec. 12 His Majesty in Council ordered that the following additions and alterations be made in the Schedule to the Proclamation of May 10, 1916:—

The following are to be deleted:—(*A*) Peroxide of manganese, (*B*) Electric lamps (except carbon lamps and arc lamps for street lighting). (*B*) Lead, pipe, scrap or sheet, and solder containing lead. (*C*) Pocket lamp cases and cases fitted with bulbs but not containing batteries, (*A*) Valves, gas, steam and water. (*A*) Wood screws, made of brass, iron or steel.

The following are to be added: (*C*) Iridium, osmium, palladium, rhodium and ruthenium compounds, (*A*) Peroxide of manganese and all mixtures and preparations of same, (*C*) Sulphites, metallic, not otherwise prohibited, (*C*) Thiosulphates, metallic, not otherwise prohibited, (*A*) Zirconium compounds, (*B*) Electric lamps, (except carbon filament lamps, arc lamps for street lighting and pocket electric lamps and their component parts), (*C*) Electric lamps, pocket and their component parts, (*A*) Fuel economisers, used in connection with steam boilers, (*C*) Iridium, osmium, palladium, rhodium, ruthenium and alloys of these metals, (*B*) Lead (except pig lead), alloys of lead, solder containing lead, and manufactures of lead or its alloys, not otherwise prohibited, (*A*) Thorium and its alloys, (*A*) Zirconium and its alloys, (*C*) Valves, gas, steam and water, (*C*) Wood screws, made of brass, iron and steel, (*B*) Zirconium minerals.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during November, 1916, and (*b*) the aggregate figures from Jan. 1 to Nov. 30, with increase or decrease compared with corresponding periods of 1915:—

Electrical machinery, (*a*) £64,841 (decrease £55,265), (*b*) £1,029,928 (decrease £364,933); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £12,662 (decrease £4,925), (*b*) £194,735 (decrease £45,902); and electrical machinery unenumerated, (*a*) £52,180 (decrease £40,340), (*b*) £835,193 (decrease £319,031); telegraph and telephone cables, submarine, (*a*) £7 (decrease £177), (*b*) £7 (decrease £304); other than submarine, (*a*) £4,655 (increase £2,515), (*b*) £75,604 (increase £47,319); telegraph and telephone apparatus, (*a*) £15,880 (decrease £14,016), (*b*) £227,915 (increase £118,921); other electrical wires and cables, rubber insulated, (*a*) £11,564 (increase £7,823), (*b*) £118,545 (increase £32,025); with other insulations, (*a*) £578 (decrease £56), (*b*) £14,766 (decrease £29,096); carbons, (*a*) £4,261 (decrease £11,536), (*b*) £77,986 (decrease £56,711); glow lamps, (*a*) £16,475 (increase £6,293), (*b*) £259,584 (increase £125,934); arc lamps and electric searchlights, (*a*) nil (decrease £136), (*b*) nil (decrease £2,800); parts of arc lamps and searchlights (other than carbons), (*a*) £11,853 (increase £5,241), (*b*) £104,303 (increase £25,176); primary and secondary batteries, (*a*) £25,372 (decrease £10,523), (*b*) £192,206 (increase £48,192); meters and measuring instruments, (*a*) £4,413 (decrease £22), (*b*) £48,452 (increase £19,772); switchboards, (*a*) £10 (decrease £175), (*b*) £267 (decrease £4,182); electrical goods and apparatus unenumerated, (*a*) £38,580 (increase £16,971), (*b*) £340,372 (increase £152,530). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £133,648 (increase £2,314), (*b*) £1,400,007 (increase £475,776).

Exports.—The exports of electrical machinery, material, &c., (*a*) during November, 1916, and (*b*) from Jan. 1 to Nov. 30, with increase or decrease compared with corresponding periods of 1915, were as follows:—

Electrical machinery, (*a*) £136,884 (increase £19,671), (*b*) £1,386,291 (increase £83,422); including railway and tramway motors, (*a*) £1,039 (decrease £6,738), (*b*) £34,248 (decrease £72,762); other generators and motors except for aeroplanes, motorcars and cycles, (*a*) £80,817 (increase £1,149), (*b*) £758,800 (increase £118,380); and electrical machinery unenumerated, (*a*) £55,028 (increase £22,260), (*b*) £593,243 (decrease £37,804); telegraph and telephone cables, submarine, (*a*) £19,342 (decrease £40,625), (*b*) £423,488 (increase £70,127); other than submarine, (*a*) £35,471 (decrease £25,161), (*b*) £475,907 (increase £70,542); telegraph and telephone apparatus, (*a*) £25,326 (decrease £5,261), (*b*) £235,515 (increase £33,452); other electrical wires and cables, rubber insulated, (*a*) £34,945 (decrease £38,526), (*b*) £516,277 (increase £183,720); with other insulation, (*a*) £39,063 (decrease £21,194), (*b*) £721,432 (increase £252,737); carbons, (*a*) £382 (decrease £676), (*b*) £9,790 (increase £1,587); glow lamps, (*a*) £23,210 (increase £8,080), (*b*) £180,782 (increase £34,436); arc lamps and searchlights, (*a*) £1,471 (decrease £1,355), (*b*) £9,449 (increase £2,488); parts of arc lamps and searchlights (other than carbons), (*a*) £6,608 (increase £5,520), (*b*) £21,710 (increase £946); primary and secondary batteries, (*a*) £15,730 (decrease £779), (*b*) £246,869 (increase £65,680); meters and measuring implements, (*a*) £16,249 (increase £1,783), (*b*) £194,652 (increase £54,717); transformers, (*a*) £12,504 (increase £4,790), (*b*) £100,169 (increase £3,431); switchboards, (*a*) £3,450 (decrease £267), (*b*) £54,808 (decrease £90); electrical goods and apparatus unenumerated, (*a*) £76,018 (increase £17,530), (*b*) £678,589 (increase £138,627). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £309,769 (decrease £96,141), (*b*) £3,869,437 (increase £937,420).

TENDERS INVITED.

Telegraph and Telephone Material.

Tenders are invited by Jan. 10, 1917, for the supply and delivery to the Postmaster-General's Department, State of Western Australia, of telephone instruments and parts (W. A. Schedule No. 497). Tender forms, specification, &c., can be obtained at the Commonwealth Offices, 72, Victoria-street, S.W. *See also an advertisement.*

Tenders are invited up to Dec. 22 for the supply to the Australian Commonwealth Postmaster-General's Dept., State of W. Australia, at the Telegraph Office, Eucla, of 340 Accumulators, with associated apparatus, as per schedule No. 492,

Electric Bell Wiring Materials.

The Commissioners of H.M. Works, &c., are prepared to receive tenders for the supply of Materials for Electric Bell Wiring. Forms of tender, conditions of contract, &c., from the Controller of Supplies, King Charles street, Westminster, S.W., and tenders (by 11 a.m. of Dec. 18) to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W.

Turbo-Alternator and Condensing Plant.

Durban Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-Alternator and Condensing Plant. Specification (No. [illegible] 258) from Borough Electrical Engineer.

Air Duct for Turbine.

Manchester Electricity Committee require tenders for the supply and erection of a Steel Air Duct for No. 15 turbine at Stuart-street generating station. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Motor-Generator, Motors, &c.

Dunedin (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

Cape Town (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

Meters, M. D. Indicators, &c.

Sydney (N.S.W.) Council require tenders by 3 p.m. Feb. 19 for supply of meters, maximum demand indicators and feeder regulators. Specifications, &c., from the Electric Lighting Dept., Town Hall, Sydney.

Electrical Fittings, &c.

West Ham Guardians require tenders by 10 a.m. Dec. 21 for three months' supply of Electrical Fittings, &c. Forms of tender from the Clerk, Union road, Leytonstone, London, N.E.

Tramway Materials, &c.

London County Council require tenders by 1 p.m. Dec. 19 for supply of 325 tons of Rolled Steel Bar for magnetic brake shoes. Forms of tender from the Chief Officer, L.C.C. Tramways, 62, Finsbury pavement, E.C.

Johannesburg Corporation require tenders by noon Jan. 3 for Iron Axles and Bushes (contract 163). Specifications, &c., from the Municipal Offices (Room 53).

Electricity Supply Concession.

Extension of Time. The time for sending in tenders for Generating and Supplying Electrical Energy for Lighting and Power in St. George (Grenada) and its suburbs is extended to Dec. 31. Particulars from Colonial Secretary, Grenada (British W. Indies).

Electric Crane and Coal Transporter Plant.

The N.S.W. Railway and Tramway Department require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

Electric Fittings, &c.

Brighton Guardians require tenders by 10 a.m. Dec. 19 for Electric Fittings, Ironmongers, &c. Forms of tender, &c., from the Clerk, Prince-street, Brighton.

TENDERS RECEIVED AND ACCEPTED

Glasgow.—The following tenders have been accepted for the tramways department:—

Miller & Co., chilled brake blocks, three months' contracts; Pilkington Bros., glass, six months' contracts; Chance Bros., glass; Brown, Bayley's Steelworks, car wheel tyres; A. Shanks & Son, malleable castings; P. & W. MacLellan, iron and steel bars; L. Sterne & Co., springs; J. Murray & Son, Marks & Johnston and J. D. Hamilton, oils.

Bath.—Messrs. Chamberlain & Hookham (Ltd.) have received the contract for electricity meters for the coming year.

Sheffield.—The City Council have accepted the following tenders:

A. Reyrolle & Co., 100-ampere e.h.t. oil break furnace switches, £520. 4s., 30 panels of three phase e.h.t. sub-station switchgear, £5,156; R. White & Sons, taking up and relaying train road track, £487. 10s.; Brush Electrical Engineering Co., 25 double-decked top-covered tramcars without electrical equipment, £1,060 per car (plus 5 per cent. for contingencies).

Salford.—The Corporation are recommended by the Electricity Committee to accept the tender of Messrs. Mossay & Co. for the supply and delivery of an "Orwell" two-ton electrically-driven tipping wagon, fitted with electrical tipping gear, at £795.

Wolverhampton. The Council has accepted the tender of the British Thomson-Houston Co. for a steam turbine-driven boiler feed pump (at £421); and that of Ransome, Simms & Jeffreys for a 2½-ton "Orwell" electric lorry (at £630).

Newport (Mon.).—The Council has accepted the tender of the British Westinghouse Electric & Mfg. Co. for converting plant, at £1,480; and that of the British Thomson-Houston Co. for l.t. b.c. switchgear (at £152), and e.h.t. switchgear, £127. 8s.

Manchester.—The Corporation has accepted the tenders of Pirelli-General Cable Works, Western Electric Co., British Insulated & Helsby Cables and W. T. Glover & Co. for cable for the electricity department.

Stockport.—The Guardians have accepted the tender of R. Bardsley for 144 electric lamps at £13. 13s.

Walsall.—The Council has accepted the tender of the British Thomson-Houston Co. for e.h.t. switchgear, at £315.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

FERRANTI (LTD.)—The profit on trading for the year to June 30, 1916, was £54,377. 9s. 3d., and after crediting transfer fees and deducting general establishment charges, repairs and renewals, legal expenses, income tax, &c., there remains a balance of £21,563. 5s. 7d., and with £1,028. 5s. 4d. brought forward the total is £22,591. 10s. 11d. Deducting interest on first mortgage debenture stock (£4,281. 10s. 6d.), interest on five-year notes (£2,076) and on bank loans (£1,659. 14s. 10d.), and £10,000 placed to depreciation reserve account, the balance to be carried forward is £4,574. 5s. 7d. The results for the year show a satisfactory improvement both in output and profit, notwithstanding the increase in cost of materials, labour, freights and other expenses. During the year £2,800 first mortgage debentures and £800 five-year notes have been redeemed, and loans against five-year notes and second mortgage debentures have been further reduced. Mr. O. Winder has been elected a director during the year, and his appointment will be submitted for confirmation.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—The report for the year ended Sept. 30 states that the accounts show, after provision for doubtful debts, a net profit of £133,778 13s. 5d. Adding £18,937 11s. 11d. brought forward, deducting £12,500, the dividend on the preference shares paid in January and July, and £12,500, the interim dividend on the ordinary shares paid in July, there remains a disposable balance of £127,716 5s. 4d. The directors have restored to the reserve fund the £50,000 which was taken from it to meet the losses sustained by Persan and the foreign branches, and recommend that the half-yearly dividend of 5s. per share, or at the rate of 5 per cent. per annum, be paid to the preference shareholders and that a dividend of 15s. per share (tax free), amounting to £37,500, making with the interim dividend paid in July a total payment of 10 per cent. for the year, be paid to the ordinary shareholders, leaving £40,216 5s. 4d. to be carried forward. No satisfactory estimate can be given as to the war taxation which the company will have to pay in respect of the profits made during the year, but the directors feel sure that the position is amply safeguarded. The directors have to report that the Company's debentures became due for repayment in March last, and under the existing state of the money market they could only be replaced at £93 and at 5 per cent. instead of 4 per cent. interest. This entailed an expenditure in cash of £28,000 and an extra liability in interest of £4,000 per annum for ten years. The directors took the opportunity of the great demand for tonnage to sell the cable ship "Silvertown," which had little prospect of cable work during the war. The "Dacia," after an absence of more than four months abroad, has been sunk by a torpedo, but all hands have been saved. She was fully covered by insurance. The Silvertown works became a controlled establishment on May 1 last. Col. Weston Jarvis has been serving with His Majesty's forces in Gallipoli and Egypt since April, 1915, and is now home. Mr. Hanbury joined the army and is with his regiment in France.

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The report for the year ended Sept. 30 states that the profit was £9,742. There was a saving of £2,445 in working expenses and the profit balance for the year is sufficient to cover all interest charges and to leave £389 to be carried forward.

MANX ELECTRIC RAILWAY CO.—The accounts for the year ended Sept. 30 state that the gross receipts were £8,150 and the expenditure was £8,885, showing a loss of £734; adding debit balance from last year (£9,436) and debenture interest (£9,000) the debit balance on revenue account is £19,170.

UNITED ELECTRIC CAR CO. (LTD.)—A circular has been issued to the shareholders on behalf of Messrs. Dick, Kerr & Co., stating they are prepared to acquire the preference and ordinary shares of the United Co. on certain terms. Preference shareholders of the United Co. will get one 6 per cent. cumulative preference share of £1 (fully-paid) in Dick, Kerr & Co. in exchange for each preference share of the United Co., the preference shares in Dick, Kerr & Co. given in exchange to rank for the full six months' dividend payable on April 1, 1917, or, in the alternative, they will pay 20s. cash. For ordinary shares, the price will be 15s. in cash for each ordinary share. The present directors of the company (other than Mr. Prestwich, who is vice-chairman of Dick, Kerr & Co.) have agreed to transfer the shares held by them on the above terms. A meeting of the shareholders will be called, when the present directors of the company (other than Mr. Prestwich) will retire from the board, and the shareholders will be invited to appoint a new board in their place, consisting of persons to be proposed by Dick, Kerr & Co. They have agreed to pay £3,000 to the directors retiring as compensation for loss of office. The directors of the United Electric Car Co. have also issued a circular, in which they say they consider the terms are fair, and are recommended for acceptance.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

BRITISH COMPRESSED AIR PUMPS (LTD.) (145,352.)—Reg. Nov. 21, capital £2,500 in 2,000 ordinary shares of £1 each, and 10,000 deferred shares of 1s. each, to carry on the business indicated by the title, and that of mechanical, electrical and general engineers, manufacturers of machinery, tools, boilers, &c. First directors are E. A. Eaover and F. H. Bailey (both permanent).

CO-OPERATIVE ENGINEERS (LTD.) (145,296). Reg. Nov. 14, capital £1,000 in £1 shares (500 deferred), to carry on the business of general engineers, founders, manufacturers of machinery and parts, tool makers, electrical and motor engineers, &c. Private company. First directors are W. N. Wright, H. Broomfield and two others to be appointed by the subscribers. Reg. office: Newhall Chambers, Newhall-st., Birmingham.

CITY NOTES.

MEMORANDA (Dec. 13).—Bank rate 6 per cent. (since July 13, 1916), Consols, 54¼. Consols Pay Day, Jan. 4. Stocks and Shares Ticket Days, Dec. 28 and Jan. 11. Pay Days, Dec. 29 and Jan. 12. Price of Silver, 36⅝d.

BRITISH VACUUM CLEANER CO. (LTD.)—The report for the year ended Sept. 30 states that after allowing for depreciation the profit is £1,428. The directors recommend a dividend of 2d. per share (being at rate of slightly over 2¾ per cent.), leaving £602 to be carried forward.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend at rate of 8 per cent. per annum (less tax) on the ordinary shares.

EAST LONDON RAILWAY CO.—The directors announce a distribution of 8s. 9d. per cent. on the "B" debenture stock for the year.

EASTERN TELEGRAPH CO. (LTD.)—The company announce the payment on Jan. 15 next of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending Dec. 31, 1916, and the third quarterly dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending 31st inst. The transfer books of the ordinary stock will be closed from Jan. 6 to 13, inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended Sept. 30 last of 3s. per share (tax free), payable on the 15th prox. The share register will be closed from Jan. 6 to 13 next, inclusive.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—A final dividend of 5 per cent., making 10 per cent. for the past year (tax free) has been declared on the ordinary stock for the year ended Aug. 31.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—Year's dividend at rate of 6 per cent. per annum (less tax) has been declared on the preference shares, making the cumulative dividend paid up to 31st inst.

METAL PRICES.

Messrs. J. B. Carnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec. 12, the following as the present basis prices of—

New Metals.	Per lb.		Per ton
Solid Drawn Brass Tubes	18¾d.	English Lead	Nominal.
Solid Drawn Copper Tubes	22½d.	Antimony	Nominal.
Brazed Copper Tubes	22½d.	Old Metals.	Per ton.
Brazed Brass Tubes	20½d.	Clean Copper Scrap	£135 0 0
Brass Wire	17½d.	Clean Brass Scrap	80 0 0
Copper Wire	22d.	Braziery Copper Scrap	110 0 0
Rolled Brass	17½d.	Old Lead	30 0 0
Brass Sheets	17½d.	Old Zinc	42 0 0
	Per ton.	Hollow Pewter	130 0 0
Copper Sheets	£189 0 0	Black Pewter	95 0 0
Spelter	57 0 0	Gun Metal	105 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Dec. 12, the following approximate prices of Scrap Metals:—

	Per ton.		Per ton.
Scrap Brass	£78 0 0	Tea Lead	£28 0 0
Clean Copper	130 0 0	Old Zinc	45 0 0
Braziery Copper	105 0 0	Hollow Pewter	140 0 0
Gun Metal	105 0 0	Shaped Black Pewter	100 0 0
Old Lead	31 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £84; Commercial Tinman's Solder, £105, Blowpipe Solder, £115.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 12.

Shrs.	Last Dividend	Name.	Price, Tues., Dec. 12	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	6%	Bournemouth & Poole E.L. Ord.	8½	7 1 2	Mar., Sept.
10	4½%	Do. 4½% Cum. Pref.	7¾	5 16 2	Feb. Aug.
10	6%	Do. 6% Cum. 2nd Pref.	9⅞	6 1 6	Feb, Aug.
5	10%	Brompton & Kensington Ord.	6 11/16	7 9 6	Mar, Sept
5	7%	Do. 7% Pref.	6¼	5 9 10	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St.	77½	5 3 1	..
St.	4%	Charing Cross West End & City Debs.	79½	5 0 8	Jan, July
5	2/3	Do. 4½ Pref.	3¼	6 18 6	..
5	5%	Do. Ord.	3½	7 2 10	Aug, Feb
5	4½%	Do. City Pref.	3¼	6 18 6	Jun, Dec
5	4%	Chelsea Elec. Supp. Co. Ord.	3¼	6 8 7	Mar, Sept
St.	4½%	Do. do. Deb.	87	5 3 5	Jan, July
10	8%	City of London Elec. Lt. Ord.	11½	6 19 2	Feb, Aug
10	6%	Do. 6% Pref.	9¾	6 1 6	Mar, July
St.	5%	Do. 5% Deb. St.	97½	4 17 6	Jun, Dec
St	4½%	Do. 4½ Debs.	79	5 11 0	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar, Sept
10	6%	Do. 6% Pref.	9¾	6 1 6	Feb., Aug.
St	4½%	Do. 1st Deb.	85	5 5 11	Jan, July
St	4½%	Do. 2nd Deb.	84½	5 6 6	May, Nov
St	4½%	[illegible] Elec. Supp. 4½% Debs.	73½	6 2 10	July
5	7%	Kensington & Knightsbridge Ord.	5 1/16	6 18 3	Feb, Aug
St	4%	Do. Deb. St.	75½	5 6 4	Jan, July
5	6%	London Elec. Supply 6% Pref.	4⅜	6 18 2	..
St	4%	Do. 4% Mort. Deb.	81½	4 19 10	Jan, July
5	3%	Metropolitan Elec. Supp. Ord.	2½	7 1 2	Mar, Aug
St	4½%	Do. 1st Mort. Deb.	80	5 12 6	Jan, July
St	5%	Midland Elec. Corp. 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & District E.L. 6% 1st Debs.	99½	6 0 6	Mar, Sept
St	5%	Newcastle-on-Tyne E. Supp. 2d Mt Db St.	87	5 14 11	Mar, Sept
1	6%	North Metropolitan E.P. Supp. 6% Pref.	15/16	6 11 9	Apl, Oct
4	8%	South London E.S. Ord.	2¼	7 2 3	Mar, Sept

† Ex dividend or interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price Tues., Dec 12	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6	6 13 4	Feb, Aug
5	7%	Do. do. Pref.	5¾	6 1 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	67¼	6 15 2	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1¼	6 8 0	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5¾	6 1 9	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	3⅞	5 16 2	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St	6%	Do. 6% Cum. Pref.	76	7 17 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	65	6 3 1	..
St.	4%	Do. do. Assented Def. Ord.	70½	5 13 8	..
St.	4½%	Do. 4½% Pref.	82½	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	74½	5 7 6	Jan, July
St.	4%	City & S. London Deb.	67	5 19 1	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2½	6 0 7	Jan, July
St.	4%	Do. 4% Pref.	61	6 11 2	Mar, Sept
St.	4%	Do. 4% Debs.	70¼	5 13 11	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23⅛	4 6 7	Feb, Aug
St.	3½%	Do. 3½% Pref.	57½	6 1 9	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	53	6 5 0	Feb, Aug
St.	3½%	Do. 3½% A Debs.	61	5 12 1	Jan, July
St.	3½%	Do. 3½% Debs.	63¼	5 10 8	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15¼	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	68¼	5 7 8	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105¾	5 13 6	Jan, July
St.	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	65½	6 2 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2⅞	5 4 4	Apl, Oct
1	6%	Do. 6% Pref.	1 11/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1½	4 13 4	Mar
100	5%	Do. Prior Lien Debs.	90⅞	5 10 0	Jan, July
1	6%	Do. 6% Pref.	29/32	6 12 5	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	12	7 5 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5 5/32	5 16 4	Jan. July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	29/32	6 12 5	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2½	5 18 10	April
100	6%	Do. 6% Prior Lien Debs.	100¾	5 19 2	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	68	5 17 7	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	13	7 13 10	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A £3 pd.	½	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1 1/16	7 1 2	May
1	7%	Do. 7% Cum. Pref.	1 1/32	6 15 9	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	13 7/16	7 8 10	July
10	6%	Do. 6% Pref.	9 23/32	6 3 2	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16 1/16	6 4 5	Feb, Aug
5	4½%	Do. 4½% Cum. Pref.	4	5 12 6	..
St.	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	13 5/32	7 12 0	Feb, Aug
10	5%	Do. Pref.	7⅜	6 7 0	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	37¾	6 7 2	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	1⅞	6 13 4	May, Aug
1	5%	Do. 5% Pref.	13/16	6 3 1	May, Aug
St	4%	Do. 1st Debs.	75½	5 6 0	June, Dec
100	4½%	Do. 4½% 2nd Debs.	99	4 10 11	June, Dec
St.	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St.	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95¼	6 6 0	Fb, My, Aug, N
St.	1½%*	Do. Def. Ord.	23 9/16	6 19 7	Fb, My, Aug, N
St.	4%	Commercial Cable 4% Debs.	70¾	5 13 1	Ja, Ap, Jly, O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6	6 13 4	Ja, Ap, Jly, O
St.	8%	Eastern Tel. Co. Ord.	139½	5 14 8	Ja, My, Jly, O
St.	3½%	Do. 3½% Pref.	62½	5 12 0	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	73¾	5 8 6	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	14	5 14 3	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. With Coup. 11	37¼	5 18 1	Ja, My, Jly
25	13%	Indo-European	51¼	6 7 2	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2 11/16	3 14 5	April
1	7%	Do. 7% Pref.	2 5/16	3 0 6	July
10	½%	West India & Panama Ord.	1¼	3 12 7	May, Nov
10	6%	Do. 1st Pref.	7⅜	8 2 9	May, Nov
10	8%	Western Telegh. Co.	14	5 14 3	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	72	5 10 3	June, Dec
..	4½%	Western Union 50-yr. Bds.	99¼	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	29/32	6 12 5	Nov
1	10%	Oriental Telephone Ord.	2 3/16	4 11 5	Apl, Oct
St.	4%	Do. Db. St.	78¾	5 1 7	Jan, July
St.	4½%	Teleph. Co. of Egypt Db. St.	82	5 9 9	Jan, July
5	8%	United River Plate Ord.	6⅝	6 0 9	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅜	5 14 3	Jan, July
St.	4½%	Do. Deb. Stk.	80¼	5 16 6	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	12 7/16	4 16 6	Sp, Dc, Mr, Jn
10	6%	Do. 6% Pf.	10 1/16	5 17 9	Sp, Dc, Mr, Jn
100	5%	Mackay Companies' Common	85¼	5 11 9	Ja, Apl, Jly, O
..	4%	Do. $100 Pref.	70	5 14 3	Ja Apl, Jly, O
100	6%	Submarine Cable Trust Certs	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4 15/16	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	94¼	5 5 10	Jun, Dec
10	6/0	Bombay E.S. & T. 6% Pref.	10¼	5 17 1	..
St.	4½%	Do. 4½% Debs.	82½	5 8 5	Jan, July
5	9%	Calcutta E.S. Corp. Ord.	6 9/16	6 17 2	May, Nov.
5	5%	Do. 5% Pref.	4 5/16	5 16 0	Mar, Sep

* Plus 3/6 bonus. † Ex dividend or interest.

THE ELECTRICIAN:

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NOTES.

Some Labour Problems.

IN a thoughtful Presidential Address to the Junior Association of Engineers, which we give in abstract on another page, Mr. F. W. LANCHESTER touches on many problems affecting capital and labour and their relations after the war. One of these questions is that of piece-work. It is often said that if men put forth their maximum output on a piece-work basis the rate is almost certainly lowered by the employer after a time as the workman appears to be earning an abnormal amount. In this connection Mr. LANCHESTER points out that much depends upon the initial rate that is fixed. If the rate is reasonably and properly fixed in the first instance and the means of production remain the same, then if an employé can make more than the customary wage in his industry the cutting down of the piece-work rate is both unjust and foolish. But, on the other hand, Mr. LANCHESTER contends that it is difficult and sometimes equally unjust to maintain the piece-work price which has been wrongly set in the first instance or which has become obsolete through a change of conditions. Obviously, if a man is able to make by piece-work many times more than a man of equal skill engaged on other work dissatisfaction is likely to arise. The difficulty is that the fixing of a piece-work rate is often a matter of experiment. It appears to us that if piece-work is to be satisfactory to master and to man alike the rate should always be fixed so that, for the workman, there is a material gain over ordinary day work. If this is not so there is not sufficient inducement. On the other hand, if the rate is too high dissatisfaction may arise among those not engaged on piece-work, which we believe is the state of affairs at the present moment in many works.

MR. LANCHESTER also touches upon the question of profit-sharing. The view is taken that many profit-sharing schemes are unsound, due to the fact that the rank and file of the working community cannot afford to gamble. It is undoubtedly a fact that the wages bill of any concern is the first charge on the undertaking and therefore the most secure, whereas the dividend is the most speculative and least certain item. Consequently, if an undertaking is paying a dividend, and profit-sharing is adopted, the men in that undertaking may be much better off than those in another firm which is not in a state of prosperity and which is not paying a dividend, notwithstanding the efforts of the employés. Only dissatisfaction would be felt by the employés of the second firm in comparing their lot with that of the first. There is also the difficulty that a state of prosperity may be followed by a state of depression, in which case the employés may feel the state of depression acutely because the profit part of their earnings is necessarily knocked off. Mr. LANCHESTER'S view is that profit-sharing is largely unsound and that it is more satisfactory to depend on a certain fixed wage. The question is certainly one of considerable difficulty, more particularly because it adversely affects any firm which is not able to pay a dividend, a state of affairs which arises generally in every new business, for possibly some years. Even so, we feel that there is a great deal to be said in favour of the employés having some direct interest in the success of every business with which they are connected.

Motor Drives for Rolling Mills.

ALTHOUGH many articles have been written on this subject, the literature on the designing of electrical drives for rolling mills is scanty. Those interested will find elsewhere in this issue an informative article by Mr. W. KNIGHT, in which the principal points to be considered are dealt with at some length. Mr. KNIGHT rightly emphasises the importance of the friction losses and states that in many mills the friction of the mill itself is about 20 per cent. of the normal rated output of the motor, and that the total friction losses are about 50 per cent. of the power used per ton of steel rolled. In order to lessen the arithmetical difficulties an ingenious graphical method is described for determining the load imposed on the motor at any instant during the process of rolling. As an example, Mr. KNIGHT gives a 1,500 H.P. induction motor coupled to a blooming mill and determines the proper size of flywheel to use when the motor, which runs normally at 80 revolutions per minute, and slows down 20 per cent. from no load to a maximum load of 1,875 H.P. We venture to think that an equally clear article on the mechanics of the mine hoist and the determination of the sizes of the several dynamo-electric machines and flywheel connected with the electric winding engine would be welcomed by many mining engineers and electrical students. The latter, although familiar with the principles, are, as a rule, unable to apply their knowledge to a concrete example.

Electric Furnaces at Sheffield.

It is sometimes felt that we move too slowly in this country in electrochemistry and electrometallurgy. Perhaps this is due to the fact that our manufacturers are particularly secretive in regard to such processes, some of which have been in operation for a great many years. As far as the electric furnace is concerned, electric smelting is out of the question in Great Britain on account of the cheapness of our fuel: and, consequently, the only line in which the electric furnace can find application is in the production of special steels and in the refining of steel. Although we hear very little about it, there is no doubt that considerable progress is being made in this direction at Sheffield, which may be looked upon as the centre of the steel industry. It is stated that there are at present 20 electric furnaces connected to the electricity supply network of that city, and that 16 are waiting to be connected, the total capacity being equivalent to an output of 100,000 tons of steel per annum. This particular application is now becoming so developed that the Sheffield Corporation have decided to promote a Bill for powers to erect a new generating station just outside the borough boundary at a cost of £1,500,000, with a view to giving a suitable supply. It is also interesting to note that the Corporation have formed a Development Committee, charged particularly with the duty of keeping in touch with consumers and seeing in what way developments in electricity supply are desirable. We are glad to see that the Corporation are realising the importance of giving an adequate supply to meet needs of this kind, and that they are looking to the future rather than depending merely upon the needs of the present.

Russia's New Arctic Railway. An important development in Russia is the completion of the Murman Railway from Petrograd to the ice-free port of Alexandrovsk on the Arctic Ocean. Apart from its present strategic value it is expected that the line will have great commercial possibilities after the war. Eventually it will be linked up through Finland with the lines of the Grand Duchy and will greatly assist the exploitation of what may prove the richest forests in Europe.

Wireless Telephonic Communication between Generating Stations. The drainage Board of Chicago has authorised the installation of wireless telephones at the generating station at Lockport and the receiving station in Chicago. The energy from Lockport is transmitted to Chicago, 32 miles distant, over a twin-circuit transmission line of steel towers at 11,000 volts. At certain seasons of the year lightning is extremely severe, putting the telephone system out of commission. It is to overcome this difficulty—namely, to permit communication between the two stations when most needed—that wireless telephones are to be installed.

The New Ministry. Mr Lloyd George has now completed the formation of the Government and we are pleased to see that in the allocation of the minor offices he appears to have borne in mind the commercial and business capacity of the office holders. In addition to the list of Ministers given in our last issue, the following appointments, which have since been made, are of interest to our readers:

Mr. S. H. Lever, Financial Secretary to the Treasury; Mr. G. H. Roberts, Parliamentary Secretary to the Board of Trade; Mr Hayes Fisher, Parliamentary Secretary to the Local Government Board; Mr Herbert Lewis, Parliamentary Secretary to the Board of Education; Major Baird, Parliamentary Secretary to the Air Board; Sir L. Worthington Evans and Mr Kellaway, Parliamentary Secretaries of the Ministry of Munitions; and Mr Pike Pease, Assistant Postmaster General.

Electric Traction in Buenos Ayres. According to an article in "The Times" Engineering Supplement, the tramway system of Buenos Ayres is the largest of any one city in the world, there being some 330 miles of line in operation, using over 2,000 cars, and yielding an annual revenue exceeding two millions sterling. This is a remarkable fact when it is remembered that the population is only about one and a half millions, whereas in London, with over seven millions, the County Council's receipts are not much higher. The outer lines of the Western Company are now being electrified, and the Central Argentine Railway is also making extensions which will comprise about 100 miles of single track. Power will be taken on the three-phase system from a power station of 18,000 kw. capacity at Canal San Fernando. Moreover, the Buenos Ayres Great Southern Railway is also electrifying its suburban lines on the same system as the Central Argentine.

American Telegraph Progress.—Since the outbreak of war great progress in telegraphic methods has been made in the United States, and it is estimated that the traffic now reaches 200,000,000 messages a year—more than double the traffic of a decade ago. Some remarkable instances of enterprises are mentioned in the "Telegraph and Telephone Journal." One firm, growing weary of a three days' post between New York and Chicago, has installed a private multiplex printing telegraph between the two cities. The typists, instead of writing letters for signature, type at the telegraph machine and the letters are printed 1,000 miles away, so that replies are received in five minutes, instead of a few days.

Large German Electric Central Station.—According to "Engineering," work at the Golpa-Iessenitz lignite deposits and the large electric central station which is to be supplied with fuel from these deposits has been somewhat retarded on account of underground water and unfavourable weather. The power station has a capacity of 180,000 kw., and the installation requires 64 boilers. The concern belongs to the Berlin Electricity Works. Whilst the work is going on energy has been generated mostly by means of fuel from other sources. During the last year efforts have particularly been aimed at supplying as soon as possible the current necessary for the Bavarian Nitrogen Company and the Electro-Saltpetre Company. The contract with the latter concern, which is located in the vicinity of the power station, is for 240,000,000 kw.h. annually. The station began work in December, 1915, with a continuous load of 15,000 kw., which by the end of the financial year, June 30, had risen to 25,000 kw. The current year also will be marked by continued construction and a gradual increase of the energy generated.

A National Science Laboratory in France. The "Comptes Rendus" of the Academy of Sciences contains a note on an interim report by a Committee composed of various eminent French scientists on the above question.

While Great Britain and other countries possess National Laboratories, such as the National Physical Laboratory (England), the Bureau of Standards (U.S.A.) and the Technische Physicalische Reichsanstalt (Germany), there is no institution of the same kind in France. The Academy of Sciences has accordingly passed a resolution putting on record the need for such a laboratory. The constitution of the controlling Council has also been discussed. It is suggested that one half the members of the Council should be nominated by the Academy, one quarter representatives of State Departments, and the remainder representatives of the chief industrial interests of the country. Several existing laboratories may be incorporated in the proposed institution.

Harnessing a Volcano. Entitled "Harnessing a Volcano to a 15,000 H.P. Electric Power-house," Prof. Luiggi, D.Sc., recently contributed an interesting article to "Engineering." In Central Tuscany there are numerous cracks in the ground, from which jets of steam spout high in the air with great violence and constancy. These powerful jets are called *soffioni*, and have been utilised for the warming of houses and other purposes, but it was not until 1903 that an attempt was made to utilise this steam for the production of motive power. To obtain a more ample supply of steam, bore holes varying in diameter from 12 in. to 20 in. were driven down to the source of the steam, which is under a hard stratum of rock about 300 ft. to 500 ft. below the surface. Experiments demonstrate that each bore can provide steam at a temperature of at least 150° C., and at the rate from 15,000 kg. to 25,000 kg. per hour, which corresponds to about 1,000 H.P.

to 2,000 H.P. per hour. After numerous experiments on a small scale, these groups of condensing turbo-alternator units, each of 3,000 kw., working with superheated steam at 22 lb. per square inch, were ordered, and are now said to be working satisfactorily. The three-phase current, generated at 4,500 volts, 50 cycles, and transformed to 36,000 volts, is transmitted to Florence, Leghorn and other towns in Tuscany. Similar utilisation of volcanic heat is contemplated in the "Campi Flegrei," near Naples.

A Labour Programme on Education.—In view of the appointment of Mr. H. A. L. Fisher, the Vice-Chancellor of Sheffield University, as Minister of Education, it is interesting to note in "The Times" Educational Supplement a summary of the proposals of the Workers' Educational Association, a body in which Mr. Fisher took a deep interest.

The following are a few out of a large number of proposals :

1. That the age for exemption from compulsory attendance at school should be 16.
2. That part-time education should continue up to the age of 18, and that the hours of labour for young persons under this age should be limited to a maximum of 25 per week.
3. Free provision for suitable scholars to enter secondary schools.
4. Limitation of size of classes in schools to 30 scholars.
5. Technical education to be regarded as supplementary to good general education ; close contact to be maintained between the Universities and Technical Institutes, and a generous provision of grants to enable students with a bent for scientific and technical work to enter the Universities.

The general trend of these and other proposals is to fill in the gaps between lower and higher education. It is also suggested that, in view of the importance of discussion of educational problems among the community, State aid should be given towards the organisation of special educational work, such as the University Tutorial Classes, promoted by the W.E.A.

OBITUARY.

Wm. Ellis.—The death recently took place of Mr. William Ellis F.R.S., who was formerly superintendent of the Magnetical and Meteorological Branch of the Royal Observatory, Greenwich. He joined the Observatory in 1841, and was attached to the Astronomical Department until 1874, having during the preceding 18 years been in charge of the chronometric and electric branch. Mr. Ellis was in his 89th year.

Killed in Action.—The following deaths in action or of wounds are reported :—

Sec.-Lieut. J. S. Gibson (Bedford Regt.), who died the day following that on which he was wounded by a shell (Oct. 14), was 32 years of age, and an electrical engineer.

Capt. P. T. Foyster, R.E., 28 years of age, who died of wounds on Dec. 11, was an assistant engineer to the British Engine, Boiler & General Insurance Co.

Mr. L. McKechnie, switchboard attendant in Barrow Corporation's electricity department, is reported to have died in action.

Pte. H. Evanson (M.G.C.), 27 years of age, reported killed, was formerly employed at the General Electric Co.'s works, Witton, Birmingham.

Pte. P. A. Davis (Warwickshire Regt.), 23 years of age, who has been killed, was a conductor on the Birmingham Corporation tramcars.

Members of the staff of the County of London Electric Supply Co. who have died on active service (in addition to those recorded in our last issue) include Electrician F. W. Allsup, R.N. ; Electrician A. E. Craker, R.N. ; and Pte. W. Cox (4th Dorset).

PERSONAL.

Mr. Neville Chamberlain, Lord Mayor of Birmingham, has been appointed Director-General of National Service.

☞A peerage has been conferred upon the Right Hon. C. B. Stuart-Wortley, K.C., M.P. The new peer is chairman of the City & South London Railway and the London & Suburban Traction Co. ; and also a director of the Underground Electric Railways Co. of London and the Central London Railway.

Sir Albert Stanley, the new President of the Board of Trade, has been adopted as the candidate for Ashton-under-Lyne, in succession to Sir Max Aitken, who has been elevated to the peerage. Sir Max Aitken is a director of several Colonial electric power companies.

At the recent meeting of the Senate of the University of London the title of Emeritus Professor of Physics in the university was conferred on Dr. F. T. Trouton, Sc.D., F.R.S., who held the Quain Chair of Physics at University College from 1902 to 1907, and after the incorporation of the college held it in the university from 1907 to 1915.

War Honours.—Mr. R. Williams, formerly engaged in the mains section of Barrow electricity department, has been awarded the Military Cross.

Sergt. W. E. Rickard, R.A.M.C., a former employé of the India Rubber, Gutta Percha & Telegraph Works Co., has been awarded the Military Medal.

War Casualties.—In addition to those in our Obituary column, the following casualties are reported :—

Pte. R. Young, formerly in the service of the Willesden electricity department, has been missing since July 1.

Former members of the staff of the County of London Electric Supply Co. and associated companies who have been wounded are Lieut. L. Roseveare, R.G.A. (County of London Co.) ; Sergt. T. Brown, R.E. (Richmond Co.) ; L.-Corp. A. Homewood, 12th K.R.R. (County of London Co.) ; Pte. G. Everingham, R.A.M.C. (Bournemouth & Poole Co.) ; A. B. Seaman H. Bagg, R.N.R. (Bournemouth & Poole Co.).

APPOINTMENTS VACANT AND FILLED.

An advertiser wants lady assistants for an electrical test room.

An experienced foreman armature winder is required for a.-c. and d.-c. winding department of Manchester controlled firm. *See advertisement.*

An assistant electrical engineer, with experience in testing meters and electrical instruments, is wanted by a London firm. *See an advertisement.*

A meter and instrument tester is required by large electric power company in the Midlands. *See an advertisement.*

A shift engineer is wanted for the London district, with experience in the running of large generating stations. *See advertisement.*

An advertiser wants a first-class female coil-winder, with experience of high-class telegraph instruments.

Mr. A. W. Johnson, at present employed at Greenwich station of the L.C.C., has been appointed a charge shift engineer at £250 a year, rising by annual increments of £10 to £300 per annum.

Mr. E. Eastwood, who for the past 11 years has had charge of the electrical repair shops of the L.C.C. tramways at their central repair depot, has resigned his appointment, and has accepted the post of manager for the Electrical Repair Co., of Brockley, S.E.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—A Christmas card is being sent to all members of the Institution on active service, expressing to them the hearty greetings of the President and Council and wishing them God-speed and a happy return.

ARRANGEMENTS FOR THE WEEK.

ROYAL INSTITUTION.

Meetings at Albemarle-street, Piccadilly, London, W. Six illustrated lectures adapted to a juvenile auditory, on "The Human Machine which all Must Work," by Prof. Arthur Keith, M.D., F.R.C.S., LL.D., F.R.S.

Thursday, Dec. 28th.
3 p.m. Lecture I., "Living Engines."
Saturday, Dec. 30th.
3 p.m. Lecture II., "Living Levers."
Tuesday, Jan. 2nd.
3 p.m. Lecture III., "Living Pumps."
Thursday, Jan 4th.
3 p.m. Lecture IV., "Living Bellows."
Saturday, Jan. 6th.
3 p.m. Lecture V., "Living Workshops."
Tuesday, Jan. 9th.
3 p.m. Lecture VI., "Living Wires and Central Exchanges."

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week :—

Officer for the Week.—Platoon Commander L. C. Hughes Hallett.

Next for Duty.—Platoon Commander, J. O. Cheadle.

From Thursday, December 21st, to Thursday, December 28th, inclusive. Headquarters closed.

Friday, December 29th.—Technical for Platoon No. 10 at Regency-street. Squad and Platoon Drill, Platoon No. 9. Signalling Class. Recruits' Drill, 6.25 to 8.25.

Muskotry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

MOTOR DRIVE FOR OPERATING STEEL ROLLING MILL.*

BY W. KNIGHT.

Summary.—A survey is made of the main points to be considered in designing an electric drive for a rolling mill, and a graphical solution is given which, it is hoped, will simplify the necessary calculations for determining the load imposed on the motor at any instant during the process of rolling.

In order to combine efficiency and economy in rolling mill drives the demand for power on the generating station must be as steady as possible. This is usually obtained by using a flywheel in conjunction with the motor and a speed-controlling device which reduces the speed of the motor and flywheel, enabling this to give up some of its stored energy during the period of retardation. Commercial motors can stand a momentary overload of only 100 per cent. for a few seconds without being injured. If we assume that the motor would fall in speed about 6 per cent. from no load to 100 per cent. overload, the flywheel would give up only about 11 per cent. of its stored energy, and in order to supply the balance of energy equivalent to four times the normal load of the motor, which is required for a few seconds when the ingot is between the rolls, the inertia of the flywheel and motor would be such that a flywheel abnormally heavy should be used which would not be a commercial proposition. If, instead, we artificially increase the slip of the motor as the power demand increases (say, for instance, a 20 per cent. slip is provided from no load to 100 per cent. overload), the percentage of energy given up by the flywheel will be 36 per cent. instead of 11 per cent., and the needed flywheel effect will be 3·3 times smaller than it would have been if no speed controlling device had been used. In this case a flywheel of moderate weight and size could be successfully used to take care of heavy demands of power for a short time only.

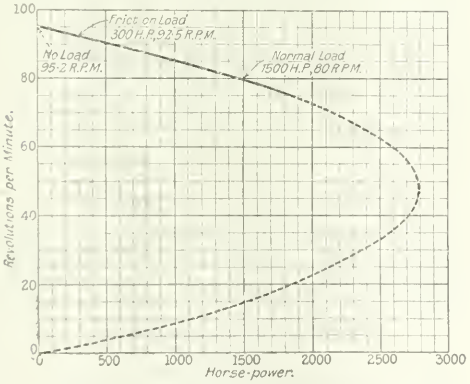

FIG. 1.—LOAD CARRIED BY 1,500 H.P. 80 R.P.M. MOTOR AT DIFFERENT SPEEDS WHEN TORQUE AT ANY SPEED VARIES AS THE SLIP.

Two devices are generally used for controlling the fall in speed in the motor, the continuous slip regulator and the intermittent slip regulator. The continuous slip regulator consists of a resistance permanently inserted into the rotor circuit of the motor, which produces a steadily increasing fall in speed as the power increases. The intermittent slip regulator consists of a resistance which is inserted into the rotor circuit of the motor when the power demand reaches a definite value.

One of the most important considerations in the choice of motor and flywheel is whether the power is generated within the works or from an outside source. If several rolling mills, all doing similar work, are in operation at the same time, an automatic balance of the demand of power can be obtained and flywheels of small sizes can be conveniently used with the mill motors.

If the power is generated within the works, it is essential that the demand on the power station be kept as uniform as possible, and this is obtained by using heavy flywheels and a proper regulation of slip.

The speed of a mill is generally limited by the first passes in the roughing rolls. When the billet is very short, and is thrown out at a high velocity, it will be very difficult for the men to catch it. In the later passes, instead, the bar will be considerably elongated and a very long time will be required in the last passes, where, instead, a high speed is most desirable from a manufacturing standpoint, while a considerable fall in speed is necessary in order to utilise the stored energy of the flywheel. This inconvenience is overcome by using a separate motor-generator set and flywheel running at a comparatively high speed, supplying current to the mill motors which may be run at a constant speed or (if the Ilgner system is used) at a variable speed, which may be obtained by varying the voltage of the generator of the motor-generator set. In this way a very rapid increase or decrease in speed of the mill motors may be obtained and the tonnage that the mill can roll is greatly increased and a reduction in cost of production will result in spite of the increased capital cost of the electrical plant.

When the power is obtained from an outside source the charges are generally made either on the maximum demand system or on a flat rate. In the former, large flywheels are needed in order to reduce the fluctuation of power, and in the latter case it is essential to reduce the friction losses by using small flywheels and large motors. The friction losses may be reduced to a minimum by doing away with the flywheels entirely and using motors large enough to take care of the peak loads on the mill at a speed practically steady. In this way a cheap price for the power and the maximum output is obtained, but the capital charges are increased due to the increased cost of the motors.

Particular attention should be paid to the friction losses and, in general, to all those losses which are more or less steady, independent of the output of the mill. In many mills the friction of the mill itself is about 20 per cent. of the normal rated output of the motor, and the total friction losses are about 50 per cent. of the power used per ton rolled.

The size of a motor for a given service may be determined by the mean effective current of the duty cycle.

$$I_e = \sqrt{(\Sigma I^2 t/\Sigma t)},$$

or

$$\text{H.P. rating} = \sqrt{(\Sigma HP^2 t/\Sigma t)}.$$

This is the mean rating that will give the same heating effect as the given loads I (or H.P.) acting successively for periods of time t. After the minimum size of motor that can be used for a given duty cycle of a rolling mill has been found, the proper size of flywheel to use in connection with the motor must be found in a tentative way when the allowable slip and the overload capacity of the motor are specified.

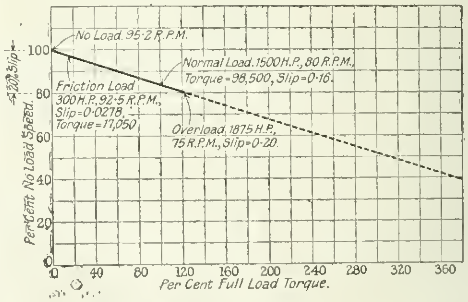

FIG. 2.—VARIATION OF TORQUE WITH SLIP FOR 1,500 H.P. 80 R.P.M. MOTOR DRIVING BLOOMING MILL.

For instance, assume a 1,500 H.P. induction motor to run at about 80 revs. per min. with a slip of 20 per cent. from no load to the maximum of 1,875 H.P. coupled to a blooming mill, and let us find the proper size of flywheel to use.

With a 1,500 H.P., 80 revs. per min. motor, normal load torque $= 5{,}252 \times 1{,}500 \div 80 = 98{,}500$ ft.-lb. Torque at 25 per cent. overload $= 123{,}000$ ft.-lb.; speed drop from no load $= 20$ per cent. (slip).

We will assume that the torque is proportional to the slip, then the slip at normal load will be: $(98{,}500 \div 123{,}000) \times 0{\cdot}2 = 16$ per cent. If we call y the no-load speed, we will have $(y - 0{\cdot}16y) = 80$ revs. per min. from which $y = 95{\cdot}2$ revs. per min. This is the speed of the motor at no-load and zero slip.

By laying out the per cent. of normal load torque against the per cent. of no load speed for two points, zero load against zero slip and 125 per cent. full load against 80 per cent. of no-load speed (giving the required 20 per cent. slip) and connecting these two points with a straight line, the speed at any other torque can be shown as in Fig. 2.

The torque and the speed corresponding to any other given horsepower may be found in the following way:

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* From the "Electrical World," slightly abbreviated.

By keeping in mind that the torque at any speed is assumed to be proportional to the corresponding slip s expressed in percentage of the no-load speed, the torque and the speed corresponding to any horse-power may be found as follows, remembering that the speed in revs. per min. is equal to $95{\cdot}2(1-s)$:

$$(5{,}252 \times 1{,}500 \div 80) \div [5{,}252 \times \text{H.P.} \div 95{\cdot}2(1-s)] = (0{\cdot}16 \times 95{\cdot}2) \div (s \times 95{\cdot}2)$$

From this:

$$\frac{1{,}500}{80} \div \frac{\text{H.P.}}{95{\cdot}2(1-s)} = \frac{0{\cdot}16}{s}$$

$$\frac{1{,}785(1-s)}{\text{H.P.}} = \frac{0{\cdot}16}{s} \text{ and H.P.} = 11{,}156(s-s^2)$$

$$= \text{H.P. corresponding to a given slip.} \quad . \quad . \quad . \quad . \quad (1)$$

$$s = 0{\cdot}5 - \sqrt{0{\cdot}25 - \frac{\text{H.P.}}{11{,}156}}$$

$$= \text{slip corresponding to a given H.P.} \quad . \quad . \quad . \quad . \quad (2)$$

$$\text{Revs. per min.} = 95{\cdot}2(1-s) = 47{\cdot}6 + \sqrt{(2{,}260 - 0{\cdot}81 \text{ H.P.})}$$

$$= \text{speed corresponding to a given H.P.} \quad . \quad . \quad . \quad (3)$$

By inspecting equation (2) it is observed that real values are obtained for s up to the limit when (H.P. ÷ 11,156) is less than 0·25. Beyond this limit we obtain imaginary quantities for s. This means that under these conditions the point at which H.P. = 2,789 is the point at which the motor will break down, and for any increase in slip we will find a drop in horse-power.

The curved line in Fig. 1 shows horse-power plotted against speed. At any point of this curve the speed is $= 95{\cdot}2(1-s)$, corresponding to the straight line relation of torque against slip shown in Fig. 2. It will be noticed that between the limits the motor will be operated (from 300 H.P. friction load to about 1,875 H.P. corresponding to 25 per cent. overload), the curve is nearly a straight line, or, in other words, the horse-power is nearly proportional to the slip. Figs. 1 and 2 are by no means correct representations of motor performance at any overload. They simply represent the relation that would exist if the assumption that the torque is proportional to the slip was true for any overload.

If we compare the (H.P. × seconds) needed on the rolls for every peak, the approximate point where the maximum demand on the motor is liable to occur will be found. Assume, for instance, a certain peak load of 2,820 H.P. for 3·73 seconds. The corresponding H.P. × seconds = 10,500. That supplied by the motor is 1,500 × 3·73 = 5,600. The difference of 4,900 H.P. × seconds will have to be supplied by a flywheel. If it is known that after taking up any peak the motor had time enough to reach the speed corresponding to friction load (92.5 revs. per min., *see* Fig. 2), all that would be required would be to supply a flywheel capable of giving up 4,900 H.P. × seconds of its stored energy in slowing down from 92·5 revs. per min. to 76·16 revs. per min., the speed corresponding to the maximum 20 per cent. slip that can be allowed. If WK^2 is the ft.-lb.^{2} flywheel effect of the flywheel and rotor, we have:

$$WK^2 = \frac{\text{H.P.} \times \text{seconds}}{0{\cdot}000{,}000{,}31\,(N_1^2 - N_2^2)}$$

$$= \frac{4{,}900}{0{\cdot}000{,}000{,}31\,(92{\cdot}5^2 - 76{\cdot}16^2)} = 5{,}800{,}000 \text{ lb.-ft.}^2 \quad (4)$$

Due to the fact the speed of the motor is not known just before taking up the peak in consideration, in order to make allowance for this unknown we increase by 50 per cent. the above flywheel effect and figure on using a flywheel having a flywheel effect of 8,950,000 lb.-ft.^{2} Having found the flywheel effect WK^2, the mass moment of inertia of our flywheel and rotor will be:

$$MK^2 = 8{,}950{,}000 / 32{\cdot}16 = 278{,}000.$$

If p is considered the constant ratio of torque to slip of the motor, we will have

$$p = \text{any torque / corresponding slip} = 98{,}500 / 0{\cdot}16 = 615{,}000.$$

Calling v_s the no-load speed at 1 ft. radius, we have

$$v_s = 2\pi \times 95{\cdot}2 / 60 = 10 \text{ ft. per second.}$$

Several formulæ have been derived for obtaining T_2 (*see* Fig. 3), all expressed in a more or less complicated form. They may be expressed much simpler, as follows:

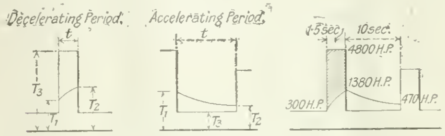
$$T_2 = \frac{T_1 - T_3}{e^{\frac{pt}{MK^2 v_s}}} + T_3. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Where e is the basis of the Napierian logarithms = 2·718, T_1, T_2, T_3 are the torques corresponding to Fig. 3, and t is the time in seconds at the end of which T_2 is calculated.

For a given combination of flywheel and motor $e^{\frac{p}{MK^2 v_s}}$ is a constant, and the above formula may be expressed in the simple form

$$T_2 = \frac{T_1 - T_3}{A^t} + T_3. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

In the case under discussion $A = 1{\cdot}25$.



FIGS 3 & 4.—TORQUES OF EQUATION 5 DURING DECELERATING AND ACCELERATING PERIODS

Considering that during the decelerating period the minimum value that T_2 may reach is $T_2 = T_1$, and during the accelerating period the maximum value that T_2 may reach is $T_2 = T_1$, it is observed that this condition is reached when in the above formula $A^t = 1$. If the values of A^t are plotted for a given range of values of A and t we will have to set as a minimum value $A^t = 1$. The maximum value that T_2 may reach during the decelerating period is $T_2 = T_3$ approximately, and the minimum value that T_2 may reach during the accelerating period is also $T_2 = T_3$. This condition is reached when $(T_1 - T_3)/A^t$ is very small as compared to T_3, say, for instance, $(T_1 - T_3)/A^t = T_3/100$, and considering that in practice T_1 is about 20 per cent. of T_3 during the decelerating period, and about $5T_3$ during the accelerating period. Substituting and solving for A^t we find that the maximum value that A^t may reach is about 80 during the decelerating period and 100 during the accelerating period.

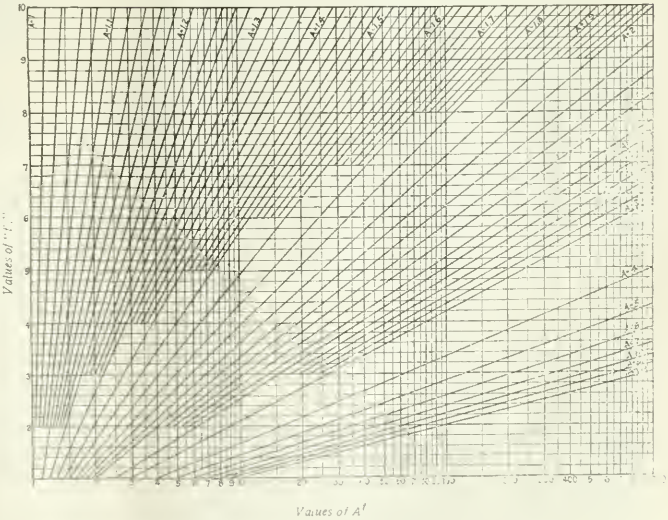


FIG. 5.—VALUES OF a OF EQUATION 6 FOR DIFFERENT VALUES OF t.

If we set as a limit of maximum value that A^t may reach, $A^t = 1{,}000$, and plot the values of A^t between the limits of $A^t = 1$ and $A^t = 1{,}000$, we will have covered about every case of electric drive of rolling mills (*see* Fig. 5).

Due to the fact that p, MK^2 and V_s are connected one to the other in such a way as to give a rather limited range of values of p/MK^2V_s

it will be found that the values of A given in the diagram will be sufficient for taking care of every case. The values of t given vary between $t=1$ second to $t=10$ seconds. If it is desired to have values of A^t for corresponding values of t larger than 10 seconds, find the point corresponding to A^{10}. Trace vertically downward from this point as many seconds back of the line corresponding to 10 seconds for as many seconds more than 10 as it is desired to find A^t, and from this point trace a parallel to the line corresponding to the given value of A until it strikes the line of $t=10$. The point on that line will be the value desired. For instance, if it is desired to find $1{\cdot}12^{12}$ proceed as follows: Find $1{\cdot}12^{10}=3{\cdot}1$, trace vertically 2 seconds back of 10 (stop on the line $t=8$), and from that point trace a parallel to $A=1{\cdot}12$, which will strike the line $t=10$ at the point 3·9. This point will represent the value desired of $1{\cdot}12^{12}$.

Applying the above formula to the numerical example under consideration, and starting at the beginning of the duty cycle of the motor, we have at starting (*see* Fig. 4):

$$T_1=\text{friction torque}=\frac{5{,}252\times300}{92{\cdot}5}=17{,}030,$$

$$T_3=\frac{5{,}252\times4{,}800}{92{\cdot}5}=272{,}000,$$

$$A=1{\cdot}25=\text{constant},$$

$$t=1{\cdot}5\text{ seconds}; \quad A^t=1.4 \text{ (from Fig. 5)},$$

$$T_2=\frac{T_1-T_3}{A^t}+T_3=\frac{-254{,}950}{1{\cdot}4}+272{,}000=90{,}000.$$

The above value of T_2 is 91·5 per cent. of the normal torque (normal torque = 98,500). From Fig. 2 we find that the corresponding speed is 85·3 per cent. of the no-load speed, or 81 revs. per min., and from Fig. 1 we find that the corresponding horse-power load on the motor after taking up the first peak is 1,380 H.P.

During the accelerating period we have:

$$T_1=90{,}000,$$

$$T_3=\frac{5{,}252\times300}{81}=19{,}400;$$

$$A^t=1{\cdot}25^{10}=9{\cdot}1 \text{ (from Fig. 5)}$$

$$T_2=\frac{T_1-T_3}{A^t}+T_3=\frac{70{,}600}{9{\cdot}1}+19{,}400=27{,}150=27{\cdot}6 \text{ per cent.}$$

of normal load torque, which corresponds to 470 H.P. at 91 revs. per min. (*see* Figs. 1 and 2).

To check proceed as follows: Find the load on the motor during the accelerating period for a number of values of t between $t=0$ and $t=1{\cdot}5$ and plot these loads. A logarithmic curve will be obtained. Measuring with a planimeter the shaded area on Fig. 1, that area will represent the energy in horse-power-seconds given up by the flywheel in slowing down from 92·5 revs. per min. to 81 revs. per min., and must be equal to the calculated energy given up by the flywheel during the retardation period:

$$\begin{aligned}\text{H.p. seconds}&=0{\cdot}000\,000{,}31\times WK^2(N_1^2-N_2^2) \quad . \quad . \quad . \quad (7)\\&=0{\cdot}000{,}000{,}31\times8{,}950{,}000(92{\cdot}5^2-81^2)\\&=5{,}600\end{aligned}$$

In the same way the area comprised between the motor-load curve and the friction load during the accelerating period must be equal to the energy necessary to accelerate the flywheel from a speed of 81 revs. per min. to 91 revs. per min.

The load on the motor at any instant during the duty cycle may be found in the same way. If we find that either the slip or the overload exceeds the limit set (20 per cent. slip and 25 per cent. overload), it will be necessary to assume a different value of WK^2, and try again until a value of WK^2 is found that will satisfy the conditions.

When the proper value of WK^2 has been found the dimensions of the flywheel may be calculated, keeping in mind that if a cast iron flywheel is used the peripheral speed must not exceed 6,000 ft. per minute, [illegible] speed of 12,000 ft. per minute is the maximum [illegible].

If the flywheel is mounted on a separate shaft running at N revolutions per minute [illegible] motor $=N$ revs. per min.), the flywheel effect of the flywheel [illegible] (N^2/N_1^2), so that if the flywheel [illegible] the motor, the flywheel effect required of the flywheel would be only one-fourth of what we would have needed if the flywheel had been mounted directly on the motor shaft. In the calculations, however, it is simpler always to use a value of WK^2 corresponding to the case of a flywheel mounted on the motor shaft.

COLONIAL TELEGRAPHS AND TELEPHONES.*

BY R. W. WEIGHTMAN.

(*Continued from page* 354.)

Summary.—After referring to British Post Office practice, the author deals with the appointment of engineers, with working staffs and sources of supply. He then considers telegraph and telephone administration in the Crown colonies, and amalgamation of railway telegraphs with postal telegraphs. The next section of the Paper is devoted to overhead construction. The telegraph and telephone systems of the Crown colonies, South Africa, Canada, Australia and New Zealand are described at some length, and in conclusion the important question of lightning protection is considered.

POLE-FITTINGS.

Crown Colonies and South Africa.—There are many types of iron brackets and arms available for use with iron poles, and South Africa may take some credit for having helped to evolve a number of useful improvements to these fittings.

The bracket shown in Fig. 1 is of malleable cast-iron. It is typical of many other patterns which vary mainly in the size of the seat.

For a wood arm, Jobson's combination bracket is a useful fitting. This was originally made with straight fixing bolts, and it is still used in this form by some administrations. In South Africa it gave much trouble owing to the arm shrinking in dry weather and causing the clamp to become loose. On angle poles this often allowed the arm to cant and even to twist right round. To prevent this and to enable the clamp to be tightened up on the pole independently of the arm, the author's old chief in Natal, the late Mr. T. T. Hardaker, devised the shoulder bolt shown in Fig. 2.

With the introduction of the tubular iron arm by the Post Office in England several of the colonies quickly took it up, and with some of these it is now the standard arm. The spacing between insulators and arms is somewhat varied in the different colonies, and in the Paper the author gives the well-considered spacings for the different numbers of wires.

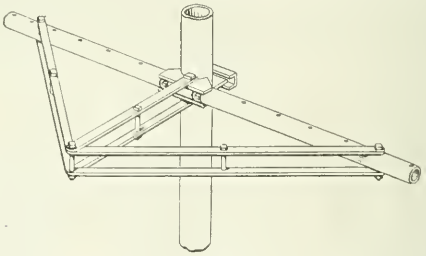


FIG. 2.—COMBINATION BRACKET WITH SHOULDER BOLTS FOR TUBULAR IRON POLE.

When the author adopted tubular arms in Natal he designed and introduced a number of fittings, such as tie rods, arm supports, cross-arms, back braces and cage frames. Where wires are terminated on an 8 or 12-wire arm the arm is back braced. The end of the pole arm is sometimes scalloped to take the cross-arm which is held in position by means of an eye-bolt. The head of the eyebolt is slipped inside the main tube, and is held by the first insulator spindle on it. Where the end of the pole arm is not scalloped a cross-arm holder is used. Where 8 or 12-wire cross-arms are used they are back braced to the pole arm by means of two strands of 7/16 steel wire (galvanised) each with a small swivel tightener.

A four-sided tubular iron frame is used on a junction or leading-in pole carrying wires in four directions. These frames are built up in the form of a cage and the design is such that the lineman has plenty of elbow-room.

The sizes of tubular arms most commonly used are all 1-11/16 in. diameter by Nos. 7, 9 and 12 S.W.G. thick. They are always galvanised. In a table in the original Paper the results of tests are given of one arm of each of these sizes and, for comparison, one oak arm. These tests show that the No. 9 gauge tube is sufficiently strong for all practical purposes.

If line construction is good the maintenance costs will be low, and the great advantage of freedom from faults is gained. Probably in no other class of engineering is the success of a work dependent upon factors of such low value mechanically as in telegraph and telephone engineering.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

Double-shed white porcelain insulators of Post Office types are generally used in these colonies and in South Africa. On the farmers' lines in South Africa a small single-shed porcelain cup is used. The spindles and cupholders used with these cups are generally of the standard types adopted by the British Engineering Standards Committee, although for light conductors single and double J and also U cupholders of lighter patterns are used.

Glass insulators so much used in the United States and Canada, where the climate is dry, are not used to any extent in the Crown colonies, and not at all in South Africa. Some insulations tests of porcelain and glass insulators of the same size and shape gave an average of 50,000 megohms for the former and 3,500 for the latter. Glass insulators are much affected by changes of temperatures and are liable to fly to pieces even when these changes are comparatively slow. Porcelain insulators are less affected by temperature changes, and when used in the standard manner on screwed spindles with elastic washers of felt or indiarubber they are quite reliable. The insulation of a line is a matter of the first importance. The best insulator gives the best service, and the author is prepared to say that no insulators made are to be compared either for insulation, strength, or general serviceableness with the British Post Office standard porcelain types as made in England.

Canada.—The arms generally used are of British Columbia fir. A 6-wire arm used by the Grand Trunk system is 7 ft. long by 4¼ in. by 3¼ in. On telephone lines 6 and 10-wire arms are used, but the 10-wire is the general standard. The spacing is usually 12 in. between cups, with 18 in. at the pole, and the arms are generally spaced 24 in. apart.

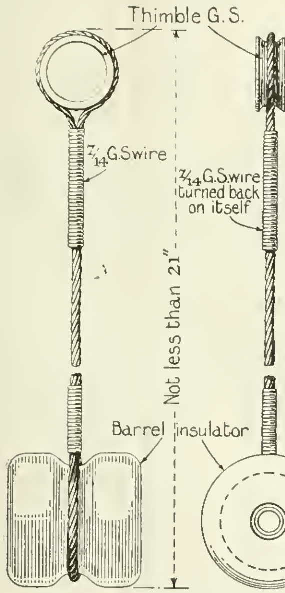

Fig. 3.—Barrel Insulator with Sling.

Both porcelain and glass insulators are used on both telegraph and telephone lines; but, owing to the wonderful dryness of the climate, glass is found to give sufficient insulation. Where high insulation is required, porcelain is used.

Australia.—Wood arms and single iron brackets are used on both wood and iron poles. They are usually of 3 in. square section with the edges chamfered. The standard lengths vary from 42 in. for 4 wires with 9 in. spacing to 96 in. for 10 wires with 9 in spacing.

The standard insulators used are of porcelain or stoneware of double-shed type and made in two sizes. They are threaded internally and are usually carried on wood pins similarly threaded, although iron spindles with lead-screw tops are also used.

The "cheaply constructed line" is a novel feature authorised by the Commonwealth Department. Such a line is only erected when the cost of a standard pole line is prohibitive, and it is erected on trees, saplings, scantlings and fences. Owing to the low efficiency of the insulation this class of line is used almost exclusively for local telephone services. Where the wire is attached to a tree a sling insulator as illustrated in Fig. 3 is used. Where the wire is carried on fencing posts barrel insulators of the same type are employed.

New Zealand.—The question of pole arms is a vexed one owing to the scarcity of suitable timber for the purpose. The arms in use are mostly of Rata wood, which is hard and suitable in every way, but difficult to obtain. The insulators used are of standard Post Office white porcelain types. Iron arms are not used. Insulators made from a black composition have been tried, but have not given satisfaction.

LINE WIRE.

Crown Colonies and South Africa.—Galvanised iron wire is not so much used now, although for minor telegraph circuits 200 lb. and 400 lb. wires are still employed considerably.

For long-distance telegraph lines 150 lb. and 200 lb. copper wires are used. Practically all telephone circuits are of copper. In South Africa 70 lb., 100 lb., 150 lb., 200 lb., 300 lb. and 400 lb. gauges are used according to the grade of service required. The telephone trunk wires are generally erected on the twist, and on main lines and as a matter of economy both telegraph and telephone circuits are erected on the same poles. In cases where separate pole lines are erected for telephone circuits the wires are transposed on U cupholders.

Bronze wire usually 150 lb. per mile is employed in some colonies for long spans, but not largely, and copper clad steel wire has also been used to a slight extent. In two colonies where this latter wire has been tried it has quickly broken down owing to moisture penetrating the copper, probably through defects caused in the handling. Where it is erected near the sea the life of the wire is very short indeed.

In situations where the insulation of open wires may be lowered from any cause, hard-drawn copper and bronze wire with a special insulation to a Post Office specification is sometimes used.

The Britannia joint is commonly used for jointing both iron and copper wires, but here and there McIntyre sleeves of both oval and twin tube type have been introduced. The author has all along favoured the wire joint, as with native workmen there is less risk with it. In inexpert hands the sleeve is liable to be badly twisted and the wire damaged. On the other hand, with the sleeve the soldering iron is dispensed with, and this is certainly a great advantage in a country where the work is in skilled hands.

Canada.—Copper and iron wire are both used largely on both telegraph and telephone systems.

The open telephone circuits in Canada are transposed. The system of transposition is based on that of the American Bell Telephone & Telegraph Company, and is worked out in a very thorough manner. Phantom telephone circuits superimposed on physical circuits are largely used and special transpositions are arranged in these cases.

McIntyre sleeves are employed generally for making joints. On copper wires copper sleeves, and on iron wires steel sleeves, and also tinned copper sleeves are used.

Farmers' Lines on Fences.—There are a few lines of this character in Canada. The fences generally consist of three separate strands of barbed wire on wood posts, the top strand being 15 in. to 20 in. from the next. The top wire is used for the line, and it is not usually insulated in any way, but merely stapled to the posts. The earth is used for the return. In dry weather no great amount of leakage takes place, but in wet weather the speech-transmission value of such lines is very poor. These lines are not permitted to be joined up to public exchanges.

Australia.—For main trunk telephone circuits copper wire 300 lb. and 400 lb. per mile, and for minor trunk circuits which connect with the main trunk system 100 lb. and 200 lb. per mile, is used. For other minor trunk lines and also for telegraph circuits, other than those on which fast speed Wheatstone is employed, 200 lb. and 400 lb. galvanised iron wire is used. For the high-speed circuits copper wire is provided. Phosphor bronze wire is used for subscribers' circuits on telephone exchange systems, so also is copper wire of 50 lb. and 70 lb. gauges. All joints are made by means of McIntyre or other approved type of sleeve.

New Zealand.—Copper, iron, and bronze line wire is used. Copper wire of 100 lb., 150 lb., 200 lb., 300 lb., and 400 lb. is employed generally for telephone circuits of importance, and also for long telegraph circuits. Iron wire is being less used than formerly. Bronze wire of 40-lb. gauge is used on exchange distribution lines. The McIntyre sleeve is not used, all joints being of the "Britannia" standard type. Fence wires are often used by the farmers for telephone purposes as in Canada.

TELEGRAPH SYSTEMS.

Crown Colonies.—In the Crown colonies, Post Office standard apparatus is in general use, and the circuits are to Post Office diagrams. In British East Africa and Uganda, Wheatstone automatic has been introduced with Gell keyboard and ordinary mechanical perforators. The Vyles polarised sounder is replacing the sounder and relay, and is also being adopted with condensers on central battery omnibus circuits. The standard practice on these circuits is to use a voltage of 80 with a feed resistance, non-inductive, of 1,000 ohms between the battery and the line. The sounders are wound to 2,000 ohms, and the condenser is of a 4 mfd. capacity.

At Colombo, Ceylon, the Baudot system has been installed on a circuit 800 miles in length, connecting with Madras. There is usually one repeater in the circuit, but direct working is often carried on satisfactorily. Some difficulty was experienced at the start owing to the storage batteries being of very low capacity. The trouble was overcome by the motor circuits being tapped off different sections of the battery, so that only one motor was run off the one lot of cells. With this arrangement there was no further trouble.

This system was introduced to fit in with standard practice in India. The native Morse operators quickly picked up the new alphabet and became expert in manipulating the instruments. The Morse is undoubtedly better suited to native operators than the type-printing apparatus. But for heavier traffic one or other of the type printing multiplex systems will be found to give better results than either the Morse quadruplex or the Wheatstone.

In 1910 the British Post Office designed a secondary cell equipment on cheaper lines than that which embodies the charging cabinet with rotary switches, referred to later, and in which the charging board is so arranged that the different sections of the battery are charged in turn and while they are at work. The chief engineer of the Federated Malay States is installing plants of this character at Kuala Lumpur and at Ipoh. The voltages available will be 24 for locals, 40, 80 and 120 positive and negative for lines. The cell adopted is of the 45 ampere-hour Hart type. In this equipment the main distributing cabinet is dispensed with, and a cabinet combining the functions of this and the instrument table distributing and fuse case is substituted. Line test cabinets of switch spring type equipped for 40 lines with "earthing," "grouping," and "intermediate returns" strips, are being installed with this equipment.

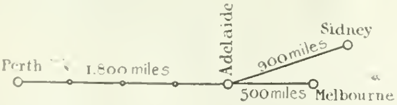

FIG. 4.

The question at what stage secondary cells should be installed for telegraph working is an important one, and the author thinks that where the number of primary cells in use is over 200 and a local supply of current is available for charging, the adoption of this system is worth considering.

Leclanché porous-pot form cells are much used on ordinary line and local circuits. In some directions weird types of Daniell and gravity cells are still used, notwithstanding the practice of the British Post Office in this respect, referred to later.

The lightning discharger chiefly used on telegraph lines is the Post Office carbon disc with mica disc separator. The large double-plate discharger is also used in some colonies.

South Africa.—In South Africa, Post Office standard apparatus is also in general use. The Vyles polarised sounder is replacing the relay and sounder, and it is also being adopted on central battery circular circuits, and on concentrator systems. The author regards this system as one of the greatest developments in telegraphy in recent years. There should be a large field for the application of this system on the many unimportant omnibus circuits that run out from centres in the dominions and colonies.

The duplex and quadruplex systems are employed between centres according to traffic requirements. One of the longest quadruplex lines is that between Durban and Johannesburg, about 350 miles by line, and this works quite satisfactorily without a repeater. The A side of the circuit is sometimes repeated at Johannesburg to the Stock Exchange. On circuits of greater length full quadruplex repeaters are employed.

The decision to adopt the Creed system followed an investigation by the engineer-in-chief of South Africa of the various heavy traffic systems in use in Europe and America, and for the conditions prevailing in South Africa and the system of traffic circulation proposed it is admirably suited. The Creed circuits are worked duplex, and high-speed duplex repeaters are employed on them where necessary. One of the longest of these circuits is that between Cape Town and Johannesburg, about 1,000 miles, and this has two repeaters on it. The latest type of sounder-clearer is being installed. Motor-driven [illegible] have been introduced, the motors being of the type adopted by the Post Office. At the principal offices the working current is got from secondary cells with charging and distribution equipment of Post Office standard design. At other stations primary cells of both bichromate and Leclanché types are used, the bichromate on duplex, quadruplex and Wheatstone lines, and in some cases for locals; and the Leclanché of six-block agglomerate and porous-pot forms on all other lines and locals. The "sack" form of Leclanché cell is even more suitable than the porous-pot form where heavy currents are required, owing to its lower internal resistance. Dry cells are only used on telegraph work where portability is desired.

Canada.—In Canadian practice minor circuits are worked single current on the closed-circuit system, the battery power being divided generally between the two terminal stations. In some cases the battery power is all at one end. On the more important lines double-current duplex and quadruplex are in use. The Morkrum printing system is also in use on several of the lines of the Canadian Pacific Company.

There is one Wheatstone circuit between Montreal and Bamfield, B.C., which is leased by the Canadian Pacific Company to the Pacific Cable Board, but on the public lines there is no Wheatstone, Creed, Baudot, Vyles or single-needle apparatus in use.

On many of the longer telegraph circuits, repeaters are employed. The longest lines and the number of repeaters on them are as follows:

Line.	Distance. Miles.	System.	No. of repeaters.
Montreal to Vancouver	2,900	Duplex.	2
Montreal to Winnipeg	1,400	Printer duplex.	2
Toronto to Winnipeg	1,800	Duplex.	2
Winnipeg to Prince Rupert...	1,746	Simplex.	1
Edmonton to Prince Rupert	953	Simplex.	1

A form of sulphate of copper gravity cell is in general use for both line and local circuits, except at the larger offices, where dynamo current is available and where the current requirements make it worth while to provide the necessary plant.

The Canadian Pacific Company's practice in this respect is noteworthy. Where power is available from two different supply stations, motor-generators are employed directly on the line and local circuits.

Where power is available from one supply station only, secondary cells are used, which are charged either direct from the main power leads or through the medium of a motor-generator. With secondary cells both negative and positive batteries are installed, and stand-by batteries of 50 per cent. the value of the batteries in use are provided.

Other companies install a complete duplicate equipment in the case both of storage batteries and of direct motor-generator operation. The voltages employed are notably high compared with British practice.

Australia.—Morse sounder and Morse printer apparatus is used on the minor telegraph circuits worked on the closed-circuit system Morse duplex and quadruplex are employed on the busier circuits. Telephones are now frequently used where formerly Morse apparatus would have been installed. The introduction of either the Murray or Western Electric multiplex or the Baudot system is under consideration. The Wheatstone automatic is in constant use for both ordinary and Press work between the main centres and this system has recently been extended. It is found to be quite reliable and satisfactory. Creed apparatus was introduced between the Eastern and Western States in 1913, and has been in regular use for the past two years. The arrangement is shown in Fig. 4. Repeater stations are installed at the points dotted between Perth and Adelaide. Standard duplex repeaters are used.

There are a few central-battery telegraph circuits in use fitted with Vyles polarised sounders.

Secondary cell plant has been installed at the chief telegraph offices, and similar installations have recently been provided at country offices where the conditions have been found to warrant this being done.

Primary cells of Meidinger, gravity and carporous types are in use, but the British Post Office type of Leclanché cell has recently been adopted.

A reorganisation of the circulation of traffic from small offices has recently been made. Where formerly a number of small offices situated at great distances from the chief office of a State, worked direct with the chief office on one wire, they are now subdivided and connected on short lines with distributing centres which have fast direct communication with the chief office.

New Zealand.—Single current Morse, both open and closed circuit. Morse duplex and quadruplex are the principal systems in use, and the apparatus is generally of British Post Office type. The Murray multiplex is being introduced with two quadruple sets at Wellington, which will connect with a similar set at Auckland, and another at Christchurch.

The longest telegraph circuit is that between Wellington and Dunedin, about 530 miles, including a section of submarine cable 40 miles in length. Quadruplex repeaters are used freely, and they are forked to meet the traffic requirements. Vyle's polarised sounders are employed on quadruplex repeaters instead of relays in a good many cases. The energy for the working of the telegraph circuits is obtained from primary cells of Callaud, bichromate, Gordon and Leclanché types. Secondary cells are employed in the larger offices for local batteries, but where these are not installed, Leclanché cells are very largely used. Complete central-battery secondary-cell plant has not so far been introduced. The telephone is largely used for the transmission of telegrams.

TELEPHONE SYSTEMS.

Crown Colonies.—Throughout the Crown Colonies, and also in South Africa the natives are not sufficiently concerned in commercial pursuits to use the telephone. Statistics do not usually make allowance for this, and consequently the telephone development in these countries does not compare favourably with that of European countries.

In almost all these colonies the telephones are in the hands of the Government. In Trinidad the telephones are in the hands of a private company. The principal exchange has a central-battery manual multiple board equipped for 1,200 subscribers, with a separate magneto trunk section.

At Suva, Fiji, a multiple magneto board on the "ring through" system is about to be installed. This will have an ultimate capacity of 1,200. The line signal is a plug restoring drop indicator, and the clearing signal a circular star-type galvanoscope indicator.

The author is aware that there are objections to the adoption of this system in a large exchange, but he is of opinion that for exchanges in countries where the commercial conditions are not so pressing as in large centres the "ring through" has its advantages.

At Colombo, Ceylon, a magneto lamp-signalling multiple board is in use, equipped for 1,400 subscribers. At Hong Kong and Singapore, the local systems are owned by a private company. At both places magneto lamp-signalling multiple boards with automatic supervisory lamp signals are in use. The ultimate capacity in each case is 5,000. The main cables from the exchange are underground with overhead dry-core cable distribution to open wires.

There are no automatic exchanges in any of the Crown Colonies. Not only are insulation difficulties felt to be a bar to their introduction in the damp climates of these countries, but the need for the employment of highly skilled mechanicians to look after the plant is regarded as another obstacle.

The distribution at the larger of these exchanges is generally by means of cables from the exchange led to pole lines through distribution and protector boxes fixed to the poles. The subscriber density is so low that service by direct cable can be given but rarely. Business premises and dwelling houses are not so cramped as in European towns; they are more open and scattered, so that the direct cable service or the block and alley system of distribution cannot be applied to any extent. 10-lb. and 20-lb. conductors are employed.

Where the distribution is by means of armoured cable the lead-sleeve joints are usually in cast-iron boxes for protection and to preserve the continuity of the armouring. Where aerial lead-covered dry-core cable is used it is supported in the usual way on steel suspender wires.

For small exchanges the author prefers the underground armoured cable. It can be used with complete safety. The upkeep is practically nil, all the work of erecting suspender wires and the heavy stresses they bring upon the poles are obviated.

The termination of cables in a building usually follows Post Office practice, the cables being connected to distribution cases by means of a link of enamel and cotton-covered lead-sheathed cable made airtight with bees-wax.

Aerial rubber cable has been tried in some of the tropical colonies, but it is liable to break down owing to the heat and rain to which it is exposed.

The pole distribution-boxes in use are usually of cast iron, having two compartments, one at the back for the dry-core cable which is sealed up with compound when the paper-covered wires have been soldered on to their tabs. The other compartment is fitted with ordinary carbon dischargers and fuses. The leading-out cables from the pole boxes are single-pair enamel and cotton-covered and lead-sheathed.

Special measures are taken in the manufacture of all apparatus for use in the hot humid climate of the tropical colonies to keep up the insulation of all electrical parts, and precautions are taken as far as possible to prevent insects getting inside the instruments.

South Africa.—In South Africa every town and village of any importance has its exchange, and a large trunk system has been developed. At present the longest connections in regular use are about 500 miles in length. A speech efficiency equal to 30 miles of standard cable is aimed at, and inter-communication is given to all stations that come within this limit. Loading coils have not yet been introduced, but they will be employed when the time arrives to consider the longer trunk lines between the Cape and Transvaal main centres.

The Durban exchange has a central-battery manual board, with an ultimate capacity of 7,200. The distribution in the busy area is by dry-core underground cable. Connection is given with other towns in Natal and in the adjacent provinces through the Government trunk system.

At the principal Government exchanges central-battery manual boards are in use, the largest being that at Johannesburg, with an ultimate capacity of 9,000 lines. Similar exchanges of rather smaller capacity have been installed at Cape Town and Pretoria, and also at about half-a-dozen other towns on the Witwatersrand. At nearly all other towns magneto boards on the "ring through" system are employed.

Magneto boards with automatic clearing are in use at certain exchanges. With this system a condenser is placed in the telephone circuit of the subscribers' instrument. When two subscribers are through, potential is on both subscribers' lines through the supervisory relays. When the telephones are hung up the loops are closed, the supervisory relays are energised, and the clearing signals operated.

Telegraph circuits are superimposed on telephone wires where it is advantageous to do so, and phantom telephone circuits are obtained wherever possible.

The installing of an experimental automatic exchange was decided upon some time ago, but the war has interfered with this project, as it has done with the telephone development generally in the country. Both wet and dry cells are used on magneto telephones. The author always used wet cells in Natal, as he found them more reliable and economical than dry cells.

The underground cables and distribution methods vary, but the work of co-ordinating the methods to one standard has now made great headway. In present-day practice underground cables having 10-lb. conductors are in use. Heavier conductors are employed where required, also composite cables having large conductors for long-distance circuits.

Distribution is carried out both by underground direct cable, and on the block system from high poles by means of both dry-core cable and open wires. In both cases the internal distribution is through lead-covered cables to distribution frames or cases, and thence to the subscribers' sets. Open-wire distribution is on somewhat similar lines to those already described as in use in the Crown Colonies.

The practice of drying out paper cables by means of dry-air pumps fitted with desiccators is followed in some of the Crown Colonies, but the tendency now is to adopt the method of jointing described later under Canadian practice. In South Africa portable dry-air pumps are provided for use only when a definite fault appears.

(*To be concluded.*)

Lifting Boats on the Amsterdam Canals.—The City of Amsterdam is supplied with fresh fruit and vegetables from the surrounding country by means of a network of canals, on which the trucks containing the produce are carried. There is, however, a considerable difference in level between the main trunk canal and the smaller one, into which the various subsidiary canals in the adjacent district communicate. Hitherto it has been necessary to raise the trucks to the higher level by the rather primitive method of a large chain and wheel, worked by hand, and this sometimes caused much congestion. The much speedier method of lifting by electric power has now been substituted, the necessary funds, amounting to 50,000 florins (about £1,166) having been raised by private subscription among the chief canal users. A large concrete tank has been built at the upper level at the junction of the two canals. Two lifting engines run on tracks overhead, and a large cradle is lowered into the low-level water until it is submerged. The boats enter the cradle in turn, being then hoisted into the tank at the upper level, whence they can travel into the main canal. The result has been a great saving in time and relief of congestion, and the running costs are met by a charge of 5d. per lift up or down.

SOME NOTES ON THE THEORY OF IRON-CORED HIGH-FREQUENCY CURRENT TRANSFORMERS.

BY N. W. MCLACHLAN, D.SC., ENG.

Messrs. Campbell & Dye* have demonstrated the use of current transformers with cores of stalloy stampings (silicon iron) for measuring very high-frequency alternating currents. During the progress of the work undertaken by the author† on the "Magnetisation of Iron at very High Frequencies," it became necessary to consider the theory of this method of measurement for such frequencies as occur in wireless telegraphy, and the results of this investigation are given below.

I_2 = Maximum current in the secondary winding.
I_0 = Maximum current in the primary winding balancing I_2 $= I_2\left(\frac{n_2}{n_1}\right)$.
I_M = Maximum magnetising current 90 deg. out of phase with E_2.
I_W = Maximum energy current 90 deg. out of phase with I_M.
I_T = Vector sum of I_M and I_W.
I_1 = Total primary current = Vector sum of I_0 and I_T.
R_2 = Total resistance of secondary circuit, including instrument or heater.
L'_2 = Inductance in external circuit—leakage inductance.
$X_2 = \omega L'_2$.
$\omega = 2\pi \times$ frequency.
$Z_2 = (R^2_2 + X_2^2)^{\frac{1}{2}}$ = impedance of secondary circuit (excluding internal self-inductance of winding).
I_2R_2 = Ohmic drop in secondary circuit in phase with I_2.
I_2X_2 = Reactive drop in secondary circuit 90 deg. out of phase with I_2.
E_2 = Total voltage drop in secondary circuit. = Vector sum of I_2R_2 and I_2X_2.
n_1 = Turns on primary winding.
n_2 = Turns on secondary winding.
Φ_m = Flux in phase with I_M and 90 deg. out of phase with E_2.
$\theta = \theta_1 - \theta_2$.

The secondary E.M.F. consists of two components 90 deg. out of phase with each other. (1) I_2R_2 the ohmic drop, (2) I_2X_2 the reactive drop. The primary magnetising current I_M is 90 deg. out of phase with E_2 and the energy component I_W is 90 deg. out of phase with I_M. The vector sum of these components, viz., I_T, represents the apparent magnetising current, and θ_1 is the angle between I_W and I_T.

In developing the following theory the apparent permeability of the iron μ_a, has been assumed constant. The values of $B_{\text{max.}}$ used in high-frequency current transformers are very small, and since the slopes of the alternating current B-H curves appear to be almost constant near the origin where $B=0$, this assumption seems to be quite reasonable. (*See* author's Paper, *loc. cit.*)

From Fig. 1 we have

$$I_1^2 = I_0^2 + I_T^2 + 2\ I_0\ I_T \cos\theta. \quad . \quad . \quad . \quad . \quad (1)$$

The maximum E.M.F. induced in the secondary winding is

$$\omega B_{\text{max.}} A n_2 \times 10^{-8} \text{ volt}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where B = maximum apparent flux density in the iron core and A = cross-sectional area of iron core in square centimetres.

Now $\mu_a = \frac{B_{\text{max}}}{H_{\text{max}}}$, where μ_a = apparent permeability of iron and $H_{\text{max.}}$ = maximum apparent magnetising force.

Also $H_{\text{max.}} = \frac{4\pi n_1 I_T}{10 l}$, l being the mean circumference of the iron core.

Substituting these values in equation (2) and multiplying above and below by n_2, we obtain

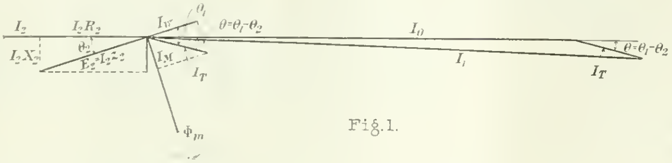

Fig. 1.

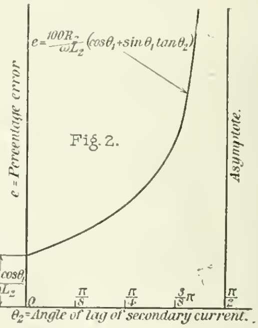

Fig. 2.

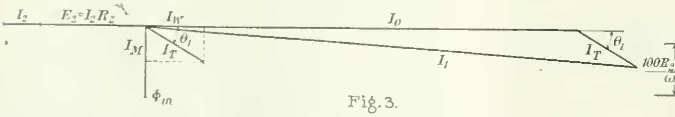

Fig. 3.

FIG. 1.—VECTOR DIAGRAM FOR CURRENT TRANSFORMER IN WHICH THERE IS SECONDARY LEAKAGE AND SELF-INDUCTION IN THE EXTERNAL SECONDARY CIRCUIT. (The wave forms of the various vector quantities are assumed to be sinusoidal and undamped.)

FIG. 2.—CURVE SHOWING INCREASE IN ERROR WITH INCREASE IN θ_2 THE ANGLE OF LAG OF THE CURRENT IN THE SECONDARY CIRCUIT, FOR A GIVEN FREQUENCY.

FIG. 3.—VECTOR DIAGRAM FOR CURRENT TRANSFORMER WHEN CAPACITY AND INDUCTANCE IN THE SECONDARY CIRCUIT ARE NEGLIGIBLE, i.e., THE SECONDARY CURRENT AND E.M.F. ARE IN PHASE.

$$E_2 = \frac{n_1}{n_2}\omega I_T \times \frac{4\pi n_2^2 A\mu_a}{10 l} \times 10^{-8} \text{ volt.}$$

$$= \frac{n_1}{n_2}\omega I_T L_2, \text{ where } L_2 = \frac{4\pi n_2^2 A\mu_a}{l} \times 10^{-9} \text{ henry}$$

$$= I_2 Z_2 \qquad = \frac{4 n_2^2 A\mu_a}{d_m} \times 10^{-9}, \text{ for an anchor ring mean diameter } d_m.$$

Hence,
$$I_T = \frac{n_1 I_2 Z_2}{n_2 \omega L_2}.$$

Substituting this value for I_T and $I_2\left(\frac{n_2}{n_1}\right)$ for I_0 in equation (1) we obtain

$$I_1^2 = \left(\frac{I_2 n_2}{n_1}\right)^2 + \left(\frac{I_2 n_2 Z_2}{\omega L_2 n_1}\right)^2 + \left(\frac{I_2 n_2}{n_1}\right)^2 \frac{2Z_2\cos\theta}{\omega L_2}$$

or
$$I_1^2 = I_2^2\left(\frac{n_2}{n_1}\right)^2\left\{1 + \frac{2Z_2\cos\theta}{\omega L_2} + \frac{Z_2^2}{\omega^2 L_2^2}\right\} \quad . \quad . \quad . \quad (3)$$

In practice $Z_2/\omega L_2$ is small compared with unity, and therefore $Z_2^2/\omega^2 L_2^2$ can be neglected.

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* "Proc. Roy. Soc." Series A, Vol. XC., 1914. Messrs. Campbell & Dye used [illegible] in their experiments. The values of B_{max} in current transformers are so small that the apparent permeability [illegible] the working range is on the straight portion of the B-H curve in the neighbourhood of the origin. Thus the apparent permeability would be sensibly constant at the amplitude of the oscillations [illegible]

† [illegible] Report of British Association, 1916, "Journal I.E.E.," Vol. [illegible], p. [illegible], 1916.

Thus (3) reduces to

$$I_1/I_2=n_2/n_1\left(1+\frac{Z_2\cos\theta}{\omega L_2}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and the percentage error in the transformation ratio is

$$\frac{100Z_2\cos\theta}{\omega L_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Since $Z_2=\frac{R_2}{\cos\theta_2}$ and $\theta=\theta_1-\theta_2$, equation (5) may be written :

$$\frac{100R_2}{\omega L_2}\frac{\cos(\theta_1-\theta_2)}{\cos\theta_2}=\frac{100R_2}{\omega L_2}(\cos\theta_1+\sin\theta_1\tan\theta_2). \quad (6)$$

At very high frequencies θ_1, for a given frequency, remains almost constant* for values of $H_{max.}$ between 1 and 5 C.G.S. units. If this be assumed to hold good for values of $H_{max.}$ obtaining in high-frequency transformers (which are much smaller than 1 C.G.S.), the only variable in equation (6) is θ_2. Thus the error increases with increase in θ_2 as shown in Fig. 2.

If $L'_2=aL_2$, where a is a variable parameter depending on the secondary leakage and the inductance in the external secondary circuit, equation (6), may be written,

$$\frac{100R_2}{\omega L_2}\cos\theta_1+100a\sin\theta_1. \quad . \quad . \quad . \quad . \quad (7)$$

$100a$ may be termed the "percentage equivalent leakage" of the total flux linked by the secondary winding. Since the apparent permeability of the iron decreases with increase in frequency, the secondary leakage, if any, will therefore increase.

The application of the foregoing formulæ is illustrated in the following example, the details of the transformer having been taken from Messrs. Campbell and Dye's Paper.† The data and calculations are only approximate.

CASE 1.

$R\doteqdot10$ ohms. $\omega=2\pi\times2\times10^5$ ($f=2\times10^5\sim$ per sec.).
$A\doteqdot1{\cdot}5$ sq. cm. $\mu_a\doteqdot35$ (deduced from data in author's Paper)
$dm\doteqdot4{\cdot}7$ cm. $\cos\theta_1\doteqdot0{\cdot}88$,, ,, ,,
$n_2=200$ turns. $\sin\theta_1\doteqdot0{\cdot}47$,, ,, ,,
$n_1=2$ turns.

By calculation from the above data $L_2\doteqdot1{\cdot}7\times10^{-3}$ henry,‡ and $100R_2\cos\theta_1/\omega L_2\doteqdot0{\cdot}4$, which is 0·2 per cent.§ smaller than the error found experimentally. Thus, in equation (7), $100a\sin\theta_1\doteqdot0{\cdot}2$, which represents the error due to leakage.

There is every reason to believe that in the present instance the leakage would be small, since the magnetic circuit was closed, being an anchor ring of stalloy stampings, which when *uniformly* and *closely* wound has, theoretically, no leakage.

In the case of 0·2 per cent. error we have

$$100a\sin\theta_1=0{\cdot}2$$

$$\therefore \quad 100a=0{\cdot}43 \text{ per cent.}$$

$$\text{and} \quad L'_2=0{\cdot}0043L_2$$

$$=7\times10^{-6} \text{ henry.}$$

The angle of lag of the current in the secondary circuit, $\theta_2=\tan^{-1}\omega L'_2/R\doteqdot41{\cdot}5$ deg. A small amount of leakage, therefore, can give rise to a large angle of lag without, however, increasing the transformation ratio to any great extent. It will be seen from equation (7) and Fig. 1 that if an instrument or heater with a smaller effective resistance is used, θ_2 increases for a given frequency, but there is a diminution in the error.

In order to reduce the secondary leakage to a minimum it is essential that the winding should consist of a single layer of fine wire as close to the iron as possible, adjacent turns being near together. Careful consideration must be given to the increase in resistance due to skin effect, and it may be necessary to use very fine stranded wire.

When the core is an anchor ring of rectangular cross-section, the value of H varies across the section. The variation will be large for a large ratio of the outer to the inner diameter (a/b), and since H is the greatest at the inner circumference, the flux will tend to crowd there. In practice, however, the values of H are so small that the apparent permeability may be assumed constant across the section. Thus the error in H will be found by calculation from modifications of the formula already given for L_2. In the case cited above where the ratio $a/b=2$, the error in the mean value of $H_{max.}$ across the section, calculated from the formula $H_{max}=4\pi n_1I_T/10l$ is 4 per cent. approx., which does not affect the transformation ratio appreciably.

A careful examination of possible cases shows that in well designed high-frequency current transformers for frequencies up to $2\times10^6\sim$ per second the effect of capacity in the instrument or heater, or in the secondary winding, is negligible.

In the experiments conducted by the author* the secondary of the transformer was connected to a Duddell portable thermo-ammeter, the inductance of which is small enough to be neglected, as the following calculation clearly shows.

Assuming that 0·1 of the error due to leakage in the example given above, represents the inductive effect of a thermo-ammeter; then inductance of

$$T.A.=7\times10^{-6}/2=3{\cdot}5 \text{ microhenries,}$$

which is much too large for an instrument of this type. At frequencies of the order of $10^6\sim$ per second, eddy currents may be induced in the elements of the thermocouple which will cause an increase in the reading. This, however, should not be serious.

On the assumption that in an iron-cored high-frequency current transformer the equivalent leakage in the secondary circuit is negligible, the secondary current will be in phase with the total E.M.F. and the vector diagram will be as shown in Fig. 3.

The error now becomes $100R_2\cos\theta_1/\omega L_2$ . . . . (8)

If a Duddell thermo-ammeter is connected to the secondary terminals, the E.M.F. for a given current and varying frequency will be constant. Moreover, $B_{max.}$ will vary inversely as the frequency for $B_{max.}=E_2\times10^8/4{\cdot}44Afn_2=c/f$. Since for a given value of $H_{max.}$, $B_{max.}$ decreases as f increases, the apparent permeability decreases. Assuming $\cos\theta_1$ (Fig. 3) to remain sensibly constant, the error in the transformation ratio (for a given value of R_2) depends on ωL_2, and since $\omega L_2\propto\mu_af$, the error depends on μ_af. Table I. shows the figures obtained for a constant secondary E.M.F., but the values of $B_{max.}$ are greatly in excess of those which obtain in high-frequency current transformers.

Table I.—0·47 *mm. Silicon Iron.*

Apparent permeability, μ_a	Frequency $\sim$ per sec.	$\mu_a f$	$B_{max.}\propto1/f_1$ for const. sec. E.M.F.
40·5	2×10^5	$8{\cdot}1\times10^6$	100
30·2	3×10^5	$9{\cdot}1\times10^6$	67
25·0	4×10^5	$10{\cdot}0\times10^6$	50
21·6	5×10^5	$10{\cdot}8\times10^6$	40

It will be observed that although B_{max} and μ_a decrease with the frequency, the product μ_af increases, and hence the error in the transformation ratio decreases with increase in frequency. For a given value of f the product μ_af increases with the flux density.

In a transformer constructed by the author, the iron was worked with a value of $B_{max.}\doteqdot0{\cdot}035$ line per square centimetre, f being $2\times10^5\sim$ per second and the primary current 5 amperes. The transformation ratio was 1:100 and the calculated error 0·2 per cent.† The same transformer was tested at 50 $\sim$ per second and 500 $\sim$ per second, the observed errors being 14 per cent. and 1 per cent. respectively. It is of interest to compare the values of μ_af in these extreme cases, and figures relating thereto are given in Table II.

At such low values of B_{max} the magnetisation losses are small and the iron remains quite cool. Both the magnetisation and energy currents are smaller than the same quantities for

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* "Journal" I.E.E., *loc. cit.*

† *Loc. cit.*

‡ L_2 has been calculated from the formula $4n^2_2A\mu_a\times10^{-9}/d_m$. The correct formula for a closely-wound anchor ring is $L_2=2n^2_2h\mu_a\log_e a/b\times10^{-9}$, where h is the axial depth of the ring and a/b is the ratio of the outer to the inner diameter. If $a/b=2$, the error in the first formula $\doteqdot4$ per cent.

§ The error found experimentally was 0·6 per cent.

* *Loc. cit.*

† Errors were calculated using equation (3).

Table II.—0·47 *mm. Silicon Iron.*

Apparent permeability μ_a	Frequency ∾ per sec.	$B_{max} \propto 1/f$.	Primary current amperes.	n_2/n_1 ratio of turns.	$\mu_a f$
1,000*	50	140	5·0	100	5×10^4
400*	500	14	5·0	100	2×10^5
30	2×10^5	0·035	5·0	100	6×10^6

a low-frequency transformer of the same size. An approximate calculation showed that in the above transformer, the losses at 50 ∾ per second were four times those at 2×10^5 ∾ per second, the primary current being 5 amperes in each case.

Experimental results show that μ_a for given conditions increases as the thickness of the core plates decreases. This will lessen any tendency for leakage to occur. Thus, for a given cross-sectional area of iron, the thinner the plates the greater the accuracy of the transformation ratio.

In conclusion, the author's best thanks are due to Dr. E. W. Marchant and Mr. Albert Campbell, B.A., for reading over and criticising the Paper.

B.T.H. ROTARY CONVERTERS.

The British Thomson-Houston Company have issued an instructive pamphlet which should prove of interest both to the engineer who wishes to know what results are obtainable by the use of rotary converters and to the student who desires to understand how these results are obtained. From this pamphlet the following description of the working and construction of these converters is taken.

Voltage and Current Ratios.—In the ideal case, the voltage generated follows a sine law with a maximum value equal to the direct-current voltage, so that the virtual value of the alternating-current voltage = direct-current voltage $\div \sqrt{2} = 0{\cdot}707$ of the direct-current voltage. This corresponds to the conditions in a single-phase converter. It follows that since the voltage between any two tapping points of a two-pole armature is proportional to the chord joining the two points, the voltage given by any phase machine is easily found.

Fig. 1 illustrates the R.M.S. voltages which exist between the tappings on single, two, three and six phase converters, the voltages in each case being proportional to the lengths of the chords, and expressed as fractions of the direct current voltage.

In the following table the theoretical ratios at no load unity power factor are given for single, two, three and six phase converters respectively, and are based on a sine wave distribution of flux in the air-gap. In actual practice the ratios may differ by values up to approximately 5 per cent., depending upon the distribution of flux in the air-gap, the load on the rotary, and the power factor.

	Assume D.C. voltage = 1.			
—	Single-phase.	Two-phase.	Three-phase delta.	Six-phase diametrical.
Voltage of transformer......	0·707	0·707	0·612	0·707
Voltage between adjacent rings	0·707	0·500	0·612	0·353
Current per line alternating-current low-tension side. (Efficiency 100 p.c.)	1·414	0·707	0·943	0·472

Armature Heating.—The current in the armature winding of a rotary converter is the difference between the alternating and direct currents. The difference materially decreases by increasing the number of phases up to six. It is, therefore, usual to equip modern rotaries for three-phase systems with six slip-rings, although they would run under the guaranteed temperature rise as three-phase machines. The six-phase winding entails a cooler machine, and one having a higher overload capacity as well as an increased efficiency of 0·25 to 0·5 per cent. Fig. 2 represents the currents circulating in the armature of a rotary converter if the machine be operated (*i.*) as a direct-current generator giving an output of 100 amperes, (ii.) as an alternating-current motor capable of driving a similar machine giving a direct-current output of 100 amperes, (iii.) as a converter by combining the functions of an alternating-current motor and direct-current generator, the output from the direct-current side being 100 amperes, and the power factor on the alternating-current side being unity. The diagrams have been drawn for every 7½ electrical degrees, and they will be found to repeat every 60 electrical degrees. The resultant currents are very low, and the average heating of the armature under the conditions shown is only 26 per cent. of the heating that would occur if the machines were operated as a direct-current generator.

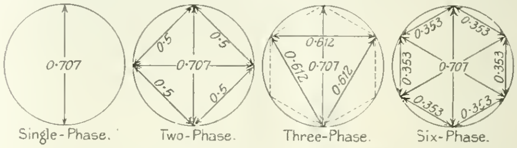

Fig. 1.—Diagram of R.M.S. Voltages.

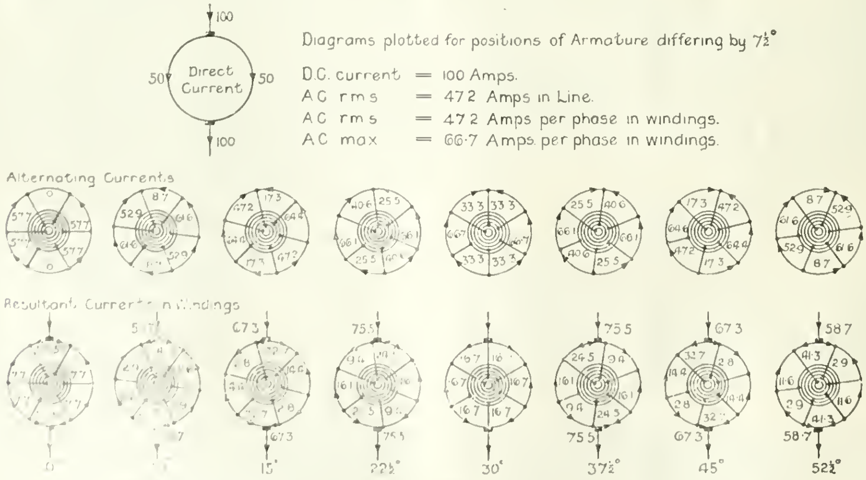
100
50
Direct Current
50
100
Diagrams plotted for positions of Armature differing by 7½°
D.C. current = 100 Amps.
AC rms = 47.2 Amps in Line.
AC rms = 47.2 Amps per phase in windings.
AC max = 66.7 Amps. per phase in windings.
Alternating Currents
Resultant Currents in Windings
15°
22½°
30°
37½°
45°
52½°

Fig. 2.—Diagram Illustrating Instantaneous Currents in a Six-phase Converter.

The heating of a rotary converter armature increases with decreasing power factor, due to the cancellation of alternating and direct currents not being so complete as at unity power factor. The diagram in Fig. 3 shows the heating factor of single, two, three and six-phase rotary converters when operating at power factors varying between unity and 90 per cent. The term "heating factor" means the ratio of the I^2R losses occurring when the machine is operated as a rotary, to the I^2R losses of the machine when operated as a direct-current generator, the output in direct current being the same in each case.

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* Deduced from results given by Mr. L. W. Wild, "Magnetisation of Iron at Low Inductions," Journal I.E.E., Vol. LII., p. 96, 1912.

Commutation and Efficiency.—In the ordinary type of direct-current generator cross-magnetisation, magnetic leakage, and saturation in the commutating pole fix a limit to the overload capacity. In the case of the motor converter, the armature on the direct-current side acts half as a rotary and half as a direct-current generator, and the M.M.F. producing distortion under the main pole and leakage under the commutating pole corresponds to half that existing in the armature of a direct-current generator. In the rotary converter the armature reaction due to the alternating current over 180 electrical degrees, balances the armature re-action produced by the direct current, and thus the commutating conditions approach closely to those that would exist were the ordinary direct-current generator fitted with completely compensating windings. It is possible in a rotary converter to produce a field under the commutating pole which will compensate for the reactance of the coil under commutation more closely than on any other type of converting apparatus, unless the converting apparatus be equipped with compensating windings, which is unusual.

Due to the cancellation of the alternating and direct current armature currents and armature reaction, and the use of the same magnetic circuit for both the alternating and direct current sides, the rotary converter with its transformer has a higher efficiency than other types of converting apparatus. The approximate gain in overall efficiency by installing a rotary equipment is shown in Fig. 4.

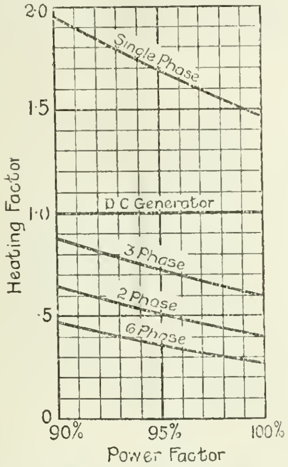


Fig. 3.—Curves giving the Heating Factor of One, Two, Three and Six-phase Converters.

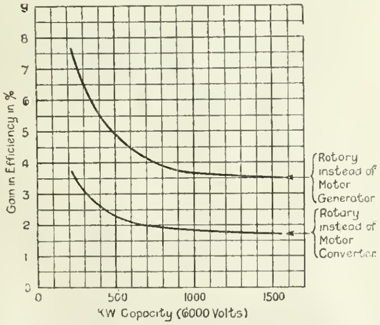


Fig. 4.—Curves showing the approximate Gain in Overall Efficiency by installing a Rotary Converter.

On account of the low armature I^2R loss, cancellation of armature reaction, good commutating conditions, and ventilating properties, the overload capacity of a rotary converter is much greater than in other converting apparatus; and it will be found that the installation of rotary converter equipments may often decrease the number of sets otherwise required in a sub-station, due to the ability of such equipments to carry large overloads without undue heating or sparking.

Power factor of Rotaries Running Alternating to Direct Current. A rotary converter runs at its highest efficiency and lowest heating on unity power factor. It is, therefore, advisable to adjust rotaries so that the normal direct-current voltage is obtained with unity power factor somewhere between three-quarter and full-load when the alternating-current voltage is normal. If, with the correct alternating-current voltage and unity power factor the direct-current voltage is not high enough to suit station requirements, the field current of the machine should not be increased to obtain the higher direct-current voltage by means of drawing leading current through the reactance; but the high-tension taps on the transformer should be changed to give a higher applied voltage at the slip-rings of the converter.

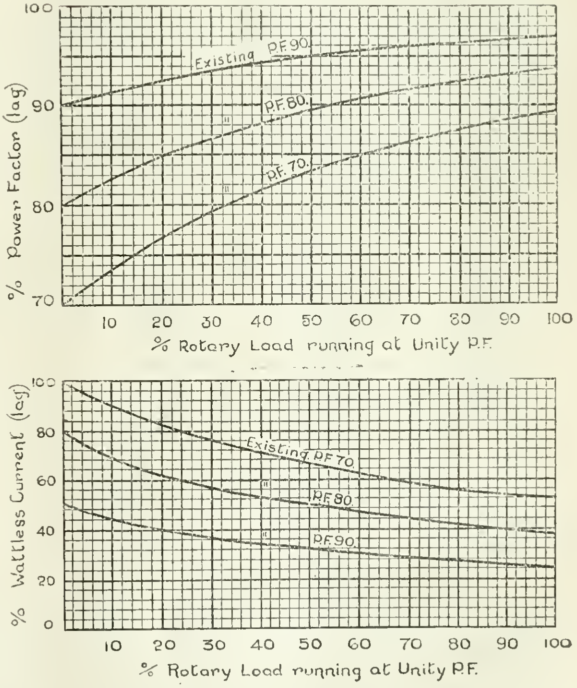


Fig. 5.—Curves showing Improvement in Power Factor which will be effected by installing, as extensions, Rotary Converters operating at Unity Power Factor.

It may, however, be necessary to install a rotary to draw leading current so as to compensate for lagging current in the system. This result can be obtained by adjusting the high-tension taps on the transformers so that the correct direct-current voltage is obtained by drawing leading current. It will be understood that with constant alternating-current voltage and varying direct-current voltage, the amount of leading current that can be drawn will vary with the direct-current voltage, except in the case of split-poles, booster or regulator controlled converters.

The ability of rotary equipments to run on unity or leading power factor is of considerable advantage, as they will improve the existing power factor of a system if it is below unity. Fig. 5 illustrates the improvement in power factor that will take place on an existing system as rotary converters drawing current at unity power factor are installed for extensions. In these curves the wattless current is expressed as a percentage of the energy current.

Variation in Voltage Ratio.

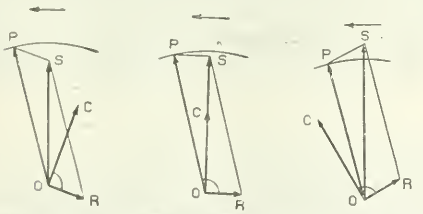
The following are the principal methods which have been adopted for obtaining a variable direct-current voltage with constant alternating-current voltage, and *vice versa*: (i.) Reactance control, (ii.) Booster control, (iii.) Induction regulator control, (iv.) Split pole control.

Reactance Control.—It has previously been shown that with constant alternating-current voltage applied to the slip-rings, the direct-current voltage will be practically constant on the ordinary type of converter. In the case of reactance control, in order to vary the direct-current voltage, the slip-ring voltage is varied even though the applied voltage at the high-tension terminals of the transformer remains constant. This control is effected by the introduction of reactance in the transformer supplying the rotary converter, or by means of a separate external reactance. The percentage reactance installed will depend on the conditions under which the rotary converter has to operate, and can be fixed to suit the case under consideration.

The method by which the voltage at the slip-rings is varied is illustrated in the diagrams, Fig. 6, constructed for a transformer ratio of 1 to 1. It will be seen from the diragrams that if the field of the rotary be adjusted to draw a lagging current, the effect of the reactance is to lower the slip-ring voltage; while if the field be adjusted to draw a leading current, the effect of the reactance is to raise the slip-ring voltage. It is evident that with this system of control the power factor on the high-tension side of the transformer varies with the direct-current voltage, and the variation will depend on the range in voltage required.

The reactance method of control is the cheapest and simplest, and is generally installed for conditions of service which do not require more than 10 to 15 per cent. voltage variations, and where independent control of the power factor is not necessary. It is not advisable to call for larger voltage ranges than are actually required, as the cost of this method of control may be thereby increased.

It is sometimes stated that the voltage control by this method is poor on account of the low power factor at which equipments of this kind operate. This, however, is not the case, provided the variation in direct-current voltage does not exceed 15 per cent., and such a range covers most conditions in practice. With constant voltage from no load to full load, the power factor will be approximately unity. With 5 per cent. variation in either the direct or alternating current side, or 2½ per cent. in the alternating-current side and 2½ per cent. in the direct current the wattless current drawn from the line under the least favourable condition of load and voltage need not exceed that which corresponds to 97 per cent. power factor on full full load. With 10 per cent. variation on the direct or alternating current voltage, or 5 per cent. variation in each, the wattless current under the worst conditions of load and voltage need not exceed that which corresponds to 95 per cent. power factor at full-load. With 15 per cent. variation in direct or alternating current voltage or 7½ per cent. in each, the wattless current drawn from the line under similar conditions to the previous example need not exceed that which corresponds to 90 per cent. power factor at full load.



O C lagging behind O S. O C in phase with O S. O C leading O S.

Fig. 6.—Vector Diagrams representing Reactance Control.

O P = vector representing the voltage at the H.T. terminals of the transformer, assumed constant.
O R = vector representing the reactance voltage produced by the current O C passing through the reactance.
O S = vector representing the slip-ring voltage, which is the resultant of OR and OP.

Where rotary converters are installed for operating on both lighting and traction, the reactance controlled machines are admirably suited. The transformers can be provided with a lighting tap which will enable the rotary converter equipment to run on either lighting or traction load under the conditions of voltage variation and power factor just mentioned.

The curves in Fig. 7 show the permissible limits of power factor under various conditions of load and voltage which will result from voltage ranges of 0, 5, 10 and 15 per cent. respectively, the high-tension taps on the transformer being so set as to give unity power factor at the mean direct-current voltage. It may be added that better results than these can be obtained if required. The curves also show the wattless current (leading or lagging) expressed as a percentage of full-load current which will be drawn from the line under various loads and voltages. It will be noticed that for a constant voltage the reactance-controlled machine will draw an approximately constant wattless current from the line from no load to 50 per cent. overload. The value of this current and whether it leads or lags depends upon the setting of high-tension transformer taps. Under the conditions shown on these curves, a reactance-controlled converter will operate at the lowest heating and highest efficiency.

It may be desirable, however, to arrange a converter to draw as much leading current as possible so as to compensate for low power factor on a certain feeder or at the main station. There is a commercial limit to the amount of leading current that can be drawn, beyond which the converter is appreciably increased in cost and reduced in efficiency. The percentage of wattless current which will be drawn from the line is also shown for various conditions of load and voltage.

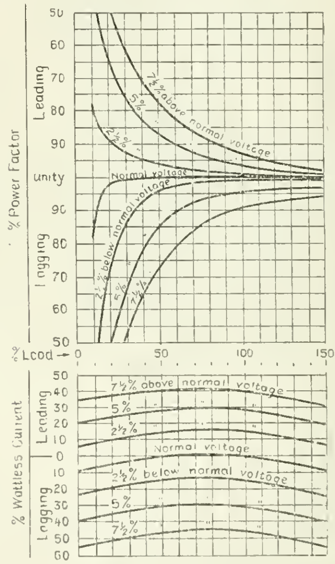


Fig. 7.—Curves showing Power Factor and Wattless Current.
(Voltage range 0 to 7½ per cent. above or below normal.)

It is always desirable to correct the power factor of a system by a number of machines drawing a reasonable amount of leading current, rather than to penalise one machine by drawing from it alone an excessive amount. The reactance-controlled machine will generally improve the power factor of a system (unless it be higher, for example, than 85 per cent.) even when running on the lower limit of a range of voltage, provided the machine is well loaded. When the higher loads and higher limits of voltage are required at the direct-current end of the converter, a leading current is drawn which helps to keep up the voltage on the alternating-current side. When there is a very light load on the rotary and it is operating at low direct-current voltage, small amounts of lagging current can be drawn from the alternating-current side, as this will be lightly loaded, and under such conditions the alternating-current voltage will tend to be high.

(*To be concluded.*)

BOOKS RECEIVED.

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INDUSTRIAL ENGINEERING: PRESENT POSITION AND POST-WAR OUTLOOK.*

BY F. W. LANCHESTER,

The term engineer is one of very wide and elastic usage. In its truest and most noble sense it recalls to our minds the names of the great pioneers of the late 18th and early 19th centuries—such men as James Watt, Telford, Stephenson and Brunel; but it is also used to denote the ordinary mechanic or machine operative of our factories, and other artisans engaged in the manual work of engineering.

There is a perfect parallel in the employment of the word *soldier*; there is no word which expresses the calling of a general or military commander with greater dignity, and yet the same word applies with equal accuracy and equal honour to the private in the ranks.

To-day the engineer has become ubiquitous, he is to be found everywhere, the scope he takes in is perpetually widening. Bit by bit the engineer, with his scientific knowledge and method, and, if I may so express it, his imaginative art, invades one industry after another, and, not content with that, seizes upon every new discovery and invention and proceeds to create new industries and new manufactures.

Thus the methods of the old trades are one after another revolutionised; our spinning and weaving mills have been transformed past anything our great grandfathers could have imagined; the milling of flour is conducted by new methods; buildings no longer depend upon the old-time architect for their design, nor upon the bricklayer or stonemason for their structural sufficiency; mining from decade to decade relies more and more implicitly upon the engineer. Shipbuilding has become a branch of engineering pure and simple; our chemical industries make greater and greater demands upon the engineer from year to year; and, in brief, scarcely one of the old trades, formerly in the hands of a coterie of skilled craftsmen, but to-day is run wholly or in part by its engineering staff, frequently men of high attainments and resource.

Of the trades which may be said to be the creation of the engineer, we have examples in the large works for the manufacture of structural iron and steel, locomotive and wagon and truck works, the whole of the electrical machinery trades, the manufacture of machine tools, &c. In a smaller way we have examples in the sewing machine and the typewriter, and, amongst more recent developments, the bicycle and automobile. Last, but not least, and particularly to the fore at the moment, there is the whole group of manufactures connected with the supply of war material of every kind.

In such trades there is employed a veritable army of trained men, who have every right to be considered engineers in the highest sense of the word; they are not professional men, they are not civil engineers in the restricted sense, they range from the specialist in some particular direction or line, possibly on the fringe of what could be fairly classified as engineering, to the fully fledged and responsible engineer, as to whose qualifications there is "no possible doubt whatever." They are perhaps sometimes to be described as mechanical engineers, sometimes as electrical engineers, sometimes as gas works engineers, and so forth; but broadly it is possible to include the whole in one general category as *industrial engineers.*

Industrial engineering is perhaps the least showy or spectacular branch of the art. There are no monumental works such as form the landmarks of progress in civil engineering, such as bridges, dams, railways, harbours, works, &c., no opening ceremonies and State occasions, nothing to arrest the public eye. The achievements of the naval architect and shipbuilder, it is true, make a vivid appeal to the popular imagination; but this is a class by itself, it is not industrial engineering in the ordinary sense, or at least it is a sufficiently distinctive branch to be a law unto itself. Even in shipbuilding it is comparatively rarely that the individual engineer comes before the public as the author of his work as did the great Brunel. The credit for achievement is usually absorbed by an impersonal organisation, of which the engineering staff, like the works of a watch, are carefully concealed from view.

No, the industrial engineer does not cut much of a figure in the limelight; but he can congratulate himself in this respect—he is at least better off than the engineer in the Services.

It is difficult to over-estimate the importance of the industrial engineer to the nation and to the State; and, of the many good things which the war has brought us, the realisation of this fact by the British Government is not one of the least.

The importance of the industrial engineer to a country such as England, and more broadly to the British Empire, is that the technical soundness of every business and industry depends ultimately upon his work. Without sound technical groundwork no industry can be built up or will stand; it is the foundation stone on which everything else rests. "Push and go" or "bluff and bluster" may succeed up to a certain point; articles may be copied from others by the aid of the foot rule, the micrometer and chemical balance. In brief, the technical groundwork may be stolen, but a national industry cannot be so established and held.

In the old days this technical foundation rested in the hands of skilled craftsmen, and was largely preserved by the guilds and by the secrets and tricks of the trade. Many such trades and industries survive even to-day. But under modern industrial conditions, with the free market in labour and the wider spread of knowledge, privacy has become well-nigh impossible, the manufacturer can no longer entrench himself in a desert of ignorance behind a barricade of secrecy. In order to maintain his position he has to make continual advance, and it is in the conduct of this advance that his security depends upon the efficiency of his engineering staff.

THE ECONOMIC OUTLOOK AND THE LABOUR PROBLEM.

There are at all times people who appear to think when anything serious happens that the world is about to undergo a transformation. I am not myself inclined to prophesy great or revolutionary changes as a consequence of the war; but there are points which are well worthy of study. Broadly stated, I believe that one result which we may hope from the war will be to some small extent the throwing down of the false values which have arisen and become accentuated during recent years, and the setting up of truer values in their places.

Up to a certain point it may be said that the work of the industrial engineer has been to serve humanity in the direction of burdening himself with a surfeit of material things, and so possibly his work in the past has contributed to establishing what I have referred to as the false values in place of true values; but it would be a mistake to suppose or to assume—in fact, it would be wrong to hold—that the cheapening of production, that is to say the obtaining of a greater output from a given amount of labour, is in itself misdirected activity or other than a true service to humanity; just as it would be a mistake to say that the discovery or production of cocaine or morphia is a moral wrong because of their abuse. The engineer who does his work, or the chemist who does his work, is not responsible because the increased powers given to humanity are misused. It is the business of the State to see that such increase of knowledge or power is rightly, and not wrongly, exercised. As engineers, therefore, we must regard the power of increased production per head and the material prosperity of the human race to be our object and goal.

There are many who will deny that life is any easier to-day than it has ever been. In fact, prior to the war, it was the fashion to speak of the strain and stress of modern life and the hard conditions which the modern worker has to face, as if for centuries things had been going from bad to worse in that respect. I will take one example as bearing on this point as food for thought, a 2 lb. loaf of bread, and I will take it at its present war price, say, 6d. At this value a loaf of bread represents an hour's labour for a poorly paid artisan, it represents half-an-hour's labour for a well-paid artisan, it represents 10 minutes or a quarter of an hour's labour for many a present-day skilled worker in munition factories, it represents about two or three hours' work for a woman employed on what I believe it is the custom to term "sweated labour."

A plough is an engineering implement, a windmill is an engineering appliance; we may accept both, we will not go back in our comparison to archaic times. Where is the superman who could dig sufficient land, sow sufficient corn, cut it with the old sickle, thresh it with the old flail, mill it, and go through the whole process of leavening and baking by the appliances of but a century ago and produce loaves at the rate of one per 10 minutes or quarter of an hour? Where is the ordinary man who could produce loaves under these conditions at the rate of half an hour labour each, and where is the community who, even with the comparatively modern appliances granted could produce their daily bread at the rate stated, and at the same time carry on a great fight for their existence? When we consider that the war price of the loaf above stated is double the normal price, which represents only about one and a half hour's work of the so-called sweated woman employé of an East End clothing factory, we realise what the engineer of the past, coupled with the trade organisation which his work has rendered possible, has done for humanity, and we realise how ill-informed and how meretricious is the cry of the stress of modern life. It is not as if the conditions applied to the loaf alone, but almost every other necessity of life has been similarly cheapened. The time of labour which it takes to support per head of population at the present day *for a given standard of living* for the necessities of life, and even including what may be legitimately termed luxuries, has been lower during the last 50 years than it has ever been in recorded history.

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* Abstract of Presidential Address to the Junior Association of Engineers, December 11, 1916.

Now it is the opinion of nearly every employer of labour with whom I have had the privilege of consulting that the standards of living at present existing and embarked upon are economically possible for the various classes concerned, *provided that the worker does not cut down his hours per week and co-operates loyally with the employer in producing the maximum output for every hour's work.*

I have also heard the opinion expressed, and that in very well-informed circles, that the labour leaders after the object lesson of the war is the cutting down of costs and increase in output, realise fully that the old restriction of output policy was a mistake and detrimental to their best interests; and, further, that no question will ever arise again of restricting output as part of a trades union policy. Let us hope in the interests of the rank and file of labour and of the whole country that this is so; but I confess to being not too sanguine of the future.

Let us examine the means by which production can be augmented, that is to say, how the output of labour may be increased. There are two main agents: (1) knowledge, (2) implements. The engineer is in a sense an apostle of knowledge and a designer of implements. His business in life is to seize on knowledge; incidentally, he may add to the sum of knowledge and apply same to the sum and total improvement of implements. Now the product of the engineer—implements—is (apart from the direct application of knowledge) *the* great means by which the product of an hour's labour may be increased. All this looks like platitude, but we have to remember that if it is platitude then the British working man's folly must be accepted as self-evident, for as long as the history of manufacture goes back he has strenuously opposed the introduction of new and better implements. We know how long his opposition was felt in the cotton spinning and weaving industries, and we hear of this kind of opposition again at the time of the great engineering lock-out in the nineties; even to-day, prior to the war, the old difficulties were cropping up as to whether the trades unions would allow one man to work more than one machine, although the said machines were designed almost to work themselves! Also the artificial restrictions of output such as were in full force both openly and otherwise at the time of the outbreak of war were a direct negation to the whole principle on which the introduction of labour-saving machinery is based.

But we can go still deeper into the matter. Implements of any kind cannot be created, they have to be made, and every implement represents in its manufacture a certain amount of unrequited labour. There is the direct labour, the work of the artisan and the unskilled labourer in producing and assembling the parts, and the labour (once removed) in the value of the material. There is behind that the work of an engineering staff applying existing knowledge to the best advantage—namely, as in the design of the implement and the study of its economic production. There is also the labour of the men who are responsible for and who form the organisation. These latter are commonly included as "dead charges," but the sum and total of the labour is represented according to the standard of coinage of the country as some certain sum of money, just as the weight of the machine is represented by a certain number of arbitrary units of mass. In other words, the value in £ s. d. is a measure in arbitrary units of labour. The labour required for supplying the community as a whole—*i.e.*, the nation—with implements during any period has to be deducted from the sum and total of labour over the period concerned.*

Thus the implements of a self-contained community are definitely the savings of the community over the period during which they are produced, and when we hear that the accumulated wealth of the United Kingdom has increased £10,000,000,000 sterling in the last half century, that £10,000,000,000 sterling is visible around us; it is in the main what anyone who has lived long enough to take stock of things for half a century may see in the growth of the "implements" by which the product of labour is enhanced and by which the comfort and standard of living have been augmented.

It has ever been one of the obstacles to the improvement in the position of the artisan and other manual workers in this country that his savings as a class relatively to the nation's needs are small. Inquiry made of some of our big industrial firms as to the position, even now during war time, with wages at an abnormally high level, is disappointing. Under encouragement of every kind, with an automatic savings scheme, including a bank on the premises, the savings do not amount to more than about 5 per cent. of the total wages; and if this is the case under present conditions with the patriotic incentive, one realises that under normal conditions the proportion is lower. It is, in fact, far lower. There are many who would suggest at once that if you want a man to save more, you must give him more; but unfortunately human experience does not bear out this view. Even the working man's organisations, the big trades unions, have no permanent capacity for saving; it is true that the funds frequently rise steadily over a long period and may run into six figures, but it is almost possible to predict when labour troubles are due from this very accumulation of wealth. When the amount of the funds in pounds sterling reaches the number of men multiplied by five, it is almost certain there will be trouble. One might term that figure the *strike point.* I have talked with men on the subject, and I have heard many views expressed by the working man. His feeling is that the money of his trades union invested in ordinary securities, such as railways, bonds, &c., is *doing nothing;* in other words, the interest which is accruing is not considered a commensurate return for the self-denial which it has required to accumulate the fund.

Neither can we look to the Government as a source of saving, since no modern Government has shown any capacity in that direction, whether democratic or autocratic; the National Debt invariably exceeds the State's productive assets.

The manner in which in the past organised labour has set itself against efficiency in production in face of the fact that restricted production is an obvious economic fallacy, denotes something more than is apparent on the face of it. The views have been so stubbornly held in the past that, in spite of piecework and of various forms of bonus system, even worked on a broad-minded and liberal basis, deliberate restriction is still continued. A typical instance came under my notice quite recently.* A certain article had been produced in a works in which a bonus system was in force, on a turret lathe with a well-devised outfit of tools; but the cost was persistently too high. There was bonus to be made by lowering the price, but batch after batch went through, sometimes in one shop and sometimes in another, but no improvement was secured. That same job went, by accident, owing to pressure of work, into the tool room, and a batch was put through by a tool maker on an ordinary engineer's lathe, with an actual saving of money! Such cases are by no means uncommon. Here the work of the industrial engineer has been entirely negatived by the systematic and organised restriction of output, in spite of every attempt at encouragement.

With the existence of the country at stake, if we may say so, and with a special Ministry created to stimulate and control production, these conditions have been largely overcome; and to-day, without question, a large majority of skilled and semi-skilled labour in this country is doing its loyal best to produce as much as possible. If this state of things can be perpetuated after the war there is hope that, not only can the pre-war standard of living be maintained (in spite of the need for an increase in the annual expenditure as due to obligations contracted during the war), but it may, perhaps, be improved. We may possibly even have a bigger margin than ever before, after allowing for the payment of both interest and sinking fund on the National Debt with which we shall then be saddled. The whole question is whether organised labour can be persuaded to take the view which its own interest, as well as that of the State, requires.

Behind the men's doctrine of restriction of production there is something more than is apparent on the face of things. The true reason why the doctrine of restricted output has found so much support amongst organised labour is that although restricted output is demonstrably injurious, and to be regarded as the curse of the country, of the nation and the State, the particular trade to which the men's organisations have applied restrictions have sometimes been seen to flourish like a green bay tree, at least as gauged by the prosperity of the wage earner.

But the same does not continue to apply when trade after trade becomes organised. It is evident that if every trade and every worker in the country were to do the same there would be a shortage in the total production, and as it would be expressed the cost of living would have gone up more than the wages. Is not this just what was being discovered prior to the war? There had been an investigation as to the cost of living, and during the period under investigation it transpired that the cost of living had gone up almost exactly to the same extent as the rate of wages. Precisely what ought to have been expected, and yet the attitude taken by the men's leaders was that the employer having been made to pay what by some process of thought was described as a "fair or living wage," and had been forced to grant better conditions of employment, the scoundrelly capitalist had put the prices of things up so that the working man was no better off than before! One cannot seriously hope for a great deal when this type of thought obtains currency.

I have no panacea or recipe to offer in the matter of dealing with this complex labour problem. It is my personal belief that some reversal or modification of the policy of recent legislation will become necessary. One cannot be blind to the gravity of the position, since no legislation of a character tending to limit the power of the trades union is possible without the general consent of the electorate; in fact, one may say unless with the mandate of the electorate. If one holds the view that logic must ultimately prevail, perhaps, a majority may in time be found for the freeing of the wage earner from the shackles of restricted output. It is, however, always difficult by a mere process of moral suasion to undo an evil which should never have been allowed to grow up.

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* Here we strike once again one of the fallacies of the working man's doctrine; he wants to know why in the name of justice the working man cannot consume (in equivalent) all that he produces.

* Prior to the War.

The whole situaton is admittedly full of complication, different employers have different methods of their own of stimulating production, and if one may say so of dodging the restrictions which the trades unions have endeavoured to enforce. There are advocates of a straight piecework system, and of various bonus schemes; there is something to be said in favour of each. So far as my personal experience goes neither the one nor the other is really effective as combating the restriction of output; in some cases it would almost appear that there is a secret organization within a works to fix its own times and prices on everything, so that although nominally the piecework system gives every inducement to the employé to obtain an increased output, in practice its whole purpose is frustrated. There are many difficulties also in the administration of a piecework system. It sounds plausible enough to say that if a piecework rate is set and a man can improve upon it the piecework rate should never be altered. If the rate is reasonably and properly fixed in the first instance, and the means of production remain the same, then if an employé can make more than a customary wage by his industry the cutting down of the piecework system is both unjust and foolish. But it is difficult and sometimes equally unjust to maintain a piecework price which either has been wrongly set in the first instance or has become obsolete because of a change of conditions. If in the performance of some one process a man is able to make three times his standing rate, whereas another process will only allow one and a half times the standing rate, and if no readjustments are permitted, it cannot be other than an injustice that two men of equal industry, skill and ability, engaged and working under the same conditions, should receive one double of what the other receives. Beyond this, is it not a danger to put into the hands of foremen or chargemen what amounts to the exercise of valuable patronage; we know the evils to which such a situation may give rise.

There are certain employers of labour and many would-be social reformers who believe they see the solution to the present industrial difficulties in schemes of profit-sharing. The unsoundness in my opinion of the profit-sharing schemes such as have hitherto been proposed and introduced in certain special instances, is due to the fact that the rank and file of the working community cannot afford to gamble. In any trading concern the first charge, if one may say so, on the finances is the wage bill, whatever else happens this must be paid; the most speculative and last charge on the company is the dividend. Now, if profit-sharing were widely introduced into our industries we should have in a number of factories men doing identical work, or work demanding equal skill, and doing it with equal industry; in all factories the men would be receiving some standard rate of wage as a basis; in one factory where big profits were made the men might be doubling their rate of wage, in another factory where no profits happened to be made the men may be getting nothing in excess of the minimum. Such risks are risks to which business men and investors as a class are accustomed; they constitute what is truly termed the gambling risk in any business or investment. It is admitted on all hands that for the working classes a gambling risk is undesirable; it is far better that the working man should know what his weekly payment will be or at least where it is variable that it shall be a matter to some extent under his personal control.

It seems sometimes to be assumed by the less well-informed advocates of profit-sharing, as against other methods of encouraging industry, that the rank and file of labour would draw a share of the profits *in addition* to what he now receives. Even were it so adjusted in the first instance the very laws or economic considerations which at present act to limit the wage equivalent, would soon bring the average down; it may be pointed out that even were this not the case, it would come off the existing dividend account of the country, and so would lower the saving power of the nation, which is inadmissible, whether viewed from the point of view of the State or the point of view of the worker himself.

The whole psychology of the manual worker is against allowing him to shoulder any of the gamble. If he is to have an increase in his pay, rather than profit-sharing, it should be on a piece work or bonus system, where the individual effort gives individual recompense. If under a profit-sharing scheme a district were to enjoy exceptional prosperity for a time, as nearly always happens in every trade, we know as a human certainty that the standard of living would go up, just as it has in the prosperous munitions districts to-day, and when the nearly inevitable slump arrives great hardships would be inevitable; in many cases the whole working class community would be better off if they had not experienced the period of abnormal success. If the rank and file of labour could accept the gambling risk without danger there would be little or no need for our present betting laws, &c. Even amongst those who have had the advantage of a more liberal education and leisure and opportunity to look around them a period of inflated prosperity does not always turn out to be an unmixed blessing. It has been the undoing of many a man in a good position.

The industrial engineer of the future will without doubt have his due measure of technical problems and difficulties to face; but it behoves him to watch carefully the wage earner's position and aspirations, and to find means to encourage him to co-operate in the campaign for industrial efficiency. Above all it is necessary that the manual worker should be more fully instructed concerning those broad economic questions and principles against which he has in the past thrown himself in vain, in opposition to his own true interests and to the disadvantge of his fellow workers, the Nation and the State.

DISTRIBUTING TURBINE LOADS FOR BEST WATER RATE.

While it may seem at first thought that the highest steam turbine economy will be obtained when each unit is operated at its most efficient load, this is not always found true in practice, according to the "Electrical World." For instance, in some tests made by Mr. W. A. Hirt, of the Detroit Edison Company, it was found that nine turbine-driven sets considered separately operated most economically at the following loads:—

Table I.—*Most Economical Loads for Machines Tested.*

Unit number.	Turbine, kw.	Generator, k.v.a.	Best point, kw.
1	8,000	8,890	6,500
2	8,000	8,890	5,750
3	8,000	8,890	5,000
6	14,000	14,000	7,000
7	14,000	14,000	8,300
8	14,000	14,000	7,500
9	15,000	18,750	11,500

These conditions existed with certain steam and condensing water temperatures, so that any change in conditions would affect the relations mentioned. When the water rate of the turbines as a whole was considered, however, it was found that the better economy could be obtained by operating the turbines at other than their individual most efficient loads. This is shown by the following results, obtained with three different divisions of load:—

Table II.—*Effect on Total Water Rate of Changing Individual Loads.*

No.	Load.	Water.	Load.	Water.	Load.	Water.
1	8,900	117,000	9,000	120,000	9,000	120,000
2	8,600	116,000	8,000	108,000	8,000	108,000
3	5,500	75,000	5,500	75,000	6,100	84,000
4	5,800	78,500	6,000	81,500	5,600	76,000
6	7,100	100,000	6,500	92,000	6,000	85,000
7	8,900	121,000	9,700	132,800	10,000	137,500
8	8,000	110,000	8,500	117,000	9,000	124,000
9	14,000	181,000	13,500	174,200	13,000	167,700
Total	66,700	898,500	66,700	900,500	66,700	902,200

While more efficient results might be obtained by some other distribution of loads, the three tests given indicate that a considerable saving can be obtained by manipulating the combination. For instance, with the same units and the same load, water rates of 902,200, 900,500 and 898,500 can be obtained by different load distributions. Taking the extreme figures, it can be seen that 3,700 lb. of water per hour could be saved.

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STEELWORKS ELECTRIFICATION.

In few industries has the adoption of the electric drive shown such striking results as in steelworks. In the latter, as far as outward appearances are concerned, the rolling mill is perhaps the most imposing machine. Modern methods of management imperatively demand a detailed analysis of the cost of the various manufacturing operations, and, as Mr. BRENT WILEY pointed out in a recent editorial note in the "Electric Journal," the motor-driven reversing mill is giving steelworks managers a demonstration of the value of the electric drive in connection with this idea.

The progress during the last 10 years in the electrification of rolling mills has been phenomenal. According to Mr. WILEY, for a period of eight years prior to 1914 the number of installations in American steelworks averaged 25 per year, totalling 33,750 H.P., including 300 H.P. motors and larger. During the last two years the number of installations has increased very rapidly, including approximately 125 units, totalling 265,000 H.P., which represents an addition of more than 65 per cent. of the drives installed from 1906 to 1914.

Prof. UNWIN, in his recent Presidential Address to the Institution of Mechanical Engineers, referred to the relative positions of this country and Germany as regards the steel trade. Viewed in a broad light, we think that figures giving the output of America are even more disquieting, because they affect equally all the steel producing countries of Europe. Although figures relating to output cannot be published at the present time, nor can particulars be given of the efforts that are now being made in an attempt to restore the balance, it may, nevertheless, be stated that really great work is being done at home, not only in the modernising of old plant, but also in the construction of new plant. Formerly steelworks machinery was ordered reluctantly in single units, whereas now scores of such units are being made.

In these new or modernised works it is possible, if not tolerably certain, that power will be purchased from outside, as it undoubtedly should be. The first business of an iron master, or of anybody else engaged in industry, is to secure a maximum output at minimum cost. The building of a power station on land in the near neighbourhood of a steelworks makes this impossible. Such land could be used to very much better advantage for steel producing purposes. To argue that because electrical energy is indispensable in industry it should be generated on the spot is every bit as foolish as to argue that because a plentiful supply of water is essential to good health every house should have its own well, pumping plant and storage tanks.

Not only does the elimination of the power station lead to greater economy, but it lessens the worry of maintaining the supply, and lessens the initial capital outlay. The reversing mill may be given as an example of the latter. When power is purchased, the cost of the electric equipment of the mill will be about 35 per cent. less than that of the corresponding steam engine equipment, whereas when power is generated on the spot the cost will be some 10 or 15 per cent. more than that of the engine-driven mill. The worry of maintaining the supply is a matter that will make a strong appeal to the iron master, for the manufacture of steel is one of the few trades in which a stoppage of any one of a dozen or more parts of the equipment automatically brings other parts to a standstill, and at the same time results in considerable loss, due not so much to the reduced output consequent on the stoppage as to the spoiling of material under treatment at the time of the stoppage.

Electrical engineers quickly recognised the importance of continuity of supply and the necessity of absolute dependability of the electric equipment—motors, controllers and switchgear. But in the early days—and by early days in steelworks electrification is meant about 15 years ago—recognition of the necessity of absolute dependability does not mean that suitable apparatus was immediately forthcoming. Till the advent of "steelworks service," the most severe service known was that of traction. It was thought that traction motors and controllers would lend themselves admirably to the driving and control of steelworks machinery; but, viewed under present-day conditions, the results were unsatisfactory. They were, nevertheless, such as to justify the optimism of the electrical engineer and to convince the user that, provided machinery of an exceedingly robust character was forthcoming, the introduction of the electric drive would revolutionise the manufacture of steel.

With this object, several of the large electrical manufacturing companies sought the advice of the steelmaker. The latter, to his credit, stated his requirements fully and without reserve. Examination of these showed that an entire re-modelling of the motors and control gears was necessary. Of the motors it may be said that the essential requirements are absolute reliability, great mechanical strength, fireproof construction, sparkless commutation under the most severe operating conditions, and ease of repair. Motors to satisfy these requirements were constructed, and from the operating records it is expected that they will have not less than four times the length of life of the type of machine which they superseded. At the same time, the "mill motor"—which is the name given to a motor suitable for steelworks service—can be run safely for a considerable time at a temperature that would quickly burn out any ordinary industrial motor.

The development of the contactor, or magnet-switch, led to the solution of the controller problem, and incidentally resulted in the introduction of control gear which was more easily operated than a steam stop-valve, and which, if so desired, could be made automatic in its action without any mechanical or electrical complications. In this way the performance of the electrical equipment was made to depend on the skill of the designer instead of on the skill of the operator. Here, again, the success was instantaneous.

Although the reversing mill was stated above to be the most imposing machine as far as outward appearances are concerned, it must not be forgotten that appearances are proverbially deceptive. In the electrification of the reversing mill many of the problems, such as load equalisation, motor control and motor design, had already been practically solved, so that little pioneer work had to be done. Much as one is impressed by the appearance of the electrically-driven reversing mill, and by the ease with which it is controlled, the imposing mill is, nevertheless, one of a dozen appliances in a steel works that have to be equally reliable. Of these appliances may be mentioned mixers, charging machines, cranes, strippers, skip hoists, mill tables, manipulators, screw-downs, shears, saws and cooling beds. Just as modern methods of manufacture demand the electrification of the rolling mill, so do they demand the electrification of the machinery above mentioned, and it is in the latter connection that we get such a good illustration of the effect of hearty co-operation of manufacturer and user in the progress of industry.

THE INFLUENCE OF TEMPERATURE ON THE FRICTION LOSSES AND EFFICIENCY OF DYNAMOS.*

BY PROF. W. PEUKERT.

The method of allowing a machine to lose speed gradually and come to rest has been used for determining the losses which take place in the machine. In this way the amount of the total losses can be ascertained and the various losses can be separated. The friction losses can be divided into those due to air friction and bearing friction, on the one hand, and those due to brush friction on the other. This is done by carrying out two similar tests, in one of which the machine is allowed to come to rest with the brushes resting on the commutator and the magnets unexcited, and in the other case the brushes are lifted. No really successful method has yet been indicated for separating the losses due to air friction and bearing friction. The difficulty lies in the fact that both depend on the temperature, but vary according to different laws. The relation of air friction to temperature has not been properly ascertained, so that no calculations are possible. Brush friction also varies with temperature.

It was, therefore, arranged to investigate the effects of a change of temperature on the friction losses of a dynamo or motor, and with this object the following tests were carried out. An ordinary shunt motor was taken, which at full load took 26 amperes at 440 volts and ran at 1,100 revs. per min. The normal exciting current was 0·554 ampere. The room in which the motor ran could be artificially heated to any desired temperature. The tests were so carried out that the temperature was slowly raised from the lowest limit. In order to bring the motor to a steady state it was run for several hours before the tests began. The temperature was very slowly raised; the temperature was kept constant during each series of tests, and the motor was allowed to run for some time at each temperature, so as to be certain that all parts of the machine had reached the prescribed temperature. All the measuring instruments were placed outside the test room, so as to free their readings from any error due to temperature. Temperatures between 18°C. and 54°C. were chosen. At each temperature a curve was constructed showing how the machine lost speed if allowed to come gradually to rest, both with excited and unexcited magnets. From these curves the total friction losses were ascertained. The figures are here given from which the curves were constructed, but the curves are not given. From these curves the various curves showing the friction losses were deduced.

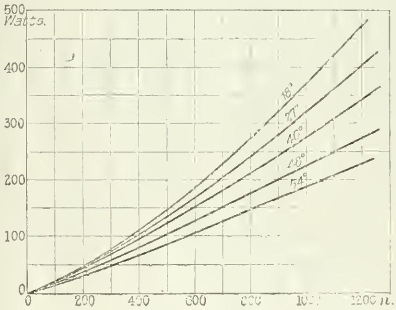

Fig. 1.—Relation between the Friction Losses, Speed and Temperature.

In Fig. 1 the total friction losses for the different temperatures, which were kept constant, are shown in relation to the speed. These curves show very clearly the decrease of the friction losses with temperature. At each temperature the no-load losses were determined for the different speeds. The figures were used for constructing curves, which show the relationship between the no-load losses and the temperature, as shown in the following tables, I. to XI. All the tests were carried out with a normal exciting current of 0·551 ampere.

Fig. 2 shows the change of the no-load losses with temperature; these also decrease with an increase of temperature. From these curves we can determine the no-load losses and the friction losses at constant speeds and different temperatures. The calculations

---

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft. 17, 1916.

Table I.—"*Running-down*" *Test at* 18°C.

Without excitation.				With normal excitation.			
Sec.	Speed.	Sec.	Speed.	Sec.	Speed.	Sec.	Speed.
0	1,080	36	412	0	1,160	28	210
3	1,020	45	291	2	1,084	32	126
6	954	54	163	4	990	36	32
9	884	63	70	8	842	...	...
18	715	69	0	16	558	...	...
27	558	...	...	24	324	...	...

Table II.—"*Running-down*" *Test at* 27 C.

Without excitation.		With normal excitation.	
Sec.	Speed.	Sec.	Speed.
0	1,000	0	1,052
6	908	4	936
12	809	8	780
24	663	12	642
30	535	18	453
39	407	24	306
51	240	28	200
66	77	32	105
72	16	36	10

Table III.—"*Running-down*" *Test at* 40 C.

Without excitation.		With normal excitation.	
Sec.	Speed.	Sec.	Speed.
0	1,130	0	1,052
6	1,024	2	990
12	919	4	926
24	756	12	685
36	564	18	495
48	407	24	337
60	270	30	179
72	105	36	42
78	23	39	0

Table IV.—"*Running-down*" *Test at* 48 C.

Without excitation.		With normal excitation.	
Sec.	Speed.	Sec.	Speed.
0	1,130	0	1,052
6	1,048	4	947
12	976	12	716
24	842	24	379
36	698	36	74
48	546	40	0
60	400	...	...
72	241	...	...
81	128	...	...

Table V.—"*Running-down*" *Test at* 54°C.

Without excitation.		With normal excitation.	
Sec.	Speed.	Sec.	Speed.
0	1,115	0	1,052
12	988	8	863
24	890	16	684
36	790	24	485
48	663	32	284
60	552	40	95
72	436	44	0
84	302	...	
96	163	...	
105	23	...	

Table VI.—"*Running-down*" *Test at* 18 C.

Speed	Armature current I.	Terminal voltage.	E.M.F., E.	IR_a	EI.
1,160	1·289	440·0	438·5	1·52	565·23
1,080	1·193	410·0	408·6	1·41	487·46
1,030	1·130	393·6	391·3	1·33	442·17
918	1·096	360·0	358·0	1·29	393·11
832	1·011	316·0	314·8	1·20	319·21
736	0·960	280·0	278·9	1·13	267·74

Table VII.—"*Running-down*" *Test at* 27 C.

Speed	Armature current I.	Terminal voltage.	E.M.F., E.	IR_a	EI.
1,168	1·226	440·0	442·55	1·447	542·57
1,105	1·184	420·0	418·60	1·397	495·62
1,021	1·089	388·0	386·71	1·285	421·13
979	1·053	372·0	370·76	1·243	390·41
842	0·983	320·0	318·84	1·156	313·42
756	0·937	287·2	286·10	1·106	268·08

Table VIII.—"*Running-down*" *Test at* 40 C.

Speed	Armature current I.	Terminal voltage.	E.M.F., E.	IR_a	EI.
1,212	1·100	461·2	459·90	1·298	505·89
1,073	1·004	408·0	406·81	1·185	408·44
956	0·940	363·2	362·10	1·109	340·37
900	0·900	361·0	360·01	0·062	324·01
780	0·845	296·0	295·00	0·997	249·28
721	0·826	272·0	271·00	0·975	223·85

Table IX.—"*Running-down*" *Test at* 48 C.

Speed	Armature current I.	Terminal voltage.	E.M.F., E.	IR_a	EI.
[illegible]	0·994	448·2	447·03	1·173	444·37
[illegible]	0·951	424·0	422·88	1·122	402·16
[illegible]	0·867	396·0	394·98	1·023	342·45
[illegible]	0·855	378·0	377·00	1·009	322·34
[illegible]	0·793	336·0	335·06	0·936	265·70
708	0·761	292·0	291·11	0·898	221·53

Table X.—"*Running-down*" *Test at* 54 C.

Speed	Armature current I.	Terminal voltage.	E.M.F., E.	IR_a	EI.
1,210	0·845	460·0	459·00	0·997	387·86
1,181	0·821	450·0	449·03	0·972	370·00
1,130	0·803	430·0	429·05	0·948	344·53
1,072	0·761	408·0	407·10	0·898	309·80
991	0·728	377·6	376·74	0·859	274·27
926	0·697	352·0	351·18	0·822	244·77
853	0·676	324·0	323·20	0·798	218·48

Table XI.

Temperature, centigrade.	Friction loss.	Friction and iron losses.	Efficiency.
18	421	516	86·68
27	361	476	87·03
40	308	425	87·47
48	252	372	87·93
54	208	325	88·35

were made for a normal speed of 1,100. The values so obtained are contained in Table XI., and give the curves in Fig. 3.

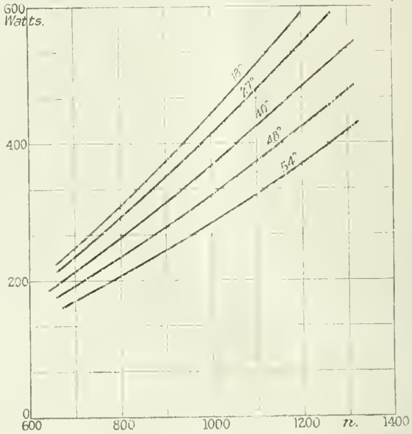

Fig. 2.—Relation between the No-load Losses and the Speed at Different Temperatures.

The friction losses at constant speed decrease with an increase of temperature. The decrease of the friction losses at high temperatures will affect the efficiency of the motor. In order to determine this effect more exactly the efficiency was determined for the different temperatures. At a temperature of 18 C. the iron and friction losses amount to 516 watts at 1,100 revs. per min. The current taken at full load by the motor is 26 amperes at 440 volts, and the normal exciting current is 0·554 ampere. The resistance of the armature, including that at the brush contacts, was found to be 1·18 ohms. The efficiencies were then calculated and found to be as follows:—

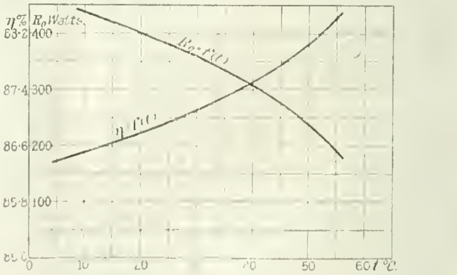

Fig. 3.—Relation between the Friction Losses, the Efficiency and the Temperature.

Efficiency at 18 C. .... 86·68 per cent.
" 27 C. .... 87·03 "
" 40 C. .... 87·47 "
" 48 C. .... 87·93 "
" 54 C. .... 88·35 "

The losses due to heat in the armature were taken as constant for the different temperatures. The armature resistance certainly increases, but the resistance at the brush contacts decreases with increased temperature; thus the one balances the other to some extent, and it is probably not unfair to take this loss as constant. Fig. 3 shows graphically the relation between efficiency and temperature; the efficiency increases with increase of temperature.

This method does not separate the losses due to bearing friction from those due to air friction; further tests would be necessary. But it is easy to see the marked manner in which the friction losses and the efficiency depend on the temperature.

ECONOMY IN LIGHTING AND THE DARKENING OF THE STREETS.

The opening Paper delivered by Mr. L. Gaster at the last meeting of the Illuminating Engineering Society on Dec. 15 covered a variety of topics, including daylight saving, economy in illumination, the lighting conditions in the streets and research in the lighting industry.

Before commencing his remarks Mr. Gaster referred to the great loss which the Society had sustained in the death of Prof. Silvanus P. Thompson, who had been President during its first four years of existence. A letter from the Chairman of Council (Mr. F. W. Goodenough) was read, associating himself with these remarks, and also an official communication from the Electro-technical Association in Russia, in which admiration was expressed for Prof. Thompson's services to science.

Daylight Saving.

Mr. Gaster then proceeded to summarise some of the changes which were now taking place in connection with lighting. At present decorative and spectacular illumination were naturally in abeyance in this country but it was worth noting, for future reference, the remarkable developments that had taken place in the United States, for example, at the San Francisco Exhibition, where the system of "flood-lighting," now becoming common in America, was employed on a large scale.

The Daylight Saving Act had been a revolutionary measure. Its effect on the revenue of lighting companies depended very greatly on the nature of the district; in some residential districts it had approached 25 per cent.

It would, Mr. Gaster added, be most instructive if a complete survey of the effect throughout the country could be made, so that the resultant approximate actual saving in fuel could be estimated. The measure had been carried out with relatively little inconvenience, and might be permanently adopted after the war. At the present time, therefore, we should be prepared by gaining as full information of its effects as possible. Such an inquiry should not be confined to the actual fuel saving. It would be useful to ascertain if the change in habits of the people had been on the whole beneficial, and the effect of the measure on conditions of work in factories and offices. If it could be shown that the percentage of absentees through sickness had been materially diminished, this in itself would be a most important result, which would no doubt influence future decisions regarding premises into which the access of daylight is always deficient.

Associated with such an inquiry, again, was the whole question of the design of buildings with a view to maximum admission of natural light, and the comparative value of the various devices for improving the light in existing buildings (the use of prismatic glass, mirrors, &c.). As a measure of economy such devices, which prolong the hours during which artificial light is not needed, deserve much more scientific study than they have yet received in this country. These problems had an important relation to the work of the Committee of the Society on Natural Lighting in Schools, which was summarised in a report issued shortly before the war. An equally important matter was the diminution in daylight caused by the practice of obscuring sky-lights, &c., in order to comply with the lighting regulations. If it could be shown—what is probably the case—that the cost of providing efficient blinds, which could be drawn down in the evening and released in the day, was small in comparison with the running saving in artificial light so caused, this in itself would be an important result.

Economy in Artificial Light.

The national importance of economising in fuel supplies had led the Board of Trade to issue circulars requesting consumers to diminish their consumption of gas and electricity for lighting, and inviting gas and electrical supply companies to co-operate in bringing about a 10 per cent. reduction. But the mere diminution of illumination, in cases where it is even at present insufficient for the purpose in view, is false economy. Good illumination is essential in factories and workshops, and defective illumination leads to diminished output, spoiled work, and an increased number of accidents. These conclusions were strongly endorsed in the series of bulletins issued by the Committee on the Health of Munition Workers during the present year, particularly in No. 9 relating to Ventilation and Lighting of Munition Factories, and No. 15 (just issued) on the Effect of Industrial Condition on Eyesight.

A well-considered scheme of economy could be made effective only through the systematic education of people to appreciate the proper use of light, and the authorities would greatly assist the objects they have in view if they were to make use of the Illuminating Engineering Society to prepare definite instructions on the subject to various classes of the community. Judicious economy in lighting, by which is meant prevention of the waste of light, and its application in practice in the most efficient manner, is one of the main objects of the Society.

From the standpoint of economy, it would be very important to determine the approximate upper limits, beyond which no gain in output or quality of work is to be obtained. A most instructive experiment is being conducted by the Commonwealth Edison Co. in the United States. A factory is being lighted in accordance with the best modern practice, and arrangements are being made for increasing at will the illumination to three times its present value. The experiment will be carried on for at least four months, the two methods of lighting being used alternately at intervals of a month, and a careful check of the output and quality of work kept throughout the entire period.

The Committee on the Health of Munition Workers has been carrying out many detailed investigations into the effect on output in munition factories of changing hours of work. It would be most instructive if, while detailed investigations into other variations in conditions affecting the health and efficiency of munition workers are being made, the influence of changing conditions of lighting could also be studied.

Lighting Conditions in the Streets.

Discussing the diminished illumination in the streets, Mr. Gaster said they were all willing to abide loyally by any conditions demanded in the interests of the safety of the country. At the same time they could not kelp being conscious that, if the assistance of those who have made a study of illumination for years were more effectively utilised, it might be possible to improve on the present arrangements in many respects—to make economies and to provide conditions of illumination which, while meeting the views of the authorities, would make the streets more tolerable for traffic and pedestrians.

When the diminution in illumination was first undertaken the Society offered its services to the authorities. Subsequently, early in 1915, a joint committee was formed with a view to aiding the authorities in this matter, and they were still anxious to be of assistance. Two years have elapsed, and there is now opportunity to judge the effect of the lighting conditions.

One fact that had been strikingly brought out was the increase in the number of accidents due to motor vehicles which, for the years 1913 to the present time, were stated in the House, in reply to a question by Mr. Gilbert, to be as follows :—

Year.	Total number of Fatal Accidents in the London Metropolitan Police District, caused by motor vehicles of all kinds.	Total number of Non-fatal Accidents in the London Metropolitan Police District caused by motor vehicles of all kinds.
1913*	424	13,153
1914	493	14,638
1915	666	16,366
1916 to Oct. 31	509	11,827

The relation between diminished illumination and accidents deserved careful study and the following additional information would furnish useful data for drawing conclusions on this matter :—

1. The returns of the accidents during *each month* of the period referred to above.
2. The respective numbers of accidents in each month during the day, and between sunset and sunrise.
3. The dates at which further restrictions in lighting have been introduced.
4. The approximate figures for the number of licensed motor vehicles, tramcars, &c., plying in London in each month.
5. The dates at which restrictions, if any, in the speed of such vehicles, have been introduced.

The importance of the matter was emphasised at the Conference called by Mr. Blain, of the London General Omnibus Co., on Friday, Dec. 1, with a view to forming a "Safety First" Campaign Council for the Metropolitan area. The present conditions made the movement especially welcome.

There were many different aspects of the subject to be considered. In addition to the question of accidents, there was the choice of methods of dimming the lights which would waste as little gas and electricity as possible. And there was also the very important consideration that the mere slowing down of traffic (in some streets to a walking pace) is, especially at busy times of the day, a great economic loss.

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* Taken from the Return on Street Accidents caused by vehicles during 1913, presented to the House of Commons, Feb. 26, 1914 (not stated in the House).

One undesirable feature of the present arrangements, to which attention was called in the discussion of the Society in 1914, is the extreme "patchiness" and uneven distribution of light, giving rise to severe contrasts of light and darkness. One of the first points to receive attention in a scientific inquiry would doubtless be the elimination of these severe contrasts in light and shade, which are distracting alike to drivers and pedestrians. Now that the darkening of London had been experienced for over two years, was it not time for a comprehensive inquiry to be made, and for the establishment of a central authority to consider *all* the various aspects of the matter, and to bring about greater uniformity in the measures taken throughout London and possibly throughout the entire country? In this way it would be possible, not only to get better results from the standpoint of the public safety but to make a very considerable saving in gas and electric consumption. Many of the present methods, which involved darkening almost the entire surface of the globe of a powerful lamp, were most unscientific and uneconomical, and at present there was apparently nobody whose duty it was to see that better methods are adopted.

Research in the Lighting Industry.

Proceeding, Mr. Gaster said that he had mentioned a few investigations of value. There were, however, many other fruitful researches to be undertaken in connection with the lighting industry, and he hoped that some of these would receive sympathetic consideration from the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. In this connection Mr. Gaster referred to the important statement of Lord Crewe to the deputation from the Board of Scientific Societies on Dec. 1.

Several committees had been formed by the Society to undertake special researches for the Government.

In view of the magnitude of the lighting industry he thought the time was ripe for the formation of some body, working in co-operation with the authorities and having for its aim the development of the industry as a whole.

DISCUSSION.

The discussion was opened by Mr. **Blain**, of the London General Omnibus Co., who briefly explained the objects of the "Safety First" movement. He agreed that illumination was a most important factor in relation to safety, and added that an invitation had been extended to the Illuminating Engineering Society to appoint a representative on the London "Safety First" Council.

Mr. F. W. **Willcox** referred to the need for education of the general public in the proper use of light. Many of the methods seen in the streets were wasteful and inefficient. There were great possibilities of improvement in connection with low candle-power lamps, which could, however, be much more readily applied with a constant current system.

Mr. A. **Cunnington** suggested several methods of securing diminished lighting by appropriate use of smaller lamps and proper reflectors, which were much to be preferred to the practice of obscuring the lights.

Mr. **Wyld**, speaking from the standpoint of the engineer to an electrical supply company, agreed that the present methods of diminishing light in the streets were unsatisfactory. But in these matters the engineer had little choice and must comply with the requirements of the authorities. The suggestion that supply companies should endeavour to bring about a 10 per cent. reduction in lighting was impracticable.

Mr. J. S. **Dow** alluded to the great variations in illumination provided in tramcars and motor-omnibuses. In some cases one could almost read but in others one could not see a coin in one's hand. In a sense the illumination might be deemed sufficient for the collection of fares, as the minimum suggested, but the collection must be a very trying and irritating process to conductors. There seemed to be an opening for a very simple tester to be used in defining a rough standard of illumination. He thought that, if the idea received encouragement from the authorities, such a device might be contrived. Mr. Dow also read an extract from "Eclipse or Empire" emphasising the need for research in the lighting industry.

Mr. **Gaster** briefly replied to some of the points raised in the discussion and a vote of thanks to the lecturer terminated the proceedings.

CORRESPONDENCE.

SOME ASPECTS OF INDUSTRIAL RESEARCH.

TO THE EDITOR OF THE ELECTRICIAN.

The description given by Mr. A. P. M. Fleming in his lecture at Manchester last Tuesday of the development of industrial research in the United States must cause everyone interested in the welfare of industry in this country to realise the urgency of the question if we are to maintain unimpaired and strengthened our industrial position. A comment in the "Electrical World" for November 18, 1916, on the scheme for industrial research proposed by Dr. Murray Butler, of Columbia University, may be of value as showing the point of view of the American electrical industry. It remarks that "we stand face to face with a Europe which will be organised with superb efficiency after the war." It seems doubtful whether the British part of the organisation is really as "superb" as the Americans appear to think it is, but there is no doubt that, as far as industrial research is concerned, American industry is far ahead of anything that has been attempted in this country. Perhaps the most interesting development described by Mr. Fleming was that of industrial research laboratories in connection with large firms and manufacturing associations. It seems self-evident that institutes to carry on the kind of work done by these laboratories must be established in this country either in connection with or independently of universities. It would appear that the best solution of the problem of industrial research will be the establishment of research laboratories or institutes in which all problems in connection with any particular industry can be worked out. The difficulty of equipping any institute capable of carrying out more than a small fraction of the research work required for the manifold industries of this country is insuperable and still more difficult must be the task of finding a fellow or a number of fellows or researchers who have the necessary knowledge and experience to work out the practical problems that have to be solved. There are, besides such institutes, two other places in which research can be carried out—*i.e.*, the universities and higher technical schools and the research laboratories of the individual works. All these laboratories would seem to have a place in the scheme of industrial research which it is hoped may ultimately be established. If one may attempt to define the scope of the various institutions mentioned, the universities and higher technical schools will probably confine their work to the more general scientific problems which lie at the basis of the industry, the research institutes will deal with the development of scientific results into commercial processes and the works themselves will deal with the technical research required to bring the operations involved in any process of manufacture to a high degree of efficiency. It is obvious that there are many cases in which the functions outlined above will overlap, but it is in the highest degree desirable that there should be some attempt to co-ordinate the different branches of industrial research. It seems evident from the reply of Lord Crewe to the deputation on scientific research last week that the conditions laid down for the expenditure of money under the Privy Council scheme are such that comparatively little will be contributed by firms to help it forward. Whether a different view of the subject will be taken by the new Government remains to be seen; but unless the manufacturer is going to derive some direct benefit from the expenditure of his money, it seems very unlikely that he will be willing to spend it on research work. The most hopeful method would appear to be for the manufacturers to take the subject in hand for themselves and establish institutions under their own control to assist their work. If this were done, Government grants might well be obtained to assist individual researches. The British Engineers' Association has already been formed, and there could be no better body to consider the establishment of research institutes for the engineering industry.

Liverpool, Dec. 15. E. W. Marchant.

NOTES ON SQUIRREL-CAGE MOTORS.

The squirrel-cage induction motor, besides being cheaper in first cost than any other, is the simplest type of motor and also has no wearing parts with the exception of the bearings; the latter, when of ball or roller pattern, have no appreciable wear and the motor will run for long periods without attention.

For this reason it is of advantage to install squirrel-cage motors wherever possible, but, owing to the excessive current of low power-factor taken during starting, the poor starting torque given, and the trouble experienced through the connections between the rotor bars and short circuiting rings working loose, the more expensive and complicated wound motor rotor has been used instead.

It is not as well known as it should be that all these disadvantages have been overcome, and for practically all drives where no speed control is required, the squirrel-cage motor will give a better service than the wound rotor motor.

We have already dealt with the method of obviating starting troubles by fitting an automatic centrifugal clutch (*see* "Pub." 146, from which we believe extracts were printed in THE ELECTRICIAN about three years ago). Numerous attempts have been made to perfect the connections between rotor bars and short circuiting rings. Rivetting was found unsuccessful, as the joints quickly worked loose owing to the alternate heating and cooling with consequent expansion and contraction of the members. Soldering the joints also proved very unsatisfactory as the heavy currents in the rotor during starting quickly heated up the joints, with the result that the solder was melted out.

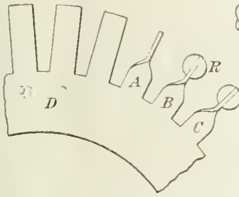

FIG. 1.

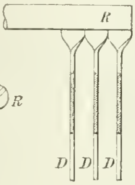

FIG. 2.

An excellent method of rotor construction is to use sub-divided end rings and brazed joints. Each end-ring is made in the form of two, three or four annular discs per side, and thereby a much greater cooling surface is obtained than with a single ring.

Fig. 1 shows a portion of an annular disc *D* of sheet copper, punched with teeth. These teeth are afterwards turned at right angles as shown at *A*, *B* and *C*, so as to fit into saw cuts previously made in the rotor bars *R* (see Figs. 1 and 2); after the discs are all in place the joints are brazed.

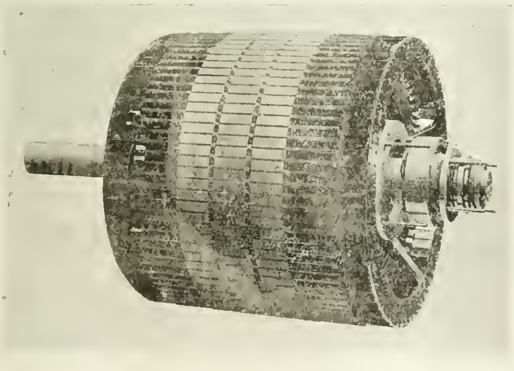

FIG. 3.

A rotor built in this manner is practically indestructible, as there is no solder to melt and the joints cannot work loose. Many hundreds of squirrel-cage motors with this class of rotor are in successful operation and tests taken on one of these coupled to a hydro-extractor may prove of interest. This motor is of the size adopted as standard for the hydro-extractor to which it was coupled and the tests were taken by the manufacturers of the hydro-extractor.

Rating of Motor.—To work continuously on the following cycle:—7 B.P.H. (19 amperes) for 2½ mins., 2½ B.P.H. (7½ amperes) for 2½ mins. stopped 1 min. This is equivalent to 13·2 amperes continuously.

First Test.—25 amperes for 2¼ mins., stopped ¼ min.

Temperature rise of rotor after 7 hours' run on this cycle—163° F. The load is equivalent to 23·7 amperes continuously, *i.e.*, 80 per cent. overload.

Second Test.—27 amperes for 1¾ mins., stopped ¼ min.

Temperature rise of rotor after 4 hours' run on this cycle immediately following first test—280° F.

The load is equivalent to 25·3 amperes continuously, *i.e.*, 93 per cent. overload.

Third Test.—Immediately following second test, the rotor was locked and full volts applied to the stator for 4½ mins., the current being 80 amperes.

At the conclusion of this test, the rotor was carefully examined and found to be in perfect condition. All the joints were solid and no metal had been thrown out or melted.

We might mention that rotors of this construction are the patent of the Lancashire Dynamo & Motor Co. Ltd., and, besides being indestructible, they also allow a certain amount of adjustment to be made on site to the starting torque of the motors. The Lancashire squirrel-cage rotor is shown in Fig. 3.

AN ANALYSIS OF ELECTRIC COOKING.*

BY H. O. SWOBODA.

The early progress of electric cooking was prevented by one serious technical obstacle, viz., the lack of a suitable substance for the electric heater, as none of the known materials except the high-priced platinum withstood the heat to which they had been subjected. The first substance suitable for high temperatures was discovered about 1892 in the nickel-steel alloys, which resist heats as high as 1,000°F. without injury. The real solution of the problem, however, was not obtained until about 12 years ago, when the nickel chromium alloys appeared on the market. They can be operated at temperatures as high as 1,750°F.; in some instances even as high as 2,000°F. without being affected, and fulfilling all ordinary requirements. Thus the foremost technical difficulty which prevented the general use of electrical heat for cooking was successfully removed more than a decade ago.

Another obstacle preventing the general adoption of electric cooking was the high cost of electrical energy. Even to-day the cost is not, in many cases, sufficiently low to warrant a rapid introduction of the art; nevertheless, considerable progress has been made during the last few years, and is being made every day. In addition thereto, central stations have just about commenced to realise the desirability of the cooking load for their systems as an "off-peak load," and in a great many cases offer now special low rates for installations with electric ranges. Tariffs are being lowered in many cities, and it is not very hard to predict that within a comparatively short time electrical energy will be offered anywhere in the United States and Canada, and, for that matter, all over the civilised world at such rates that electric cooking can be universally adopted. It may also be well to mention that the rates in the United States are by far not the lowest, and that, for instance, in quite a number of cities in England a rate equivalent to about two cents per kilowatt-hour is charged, whereas the majority of our rates range from three to six cents per kilowatt-hour.

The author gives a table showing that the rates, compared with the customary charge of 10 cents per kilowatt-hour of 10 years ago, have been cut in two in most cities, and that rates of three cents per kilowatt-hour are not very infrequent.

Methods of Charging.—Of the cities given in this table, 26, or 30·6 per cent. apply a so-called room schedule, in accordance with which the price per kilowatt-hour is reduced after a certain initial quantity at a high price has been consumed. This quantity varies in accordance with the number of active rooms in the residence. In some instances the number of the square feet of the floor space is substituted for the number of rooms.

Twenty-four systems, or 28·3 per cent., use a two, or multi-rate, schedule. As in the preceding rates, the price per kilowatt-hour is reduced after a certain initial quantity at a high price, approximately light rate, has been consumed. In this case, however, this initial quantity is the same for all consumers. Some systems make only one reduction in price per kilowatt-hour; others make two or more, setting for each step a fixed amount of current consumption.

Eighteen systems, or 21·2 per cent., have a plain kilowatt-hour schedule, there being one uniform price per kilowatt-hour, regardless of the quantity of current consumed and the capacity (connected load) of the installation.

Twelve systems, or 14·1 per cent., charge on the basis of maximum demand, as is customary for practically all power service.

Three systems, or 3·5 per cent., apply a plain kilowatt-hour schedule, same as the other 18 systems just mentioned, but in addition thereto make a fixed service charge per month.

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* Abstract of an article in the "Electrical Review and Western Electrician."

Two systems, or 2·3 per cent., also apply a plain kilowatt-hour schedule, same as the other 18, and three systems, but give a discount, which increases with the current consumption.

These figures clearly show that the room and two or multi-rate schedules are the most favoured methods of charging. The reason for this preference is that due to the scaling rate, a high return is received for a small initial amount of the energy delivered. This amount is usually made about equal to the monthly demand for light during the hours of the peak load. The energy consumed during the off-peak hours then represents the remaining amount delivered, and, of course, can be sold at a lower rate. Therefore, it is possible to use one meter for both light and cooking combined, without discriminating in the charges in favour of either kind. If a plain kilowatt-hour schedule is applied, naturally one rate for light and another for cooking should be made, necessitating two separate meters and an expensive installation.

With regard to minimum payments, 68 systems, or 80 per cent., insist upon a fixed payment, ranging from $0·50 to $3·00 per month. 11 systems, or 13 per cent., insist upon a minimum payment varying either with the amount of the connected load or with the maximum demand. Two systems, or 2·3 per cent., receive a minimum payment in the form of a fixed service charge, which is made each month whether energy has been consumed or not. One system, or 1·2 per cent., practically insists upon a minimum payment by stipulating that all cooking must be done electrically only. Three systems, or 3·5 per cent., do not insist upon a minimum payment.

As to discounts, the policy varies. Of the 85 systems considered, 51 systems, or 60 per cent., use one common meter for all requirements, and 34 systems, or 40 per cent., install separate meters.

Of all the systems investigated 10·6 per cent. charge less than three cents per kilowatt-hour for a monthly purchase of 100 kw.-hours, 65·9 per cent. less than six cents, and only 4·7 per cent. adhere to the customary charge of 10 cents of 10 years ago.

Effect of Load on System. One of the other factors affecting the electric-cooking rate is the influence of this load on the feeder system, through which the energy is delivered to the consumer. While the maximum demand for a single range seems to be between 35 per cent. and 40 per cent. of its connected load, the maximum demand for groups of ranges, as shown in the first three items of Table I., does not exceed 15 per cent. (14·6 per cent.) of the connected load. In other words, the diversity-factor is about 1 to 7, permitting the installation of seven times as many ranges on a feeder system, as the connected load apparently would permit. In fact, it is even considered safe (L. A. Gale) to figure on a ratio of 1 to 10, as the maximum demand of the domestic-cooking load does not occur at the time of the station peak.

Table I.—*Central-station Rates. Connected Load, Maximum Demand and Diversity-factor for Domestic Ranges.*

Name of city or country.	No. of households.	Connected load, kw.	Maximum demand, kw.	Diversity-factor per cent.
Salt Lake City, Utah	24	77	11·5	15·0
Great Falls, Mont	21	110	13·5	12·3
Worcester, Mass.	16	77	13·5	17·5
Anaconda, Mont...........	22	92	...	...
Canada	1	..	2·9†	...
England	1	6·2	2·2*	36·6

Similar conditions exist for large kitchens. The two named first in Table II., and supplying regular restaurant service, furnish meals at all hours of the day to single persons or small parties at short notice, and therefore, must have a high maximum demand as well as a high diversity factor (57·8 per cent., or 1 to 1·75). The other four kitchens, however, supply meals only at fixed hours of the day to large groups of persons at one time, and consequently have a maximum demand and diversity-factor of (37·7 per cent., or a 1 to 2·6) fully one-third smaller than the other two. In addition, therefore, it would be recommended that the kitchens, as well as the two [illegible] [illegible] [illegible] [illegible], which when the help [illegible] [illegible] [illegible] [illegible] load and, therefore, "smoothed" the [illegible] [illegible] [illegible] [illegible] to the people.

The [illegible] [illegible] for [illegible] food to [illegible] [illegible] can be done [illegible] [illegible] of food [illegible] [illegible] [illegible] all that [illegible] be expected [illegible] [illegible] portion [illegible] so that the figures obtained may be used as a guide in case similar circumstances should arise. Naturally, as electric cooking is still in its infancy, as the rates for electrical energy continuously change towards a lower level, and as the details of the designs for electric-cooking equipments have not as yet attained the perfection which is desirable, hardly any cost records of value are in existence. Whatever has been reported is more or less incomplete and liable to lead to misunderstandings.

Table II.—*Central-station Rates. Connected Load, Maximum Demand and Diversity-factor for Large Kitchens.*

Place of installation.	Connected load, kw.	Average demand, kw.	Maximum demand, kw.	Diversity-factor per cent.
Engineers' Club, Boston.	30·0	...	18·0	60·0
Quaker Cafeteria, Sacramento, Cal.	96·2	...	55·0	57·3
U.S. Battleship "Texas"				
Officers' Galley	120	27·4	54·0	45·0
Crews' Galley	240	21·2	90·0	37·5
Siemens-Schuckert Co., Berlin, Germany	93	20–40	40·0	43·0
North German Lloyd, Bremen, Germany	194	40–60	60·0	30·9

The author gives energy consumption and cost of electric cooking in a number of cases in England, Germany, Switzerland and the United States.

Far more satisfactory reports exist about large kitchens. Restaurant kitchens (à la carte service) range from 0·95 kw.-hour to 1·21 kw.-hours per meal. For large kitchens, feeding large groups of persons at fixed hours varies from 0·33 kw.-hour to 0·43 kw.-hour per meal.

This consumption depends upon the help being familiar with the operation of electric kitchens and not wasting the electrical energy unnecessarily. That experienced help can work more economically is clearly demonstrated by the results of the Y.M.C.A. cafeteria in Table III., as the energy consumed during the first month of operation was fully 14 per cent. larger than during the second month. It is interesting to note that the Quaker cafeteria, in Sacramento, Cal., reports a saving of $90 per month in the meat bill on account of less shrinkage.

Table III.—*Actual Energy Consumption and Costs.* Restaurant kitchens serving meals all day.

Description of items involved.	Y.M.C.A. Cafeteria, Western City 1913.		Quaker Cafeteria, Sacramento, Cal., 1916.
	1st month of operation.	2nd month of operation.	
Output of kitchen in meals per month	5,220	6,271	About 20,000
Water heated by	Fuel	Fuel	Electricity
Rate of electrical energy in cents per kw.-hour	3·00	3·00	1914 av.
Total energy consumption in kw.-hours per month	1,904	1,961	Not stated
Energy consumption in kw.-hours per meal	0·364	0·314	0·623
Cost of each meal in cents......	1·09	0·95	1·21
Saving in meat bill in dollars per month	Not stated	Not stated	$90·00

Reference is made to the results obtained at Romano's restaurant, on U.S. battleship "Texas," and at the Siemens Schuckert Works. At the latter, electric cooking showed a saving of 12 per cent. over the cost of gas.

Available data show, without a doubt, that the art of electric cooking has made considerable progress, but at the same time gives the impression that it may require many years before, with the gradual reduction of the rates for electrical energy, most of the cooking, if not all, will be done electrically. This assumption, however, is erroneous, and as the gas range practically superseded the coal range, so will the electric range conquer and control the field of cooking within a comparatively short time, even though its cost of operation may be somewhat higher for the time being than the cooking with gas. As bold as this assertion may appear, there are so many reasons which support this, only the most important ones may be enumerated, as follows:—

The practice of fitting electrical heaters to individual cooking utensils has resulted in a line of so-called "dining room ware," not only permitting the preparing of light meals on the dining room table, but also in the nursery and the sick room. The use of electric toaster stoves, coffee percolators, tea kettles, chafing dishes, milk warmers, hot plates and similar devices, has become so common in everyday life that nobody would ever think of returning to gas or alcohol heated devices, as the convenience with which the electric utensils can be handled, and their almost instantaneous action by far outweighs high cost of electrical energy.

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* 1·76 kw. are light and heat.

† Maximum demand during [illegible] [illegible].

The ease of fitting electrical heaters into a given space is also of decided advantage in the construction of electric ranges. As there are no gases of combustion, no chimney connections need be provided, and the space necessary in coal ranges for the burning coal and the ashes can either be omitted entirely or utilised for an additional bake oven or warming compartment.

The absolute control of the temperature, which is possible, will probable result in a gradual revolution of the methods of cooking. When using coal or gas ranges but little attention is paid to the actual degree of heat in or on the oven, because it is almost impossible to maintain it uniformly. Consequently a great deal of skill and time is required to watch the condition of the food constantly, to stir it and to change the position of the vessel continuously, in order to obtain satisfactory results. Automatic electric ovens are now on the market, in which the temperature is accurately controlled and the necessity of constant vigilance is removed. Therefore, once the temperature is known at which a certain food has to be prepared, an inexperienced person can hope to get uniformly good results without first passing through many failures and wasting much good material.

The superior quality of the food prepared in an electric range is the natural outcome of applying the proper temperature, in place of excessive heat, or oftentimes not sufficient heat.

The saving in labour to the housewife as well as to the cook in large kitchens is material, although very often it cannot be expressed in dollars and cents. Due to the possibility of maintaining a uniform temperature as stated before, the continuous watching of the food while being cooked is unnecessary, and the time thus saved can be devoted to other matters.

The saving in food on account of the proper control of the temperature is quite material. Not only is the possibility of spoiling food altogether reduced to a minimum, but there is a saving of approximately 15 per cent. in the shrinkage of meat. In other words, the purchases of meat can be reduced about 15 per cent. without reducing the weight of the meat served.

The low rise in temperature of the surroundings, another advantage of cooking by electricity, is due to the high efficiency of electric equipment concentrating the heat where it is required and losing but little to the surroundings. This is not only a matter of comfort, but of supreme importance in hot weather, especially in kitchens with limited space, as, for instance, in small apartments, basement kitchens and ships. The tremendous advantage of electric over fuel kitchens in this respect can be best understood from the figures in Table IV. Although the electric equipment was not perfect the heat required by gas cooking was more than double than that necessary for electric cooking, and the entire excess was absorbed by the surroundings.

Table IV.—*Miscellaneous Data. Efficiency of Electric Cooking.* Comparison of heat units required in gas and electric cooking.
Equipment : Electric range.

Food cooked.	Time in min.	Gas.*		Electric.†		Heat saving.	
		Cu. ft.	Approx. B.T.U.	Kw. hrs.	Approx. B.T.U.	Approx. B.T.U.	Per cent.
7 lbs. of bread in oven	45	180	12,000	2·0	6,826	5,174	43
1 leg of mutton, 1 small piece of beef, 2 Yorkshire puddings, 1 large rice pudding, 1 tin baked potatoes in oven	180	...	...	...	...	...	43
3 apple roll, on top of range	120	78	54,600	6·5	22,185	32,415	59
2 Yorkshire puddings, 1 rice pudding, 1 tin baked potatoes in oven	180	78	54,600	5·5	18,772	35,828	64
7 lbs. of bread, 6 buns, 1 pastry	100	25	17,500	4·0	13,652	3,848	22
12 lbs. of beef in oven	170	76	53,200	5·9	20,000	33,200	63
Totals	....	437	191,900	23·9	81,435	110,465	57

Other advantages of electric cooking are increased cleanliness, improved sanitary conditions and less fire risk, any of which very often give the electric the preference over fuel cooking.

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* 1 cubic ft. of gas contained about 700 B.T.U.

† The current consumption was high, as a ventilator was used to carry off the excess of heat, as the current could not be regulated closely.

LEGAL INTELLIGENCE.

British Thomson Houston Co. v. Duram (Ltd.)

The hearing of this case was concluded on Tuesday when judgment was delivered by Mr. Justice Astbury.

Mr. Ballantyne, who was cross-examined by Mr. Walter, K.C. (for plaintiffs), said tungsten had been known for a great many years. With the exception of the information given in Moissan he would be correct in saying that it was commonly known in the form of powder, that it was believed to be extremely intractable and that it was believed to be a metal of great hardness. He did not believe that drawn wire was easier to make with sintred filaments. He thought it was largely used because the metal suitable for squitable filaments was no longer obtainable as it was made in Germany. He had had experience of the lasting power of lamps. Comparing drawn-wire lamps with squirted lamps he found that the condition of the first-named lamp was that the drawn-wire filament became brittle in a few hours as compared with the other.

Dr. J. E. Stead, metallurgical and consulting chemist, said the patent in question told him nothing beyond what he found in Moissan.

Earlier in the case defendants were permitted to call certain witnesses as they were engaged on urgent Government work.

Mr. John Robt. Parry, foreman of James Brown & Co., Preston, wire drawers, described certain experiments in wire drawing in 1905, 1907. He drew steel wire through a steel die, having dipped the wire in graphite.

Mr. John Gustav Adolf Rhodin, chief chemist of the Muntz Metal Co. from 1903 to 1905, gave evidence of drawing zinc wire at a temperature of 150°C. to 120°C.

Mr. John Wade, of Messrs. E. & A. Smith, wire drawers, Cleckheaton, also gave evidence for defendants.

Mr. Kerly, K.C., summed up the defendants' case on the question of validity or invalidity and said the defence was three-fold : (1) the patent was bad because the claim was too wide ; (2) because it had been completely anticipated ; and (3) in view of the existing knowledge of the time there was no subject matter. Existing knowledge which he relied on, apart from general metal working knowledge was known parallel of osmium which had been shown to be pliable ; and the Siemen's patents of 1902 and 1904 which assumed as common knowledge or indicated to any instructed person everything that was indicated in plaintiffs' specification. He also relied on insufficiency. As to his point that the claim was too wide counsel contended that it was purely a claim for working tungsten hot. He could put it that it was for working tungsten coherent hot, but that made no difference because there was really nothing whatever in the suggested limitation of coherency. It included the ordinary workshop methods. In ordinary language it told one that one had to make the tungsten hot. Therefore, by implication it told one that the tungsten must be got into a form in which it could be worked hot. The claim was too wide, as he had said, because it included the working of the tungsten hot, and therefore it was a claim to a bare principle, and a claim to a bare principle was generally bad. Then the claim was merely routine ; heating a metal for operating on it was an ordinary every-day proceeding in a workshop and had been the ordinary method of dealing with metals since metals were first dealt with.

On Tuesday his Lordship gave judgment with regard to the first patent of 1906. He said an admission had been made which rendered it unnecessary to consider the question except on a very narrow consideration, and the real question was the validity of the patent, want of novelty, want of subject matter and insufficiency being alleged against it. The substantial invention, if there was one, made by the patentee was the production of a wire-drawn electric lamp filament of tungsten, but he had not been content to so limit the claim. The claim was a wide one for the working of pure coherent tungsten hot, and was not limited to any specific degree of working to any defined end provided the working was commercial working for commercial purposes. The description coherent tungsten included other forms in addition to that produced by the patentees' process. The patent was, therefore, bad for want of subject matter, and was invalid. As to the second patent of 1911 for improved methods of wire drawing, his Lordship said on the objection of prior user he had come to the conclusion that it was impossible to escape the consequences of the user of Messrs. Brown & Co., Preston, which was proved to have taken place in 1905 and 1906. That patent was also invalid, and the action must be dismissed.

Breach of Mining Regulations.

At Newcastle-upon-Tyne on the 13th inst. Ernest Renny, fireman of Shankhouse Colliery, was fined £5 for having failed to keep the electric fan running at the speed ordered by the manager. Other charges of having failed to report derangement of machinery were dismissed.

It was stated that part of Renny's duty was to visit the fan every two hours, and to report whether machinery was all right or not. According to the book, he had made his inspections at 4 a.m. and 6 a.m., and everything was all right. Another fireman, finding the book in a cabin instead of the fan house, went at seven o'clock to the fan house and found that the fan had been stopped since four o'clock. The safety of the mine depended upon proper ventilation. The miners were to go in at six o'clock in the morning, and it was conceivable that if the fan were neglected there might be an explosion and a great loss of life.

Munition Worker's Compensation Case.

At Sheffield County Court last week Judge Benson delivered his reserved judgment in a case which raised the question of compensation in case of a munition worker (the wife of Arthur Rodgers, a soldier) who died as the result of an accident incurred while following her employment.

His Honour said that there were two claims as to dependency upon the wife's earnings—one by the husband and the other by the five children. In regard to the husband, he had decided that the man, who was in the Royal Fusiliers and was making a contribution from his pay in order to ensure the separation allowance, no dependency was established and the husband's claim failed. The five children were partially dependent on the wife's earnings. The separation allowance received by the wife was £1. 7s. 6d. per week, while her earnings were £1. 10s. 7d., a total of £2. 18s 1d. weekly. The maximum award available, after deducting a small sum already paid by the respondents, was £230. After deducting 25s. army allowance to the children from the total income of £2. 18s. 1d., a sum remained of £1 .13s. 1d. Of this sum his Honour assessed £1. 3s. 6d. as being the amount of the children's dependency, and made an award of £195 to be divided in proportion to the ages of the dependents.

Workmen's Compensation.

At the City of London Court recently, before Judge Rentoul, K.C., the widow and mother of the late Walter Pearmain, electrical engineer, of Acton, claimed £300 from Messrs. Johnson & Phillips, as compensation for the death of their husband and son respectively. Counsel for the applicants said that the husband was killed by coming into contact with a live wire. The firm had paid £300 into Court, and the widow and mother had come to an arrangement whereby the former was to have £200 and the latter £100. The Judge now sanctioned the arrangement.

PARLIAMENTARY INTELLIGENCE.

REGISTRATION OF NAMES BILL.

On the 14th inst. the House of Lords agreed to accept the amendments made in this Bill.

Lord Muir Mackenzie, who acted as chairman of the Select Committee, siad that they did not feel themselves in any way responsible for the character of the Bill as returned from the House of Commons, but they did not wish to combat the Commons amendments.

The Bill was passed with some additional amendments.

On Monday the House of Commons agreed to the final amendments of the House of Lords.

Royal Assent.—The Royal Assent to the following Acts of Parliament was read on Dec. 18:—Trading with the Enemy and Export of Prohibited Goods Act, and the Local Government Emergency Provisions (No. 2) Act.

EDUCATIONAL.

Northampton Polytechnic Institute.—Last Saturday the certificates and prizes awarded to students of the Institute were presented by Mrs. R. Mullineux Walmsley. The Principal, Dr. Walmsley, in giving particulars of the work of the Institute, stated that during the past year there had been a diminution of 38 per cent. in the student hours, the diminution in the previous year being 21 per cent. Owing to the call for economy and the representations of the London County Council, the governing body have decided that the Clerkenwell Crafts School should be closed at the end of the session, after a most successful career extending over 20 years. The arrangements for training disabled soldiers had worked satisfactorily and had resulted in the release of active young men for service with the colours. During the past session no student had been presented for the final degree examination of the University of London, owing to students of military age being required for service. There had also been a great decrease in the number of candidates presenting themselves at the City and Guilds of London examinations.

Royal Technical College, Glasgow.—The governors, at the request of [illegible], offer prizes, amounting to £70, for essays on the Best Methods of Training and Employing in Industries, other than Agriculture, returned Soldiers and Sailors, maimed or otherwise. The prizes will be awarded by a committee of the governors, and may be withheld in the event of no essay of sufficient merit being submitted. The decision of the committee on this and all other points will be final. Essays must be sent in by March 1, 1917, addressed to the [illegible] of the Royal Technical College, Glasgow.

University College of Wales.—Friends of the College have expressed their intention of contributing £[illegible] to the fund, subject to their right to make such [illegible] as they may deem expedient to the Council, either as to the capital or as to the income therefrom. £20,000 will be [illegible] annually [illegible] for the purpose for the next five years.

Newcastle School of Wireless Telegraphy.—The Shipowners of Newcastle-on-Tyne are subscribing £2,000 towards the establishment of a school of wireless telegraphy.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

8,480 Yewen. Telephone transmitters and transmission. (9,11,15.)
11,332 Bastian. Incandescent electric lamps or and in the method of manufacturing same, especially applicable to the manufacture of so-called half-watt lamps or gas-filled glow lamps.
15,842 Drucquer. Electrically driven adding and listing machines, copying machines typewriting machines, addressing machines, or other machines having keyboards
15,878 B.T.-H. Co. (G.E. Co.) Electric switches.
15,930 Fery. Electric cells.
15,985 Wilson, Shepherd & Powell & Hanmer (Ltd.) Electric lamp holders for vehicle head lamps.
15,986 Wilson, Shepherd & Powell & Hanmer (Ltd.) Electrical connections for use in the electric lighting of automobiles.
16,112 Trent. Ohmmeters and like electrical measuring instruments.
16,149 Seelau & Newman. Arrangements for phonographically recording and reproducing telephonic messages. (5 12, 14.)
17,302 Welch. Electric lamp holders. (Cognate application 6,867, 16.)

1916 Specifications.

139 Smith, H. Microphones for use as transmitters or relays for telephonic and similar purposes. (4 1 16.) 102 067
425 Taylor, A. H. (Burgess, H.) Electrical heating apparatus. (11,1 16.) 102.070
1,596 Berry, A. F. Electric heat radiators. (2 2 16.) 102,077.
2,615 Railing, M. J., & Farthing, J. H. Electric heating apparatus. (22/2 16.) 102,084.
3,099 Deutsche Gold-&-Silber-Scheideanstalt vorm Roessler. Electrolytic production of sodium perborate. (1,3 16.) (Addition to 3,084/16. 102,089.
5,606 Wright, H. R. Electrical means for indicating or transmitting movements. (17 4 16.) 102.104.
6,031 Steiger, E. Electric devices for automatically turning lights on and off. (28/4/15.) 100,365.
7,009 Short, A. H. Combined electric lamp holder and lamp lock. (17/5/16.) 102.111.
10.297 Lamkin, A. E. Devices for attachment to sparking plugs for automatically cleaning and cooling their sparking points. (21,7 16.) (Addition to 8,470,16.) 102.128.
12,160 British Westinghouse Electric & Mfg. Co. Vapour-electric converters. (28 8,15.) 101,346.

The invention provides a shield for a large anode which tends to divide the arc thereto into a number of portions, each of said portions being directed to a different zone of the anode, thus ensuring a more uniform distribution of the load upon the anode and preventing overheating of limited portions thereof.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptonce of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

November 18, 1916.

16,540 Hurst & Brush Elec. Eng. Co. Brush lifting and short-circuiting device.
16,542 Colona & Maitland. Generating combustive forces by electrolysis of water.
16,563 B.T.-H. Co. (G. E. Co.) Wireless signalling systems.
16,566 & 16,567 Harrison & Creed, Bille & Co. Producing perforated strip by elec. impulses.
16,575 Bigmore & Curtis. Pocket or portable elec. lamps.

November 20, 1916.

16,588 Fenton. Electric flash lamps or torches.
16,591 Stirk. Master switches for actuating motor-reversing contactor switches.
16,600 Nuttall. Portable electric battery torch lights.
16,609 B.T.-H. Co. (G.E. Co.) Speed-regulating mechanism for electric motors.
16,610 Bergmann & Iganic Electric Co. Electric switchgear.
16,611 Moore. Overhead trollies for tramways and railways
16,633 Cashmore. Means for signalling with electric lamps

November 21, 1916.

16,636 White. Electric lamp holders, &c.
16,641 Lebeter. Sparking plugs.
16,648 Fletcher & S. Smith & Sons. Sparking plugs.
16,652 Burns. Supplying power to electric trains without continuous conductors.
16,661 Irvine. Electrodes for welding.

November 22, 1916.

16,695 Green. Electric signalling.
16,696 Morgan. Tram rails.
16,708 Whiteside. Electric device for stopping railway trains.
16,710 Hall. Pocket and suspension electric lamps.
16,731 Farren. Electric flashlights, torches, &c.
16,737 Simpson. Radiotelegraph and telephone stations.
16,749 Turner & Wilkinson. Brakes on electric tramcars, &c.
16,760 White. (U.S. Light & Heat Corpn.) Dynamo-electric machines.

November 23, 1916.

16,789 Ainsworth. Attaching [illegible] electric lamps.
16,800 [illegible] Ohmmeter.
16,801 [illegible] Capacity meter.

November 24, 1916.

16,839 Ackey. Trolley wheel guide.
16,841 Tammage. Attaching circuit connecting wires on pocket battery, &c.
16,850 [illegible] Electric reflectors.
16,855 Lamkin. Cooling sparking plugs.
16,861 [illegible] Circular grinders for commutators.
16,862 [illegible] Connection for electric leads.
16,867 British Westinghouse Electric & Mfg. Co. Dynamo electric machines. (8 12 15, U.S.)
16,880 Sharman. Indicating and measuring small electric currents.
16,892 [illegible] & International Electric Co. Telephone instruments.
16,897 [illegible] & [illegible] Telegraph Co. Automatically rendering defective [illegible] and [illegible] preparatory to transmission.

November [illegible], 1916.

16,927 [illegible] & British Insulated & Helsby Cables. Connection of electric cables [illegible]
[illegible] [illegible] & Taylor. Attaching electric lamps to holders.
16,931 Jay & [illegible] [illegible] indicators.
16,944 Marks. Electric [illegible]

November 27, 1916.

16,957 [illegible] Telephone systems and apparatus.
16,969 [illegible] Co. Electric [illegible]
16,974 [illegible] Variable contact sector for mercury interrupters.
16,990 Marks (Mercer Mfg. Co.) Electric tractors.
16,992 Marks (Mercer Mfg. Co.) Electric controller.
17,001 [illegible] & B.T.-H. Co. [illegible] electric discharge devices.
17,003 Western Electric Co. High frequency signalling. (29 11 15, U.S.)
17,011 James. [illegible]

COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL TOPICS.

The New Ministries. A Bill was introduced into the House of Commons by the Home Secretary on Monday in order to legalise the creation of the New Ministries of Labour, Food and Shipping, and also to provide for the appointment of Under-Secretaries, &c. The Bill has been read a second time and certain amendments are being made in order to make provision for the staffing of the Air Board, &c.

The heads of the Food and Shipping Ministries (Lord Devonport and Sir Joseph Maclay) are to be termed "Controllers," and are to have powers of an exceptional character. The offices of Food Controller and Shipping Controller and the Ministries of Food and Shipping are to cease to exist on the termination of a period of 12 months after the conclusion of the war, or such earlier date as may be fixed by Order in Council. The Bill also suspends the limitation on the number of Parliamentary Under-Secretaries of State, but any Parliamentary Secretaries appointed under it shall hold office only during the continuance of the war and a period of six months thereafter.

* * * *

The Ministry of Labour. Unlike the Ministries of Food and Shipping, the new Ministry of Labour is intended to be permanent. It is to take over the powers of the Board of Trade for dealing with labour questions under the heads of conciliation, labour exchanges, trade boards, unemployment insurance and the preservation of industrial peace under the Munitions of War Act. It will be seen that most of the work to be undertaken by the three new Ministers has hitherto been in charge of the Board of Trade, and we venture to think it an opportune time to reorganise the whole of the duties of that unwieldy and overworked department.

* * * *

Ministry of Commerce. The present partial reorganisation of the Board of Trade should be followed by an inquiry into the constitution and work of the Board. No time should be lost in the creation of a Ministry of Commerce, for, although it may not be able to perform much useful work at present, time is required for the organisation of the Ministry, the engagement of a suitable staff, the determination of a policy, &c., and it would be well to have these things arranged before the conclusion of the war. We are glad to see that the Chambers of Commerce and other representative organisations of the commercial and trading sections of the public are determined upon having a Minister of Commerce. This is evident from the frequency with which resolutions on this subject are passed by these bodies. In some cases special committees have also been appointed to consider questions of trade after the war, and only last week the Newcastle-on-Tyne Chamber passed a comprehensive resolution asking for, among other things, the appointment of a Minister of Commerce and other reforms.

* * * *

Allies' Technical Conference. At Paris on the 13th inst. the opening sitting took place of the General Technical Conference of the Allies, the formation of which was decided upon at the Allies' Economic Conference in June last. The Conference was presided over by M. Clementel, Minister of National Economy. As already stated the object of the Technical Conference is to prepare schemes for establishing unity of legislation in the Allied countries regarding patents, trade marks and kindred trade subjects.

* * * *

Controlled Establishments. The Minister of Munitions announces that he has made further orders under the Munitions of War Acts, under which 73 additional establishments have been declared controlled establishments, bringing the total number of controlled establishments up to 4,585.

* * * *

The British Consular Services. From time to time we have had occasion to call attention to the necessity for reforms of certain departments of the public service and particularly of our Consular Service. We are glad, therefore, that the special committee, which was appointed some time ago by the Executive Council of the Association of Chambers of Commerce, has issued its report and recommendations on this important matter. The opinion is expressed that what is now required is that every British Consulate should be an "outpost of the Empire," to which British subjects may turn for assistance and from which a keen look-out should be kept by competent officials for opportunities of extending British commerce. It is, therefore, recommended:—

(*a*) That every paid British Consular officer should be not only a British subject, as is the condition at present, but he should be also of British birth and descent. No officer should be retained in the Service who is married to a person of enemy origin.

(*b*) That the same conditions should apply, as a general rule, in the case of every unpaid British Consular officer. If in exceptional cases any unpaid officer appointed to such a position should not be of British birth and descent, then such officer should be placed under the direct control and frequent supervision of a superior officer of British birth and descent.

(*c*) That in the future under no circumstances whatever should any subject (including anyone who has become naturalised) of a Power now at war with this country be appointed to any position in the Consular Service.

The committee understands that over 40 per cent. of the unsalaried British Consular officers before the war were foreigners. In June 1916, out of a total of 831 officers, 286 paid officers were British subjects and 305 who were unpaid, but permitted to trade, were also British subjects, while 240 unpaid (but permitted to trade) were foreigners. Before the war, in Germany alone, out of 37 unsalaried officers, 29 were of German nationality. Such a condition of affairs cannot be too strongly condemned, and the committee has come to the conclusion that the interests of British trade and commerce cannot be effectively looked after by any official whose duties are not wholly directed to the expansion and promotion of those interests.

The Consular Service should be divided into two branches. The first would be administrative, and the officer would include among his duties the administration of the Merchant Shipping Acts, giving advice and assistance to British subjects trading in, residing in, or visiting the district, the relief and repatriation of distressed British subjects, and the work of a Registrar in respect of births, deaths and marriages. The second branch would furnish reports (with statistics) of the trade of each district, and lists for the Board of Trade of possible buyers of British goods, and of manufacturers, would reply to inquiries addressed by the Board of Trade and by British subjects, and carry out such other duties as may be considered necessary in the interest of trade and commerce. To improve the administrative service it is recommended that a Consular career should be rendered more attractive to young men, that the Secretary of State should have more power in the direction of calling upon Consular officers whose energy and initiative are no longer what they were to retire on a pension, that more adequate provision should be made for the clerical staff at Consular posts, and that a regular system of Consular inspectors should be constituted.

With regard to the commercial branch the committee is of opinion that apart from the existing commercial attachés, whose activities cover wide areas, a new class of officer should be created who might be called commercial intelligence officers. These officers should take over many of the duties relating to trade and commerce now assigned to Consular officers and should devote themselves to the work of developing and expanding British trade and commerce. They should be appointed to every important commercial centre and should be stationed at the Consulates. In view of the international status of Consulates and Consuls it seems necessary that they should remain at least under the nominal control of the Foreign Office. A chief commercial intelligence officer should be appointed to each country, and he should receive regular reports from the officers under him and from these prepare special reports at least once a quarter dealing with the trade of the whole country in which he is stationed, or, where necessary, of a large area of a country.

Special information secured by these officers should be made available immediately on its receipt to commercial bodies and firms in this country through the present channel of communication—the Commercial Intelligence Department of the Board of Trade or through the proposed Ministry of Commerce when formed. Commercial intelligence officers should be paid a salary sufficient to keep the position attractive to men of the most suitable class. Allowances should be fixed for different countries and towns to meet the varying cost of living and travelling, &c.

In a report by the Federation of British Industries on the Consular Service, the following recommendations are made :—

That all the activities undertaken by the Government for the promotion of British trade in foreign countries should be concentrated in a single department, viz., the Foreign Office. Its commercial duties should include (*a*) the direction of all services abroad ; (*b*) the collection and distribution of all industrial, financial and commercial information relating to foreign countries ; (*c*) the prompt and vigorous support of all British efforts to secure contracts, concessions, or orders : (*d*) advice to the department in charge of industrial and commercial affairs on all questions in the United Kingdom which may affect foreign trade : (*e*) advice to the Government as to the conditions on which they should permit the issue of foreign loans in the United Kingdom.

That really efficient machinery should be established to co-ordinate the work of the Foreign Office and of the department in charge of industrial and commercial affairs.

That the Foreign Office and foreign services should be re-organised on the following lines : The establishment of a large commercial branch of the Foreign Office, with extra staff and accommodation ; increase of staff in the Diplomatic Service to enable sufficient time to be devoted to the study of industrial and commercial questions.

The Commercial Attaché Service should be replaced by the appointment of officers of high rank, to be known as Commercial Counsellors, to each Embassy or Legation, to be in sole charge (under the Minister or Ambassador) of all commercial work in the country.

The Commercial work of the Consular Service to be subject to the direction of the Commercial Counsellors.

In all sevrices only natural born British subjects to be eligible for appointment to any post, paid or unpaid.

The introduction of a small number of men with practical business experience especially into the Commercial Branch of the Foreign Office and the Commercial Counsellor Service.

The establishment of a definite and high standard of efficiency which must be reached by all officers at different stages of their career. This standard to be administered by a Promotion Board with power to postpone the promotion of any officer who does not reach the standard, to demand the resignation of any officer who falls far short of it, and to grant a pension commensurate with past services to any officer whose resignation is demanded.

A large number of technical and commercial experts should be selected and sent, when required, to investigate and report upon industrial and commercial conditions and opportunities in particular countries and particular markets.

Ample funds should be provided to enable the best possible advice to be obtained, and the investigations should be made with sufficient frequency and thoroughness.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 9, 1916, *to* Dec. 16, 1916.

IMPORTS.

[illegible]

EXPORTS.

[illegible]

FOREIGN GOODS (duty paid and free).

Calcutta: Unenumerated, £379. *Melbourne:* Unenumerated, £425. *Cape Town:* Elec. lamps, 494 n.o.; unenumerated, £44. *Paris:* Unenumerated, £135. *Buenos Ayres:* Unenumerated, £161. *Amsterdam:* Unenumerated, £1,308. *Boulogne:* Unenumerated, £10. *Dieppe:* Unenumerated, £53. *Sydney:* Unenumerated, £13. *Batavia:* Unenumerated, £35. *Durban:* Unenumerated, £23. *Nagasaki:* Unenumerated, £182. *Treport:* Unenumerated, £270.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Dr. F. Mollwo Perkin, Ph.D., F.I.C., F.C.S., has removed to Albion House, 59, New Oxford-street, London, W.C. (telephone No., "Museum 2854)." Dr. Perkin's analytical and technical work will be conducted, as hitherto, at his laboratories, Sudbury, near Harrow (telephone No., "Wembley 108").

The old-established firms of Ratcliff & Co. and Ridout & Co. are uniting under the style of Ridout & Ratcliff (Ltd.), and will carry on business as electrical engineers at 42, Upper Baker-street, W., for the duration of the war, but they have made arrangements to remove to larger and more convenient offices in the West End on the conclusion of peace.

Owing to difficulty in obtaining supplies, the Wandsworth Electrical Mfg. Co. (Ltd.), Birmingham, and Mr. T. A. Nunwick, of 4, Carr-street, Manchester, have agreed to dissolve the existing arrangement between them as from the 31st inst., when Mr. Nunwick will cease to represent the company as agent in Lancashire and Yorkshire.

Wm. Whitworth Oldham and Thos. Bennison (trading as W. W. Oldham & Co.), electrical engineers, 7, Market-street, Hyde, have dissolved partnership. Debts by Mr. Oldham, who continues business on his own account at 7, Market-street, Hyde. Mr. Bennison will also carry on business on his own account, and in his own name.

BANKRUPTCIES, &c.

The first meeting of creditors of Edwd. W. B. Wright, electro-therapeutic expert, formerly of 133, Oxford-street, London, W., will take place on Dec. 22, at 14, Bedford-row, London, W.C., and the public examination on Jan. 16, at the Court House, Half-acre, Brentford.

An application for the discharge of James Reid Whitehouse, managing director of an electrical company, 13, St. Andrew's-rd., Golder's Green, London, N., will be heard at the Court House, Barnet, on Jan. 23.

Claims against the Electro-Flex Steel Co. (Ltd.) are to be sent by Jan. 31 to Mr. B. A. Fitzgerald, 82, Collingwood-bldgs., Newcastle-on-Tyne.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barnes.—The Council will take up a loan of £1,000 at $1\frac{1}{2}$ per cent for cable extension, the money to be repayable in five quarterly instalments.

London County Council.—On Tuesday sanction was given to Fulham Borough Council to borrow a sum not exceeding £11,000 for electricity supply purposes. The amount includes £10,500 for boilers and £500 for temporary buildings.

Sheffield.—At the last meeting the Council went into committee to consider the promotion of a Bill in the next session of Parliament, and passed a resolution, which was subsequently confirmed in open Council, in favour of the promotion.

The object of the Bill is to obtain powers for the erection of a new electricity generating station and for the extension of the city by including the proposed site, and a small intervening strip of property now in the borough of Rotherham.

Ald. [illegible], who proposed the resolution, gave figures to show the growth of the electricity undertaking. In the first year (1898) the output was 978,000 units, and the estimated output this year was 120,000,000 units. The plant when acquired was 2,200 kw., but now they had [illegible] kw., and in March, 1917, they would have at their three stations 68,000 kw., the safe running load of which was 48,500 kw. The customers now connected and applying for power represented a total of 135,699 kw., with a maximum load of 64,728 kw., which showed how necessary extensions were. There were insuperable objections to the extension of the present station. One was the great difficulty of getting coal through. The consumption was 130,000 tons per annum, and there was only one railway, over which the Gas Company also had to get large supplies. The water supply was already completely used, and at their proposed new site they would be able to draw water produced by several additional streams. The cost of transmission from the present station and the loss of current on the three miles from there to the east end, would be very serious. The cable recently laid was already loaded. The new site (some 35 acres) was already in the hands of the Corporation; it would provide sufficient accommodation for many years to come. The demand for electric power was very great and would increase, especially through the growing adoption of electricity for steel melting. There were already 20 furnaces connected, and 16 waiting to be connected. The steel producing capacity of the total number would be 100,000 tons per annum. Electric melting had now become an established method, and if Sheffield was to maintain its position as a steel producing centre it must have an abundant supply of electric current. It was not intended to proceed with the new scheme all at once, but only as the demand necessitated. The first section would cost £500,000, and the ultimate outlay would exceed £1,500,000. The Government had been approached and it was expected that they would help. The present position was that the demand was in excess of the capacity. It would require two years to give a supply from the new station.

It was decided to hold a public meeting for the purpose of considering the Bill.

GENERAL.

Alleged Preferential Method of Charging.—Sunderland Electricity and Lighting Committee recommend the Council to contribute £50 towards the cost of the action brought against the Hackney (London) Borough Council by the Gas Light & Coke Co. to restrain them from employing an alleged preferential method of charging for the supply of electricity.

Barrow-in-Furness.—Ald. Smith has been elected chairman and Councillor Wadhen vice-chairman of the Electricity Committee.

Mr. R. Williams, who, prior to being called up for active service, was for many years engaged as a jointer in the mains department, has been awarded the Military Cross.

Cahirciveen.—A recent public meeting of rate-payers urged the Council to adopt an electric lighting scheme.

Chesterfield.—The salary of the assistant borough electrical engineer (Mr. E. P. Austin) has been increased from £220 to £250 per annum.

Coke Fuel for Power Stations.—The Highways Committee of the London County Council have placed an order for eight coke-burning mechanical stokers for use at the Greenwich station.

The Committee estimate that the first sets of stokers will, if worked to their full capacity, consume 100 tons of coke per 24 hours, and having regard to the relatively high cost of coal, as well as the relatively greater degree of efficiency attainable in burning coke, every effort will be made to use the new stokers to their fullest capacity.

Croydon.—The Council has adopted recommendations of the Electricity Committee as to methods of charging for current.

All power consumers, whether using a time switch or not, who take less than 2,400 units a year, will be charged for the first 600 units consumed 2½d. a unit, and for all excess units 1d. a unit; all time switches will be removed where a consumption of at least 2,400 units during the year is not guaranteed. In this way, the Committee explains, a large number of time switches will be rendered available to meet the requirements of large consumers for some time to come, and the work of the department in setting and checking time switches will be largely reduced.

Electric Supply Committees and their Work.—At the meeting of Wigan Corporation last week a member of the Electricity Committee made a protest against the amount of work imposed upon the Committee and the length of time required to go through the average agenda of the Committee.

Mr. Farr said the remedy was for the Committee to cease trying to manage the electricity station. Leave that to the electrical engineer, and let the Committee apply itself to directing the policy of the undertaking. He could understand that during the last 12 months there had been legitimate excuse for a remarkable number of meetings, but in future he hoped the Committee would allow the manager (Mr. R. Owen) to manage the electricity works.

In reply, the chairman of the Committee (Ald. Grimshaw) said no member of the Council could go through those minutes intelligently and make himself conversant with the amount of work done by the Committee, and what was implied by the resolutions passed, the reports and the specifications set out, without feeling surprised that they had got through so much business by 11.30 the same night. At the outset of the meeting to which allusion had been made he told the Committee there was a large amount of business to be transacted, and he asked them to get through it as quickly as possible; but there was a disposition to let every man have his say upon every matter, upon every sentence, or nearly upon every word that came before the Committee, and if they did not do it they thought the public outside would consider at that juncture that they were not doing that which was expected of them. There was a great deal in what Councillor Farr said. The Committee had had to manage the electricity station, although he did not say they had any right to do so, but they had had to try and safeguard the interests of the town. He had already told the new engineer that, having studied the circumstances, he must say what his policy was, and must stick to it irrespective of what any member of the Committee might say or do.

Fort William.—The Council have accepted the offer of the Fort William Electric Lighting Co. to allow a rebate of 10 per cent. off the public lighting account.

Lowestoft.—Last week the Council decided, on the recommendation of the Electric Lighting Committee, to amalgamate the Tramways and Electric Lighting Committees under the title of the Electric Works Committee.

Malvern.—The Council has failed to obtain sanction to the laying of an electric supply cable to West Malvern at a cost of £2,400.

Municipal Development Scheme.—At last week's meeting of Sheffield Corporation Councillor Warlow moved that a special committee be appointed to consider and report what steps (if any) should be taken to form and control an industrial development department of the Council.

Councillor Warlow said the committee ought to be a committee of inquiry to see whether it was feasible to form a development committee to consider subjects of vital interest to the city. During his term of office as Lord Mayor, he had several times to invite members of the Council, the Cutlers' Company, the Chamber of Commerce and leaders of the trade union movement, to discuss matters which required immediate and prompt attention. He was impressed with the value of co-operation of associations outside the Corporation, and he was afterwards spoken to about the need for a committee for dealing with the industrial development of the city. The question of development would become more acute after the war than it had been in the past, and they required for its solution not only the wisdom and energy shown by members of that Council, but the benefit of the advice which could be given to them by men who were accustomed to deal with large affairs and also the advantage of the experience of the leaders of the trade unions.

Col. Hughes said they would have to consider the subject with very broad views and to free themselves absolutely from prejudices, whether they were caused by fear of the cost or by some other reason. It was time that the biggest city of Yorkshire, with all the world for its market, woke up to find what the position really was and what were its drawbacks. Sheffield was handicapped badly by the configuration of the city. During the past two years they had been developing to an extent that they could not have expected to attain in 10 or 15 years. Practically all the available sites for big works were in a small area. The larger works were not coming to Sheffield unless a proper and adequate area could be found for them. For a large undertaking 150 acres were not too much, and he knew that at one time one firm would have paid £5,000 or £6,000 per acre if the land could have been got. The cost of the land was nothing compared with the railway facilities. If they were not careful they would have the development going to Rotherham when it ought to be retained for Sheffield.

Councillor Ledingham contended that the reason why the big industrial concerns were keeping away from Sheffield was because the rates were too high. If the rates were excessive, manufacturers could not be in a position to give their workers good wages, cheap houses and gardens.

After some discussion the resolution was carried.

Nuneaton.—Permission has been given to the electric supply department to erect poles in Tuttle Hill and Camp Hill-road for an overhead transmission line.

Rochdale.—Councillor Walker, Chairman of the Gas and Electricity Committee, explained to the Council last week that the reason for the intermittent supply of electricity since January last had been solely the unsatisfactory working of the chain-grate stokers, consequent upon the low draught available.

In these circumstances they had undoubtedly been trying to meet too heavy a load on the station. The effect had been to reduce very considerably the amount of steam, to increase the amount of ashes also very largely and to increase the amount of both skilled and unskilled labour necessary. Since January the quantity of ash had largely increased and it was impossible to get men to undertake the work for any length of time, and some days not a man was available. The consequence was that the ashes accumulated at the back end of the stoker and damaged the ash tipping arrangements. The labour question, even were it the only one to contend with jeopardised the supply. There was no control over the men, most of the old and reliable ones having joined the army. The contractors who had carried out repairs at the works were in exactly the same difficulty. With regard to the future, it was expected that the new No. 3 chimney stack would be available by Christmas and that would undoubtedly further improve matters. Seeing, however, that the links of the chain-grates were already weakened, those needed to be afterwards thoroughly overhauled. The induced draught plant and economiser should be completed about the third or fourth week in January, when the question of sufficient draught would be settled, the amount of labour lessened and also the working costs greatly reduced. He accepted Ald. Clark's motion for a report on the causes of the unsatisfactory conditions in relation to the supply of electricity.

Stafford.—The capacity of the present generating plant has been reached and consumers are asked to limit their consumption between dusk and 8.30 p.m.

It was reported at the last Council meeting that the new plant had not come to hand as had been expected and the output would have been larger if the Gas and Electricity Committee had had the plant to cope with the demand.

Swansea.—The Borough Treasurer and the Borough Electrical Engineer have prepared a scheme for encouraging the use of electricity in houses and premises whose occupiers are unable or unwilling to bear the initial cost of installation.

In future a fee of 5s. will be charged for connecting up a supply after same has been disconnected through non-payment of account, and also for testing meters if, when such test is made, it is found that the meter is correct.

The Public Health Committee is to install electric cooking and heating apparatus at the hospital. The medicial officer of health, in his report on the matter, stated that difficulty was being experienced in getting servants for the hospital, and the installation would be of great assistance in times of stress and shortage.

LIGHTING & POWER NOTES.

Electricity in Collieries.—At the recent meeting of the Transvaal and Delagoa Bay Investment Co., the chairman (Mr. S. C. Black) said that £10,000 had been set aside for the installation of electric coal-cutting plant.

Electricity in Gold Mining.—At the recent meeting of the Frontino & Bolivia (S. American) Gold Mining Co., the chairman, Mr. S. W. Stephens, stated that they had reason to believe that the old Pocuné plant held on until the new unit was ready.

The first alternator was started on full load on Oct. 2 last. The total stoppages of the old plant during the 12 months to June 30 last were only 95 hours, a testimonial to the care with which the engineering staff had nursed it. Using steam to drive the compressor for underground work was very costly. The fuel used cost on an average 4s. per ton on the ore crushed, and when they considered that the salaries of the European staff were about 7s. per ton on their small output it was easy to understand how their working costs were so much higher than those on the Rand. They hoped that before the year was out the compressor would be worked by electricity and that the fuel item would to a great extent disappear.

Misuse of Electric Torches.—The Commissioner of Police has issued a notice to the effect that complaints have been made that persons endeavour to attract the attention of omnibus and other drivers by flashing an electric torch in their faces.

While no exception is taken to the discreet use of torches by pedestrians in the dark, the practice complained of is highly dangerous. Drivers represent that they are dazzled by the sudden light, and serious accidents may thus be caused, and the Commissioner of Police trusts that the public will abstain from this practice. Severe penalties attach to any such misuse of electric torches.

Poor Law Institution Lighting.—Chippenham Guardians have decided to obtain estimates for lighting the workhouse by either electricity or gas.

Sanatorium Lighting.—As might have been expected, the new Hawkmoor Sanatorium of the Devon County Council is provided with up-to-date electric lighting and power plant.

Electric lighting is employed in the three pavilions and throughout the sanatorium. There are intercommunicating telephones between the seven blocks of buildings, and there is a complete installation of electric bells. The laundry and electric light station are on the lee side of the site, so that the prevailing winds may carry away the smoke from the other buildings. The laundry contains the boiler house, disinfecting chamber, receiving and sorting room, washhouse, drying and ironing rooms, tubular air heater and blower, electric irons, ventilating fan, &c. Electric motors are used for driving the washing machine, hydro extractor and ironing machines. The electric lighting plant is placed on the floor below the laundry. Power is generated by a 16 B.H.P. crude oil engine, supplied by Messrs. Petters (Ltd.), of Yeovil. The dynamo is by Messrs. Mawdsleys, Gloucester; and the storage battery by the Pritchett & Gold and Electrical Power Storage Co. The wiring is on Callender's Kalecco System.

Messrs. Manlove, Alliott & Co. were contractors for the laundry and kitchen steam plant, Messrs. Foote & Milne for the electrical plant, Messrs. Wippell Bros. & Row for the electric wiring, telephones and bells. The telephones were manufactured by the Western Electric Co.

Thirsk.—The Parish Council has a three year agreement for the electric lighting of the district at £235 a year, subject to the money being voted by the parish meeting.

The first year the contract was carried out, but, owing to the war and lighting restrictions the second year, there were only a few lamps lighted until just after Christmas. After that the lamps were not lighted, and the local electric lighting company made a rebate of £41 from the £235. In the present season there has been no lighting, as the parish meeting has not voted the money, and the clerk has been instructed to write to the company that as the parish meeting has not voted the money for private lighting the Council cannot do anything further in the matter.

TRACTION NOTES.

Birmingham.—As a new 6,000 kw. turbo-generator [illegible] now been started on full load, it is hoped that there will be a [illegible] tramcar service in future.

On Christmas Day there will be a curtailed service. Exce on four routes, there will be a modified service of cars, but it has been [illegible] to suspend the whole of the service between 1.30 p.m. and 6 p.m.

Bristol.—The Bristol Tramways Co. has commenced the t ing of girl conductors, and the first batch of 25 started work the 13th inst.

Edinburgh.—An offer by the local tramways company to sell t rolling stock for £50,000 and keep up the system for six years af the expiry of the lease has been referred by the Tramways Committee to the Council for instructions.

On the proposal to construct tramways to South Queensferry, the Committee recommends that communications be opened with the authorities with a view to ascertain the present or prospective needs for further transport facilities.

At a recent lecture on "Public Street Conveyance of To-day," Sir J. H. A. Macdonald, G.C.B., said the question for Edinburgh citizens was how could a good and efficient system of public conveyance be found which would meet public needs, be capable of extension, and at the same time do as little injury as possible to the unique beauty of the city. It was not merely a question between one tramway system and another, but what was the best use of the roadway in the interests of all traffic. In advocating the free-moving motor vehicle as against the vehicle with fixed rails, he said that motor omnibuses were successfully running in London, Brighton, Oxford, Eastbourne and elsewhere. That was not the time to embark on a scheme which would require half a million of capital when a service could be provided similar to what had proved satisfactory elsewhere with an outlay on vehicles only.

The Ministry of Munitions has refused the Corporation permission to alter the existing city tramway system or to proceed with the electric supply scheme of extension at Portobello.

Electric Motor Vehicles for Dust Collection.—On the presentation of the minutes of the Health Committee at the meeting of Sheffield Corporation last week, Councillor Roberts mentioned that the cost per ton of collecting refuse by electrical vehicles was 3s. 1d., compared with 3s. 9d. by horse labour.

He said the "electrical contrivances" were a very great economy at the present time, and all the more necessary because horse keep had gone up another 10 per cent.

Hull.—The Tramways Committee has decided to abolish halfpenny fares.

Lancashire Tramway Disputes.—Owing to the numerous applications for increases of wages and salaries from members of the Tramway Workers' Union, an association of tramway authorities in Lancashire has been formed in order to find a satisfactory basis of settlement for the whole of the towns.

At Rochdale the men sent in an application for an increase of wages on Aug. 1, and as the application had not been favourably received the men decided to give 21 days' notice to the Ministry of Munitions to cease work at the end of that period if the application was not granted. Subsequently the men unanimously resolved to cease work on Sunday unless their application was in the meantime decided by arbitration. The Ministry of Munitions replied by stating that the application would be considered by the arbitrator on the 21st inst., and that on no account must the men cease work. Thereupon the tramway workers decided to work as usual pending the result of the arbitration.

L. & N.W. Railway.—Fair progress is being made with the new electric line of the L. & N.W. Railway Co. between Euston and Watford. Satisfactory trial trips were recently run on the section between Willesden and Watford, a distance of about 10 miles. The electric trains are expected to commence running in January.

Musselburgh.—In view of complaints by members of the Council of the poor service provided by the local tramways, a committee has been asked to consider the whole question of the tramways and their future. The Council have the option to purchase the system at the end of each seven years.

Newcastle-on-Tyne.—Owing to the shortage of men, the Council propose to train women as tramcar drivers.

Oldham.—There will be no tramcar service on Christmas Day.

Preston.—On Saturday there was a collision between two tramcars, resulting in injuries to both drivers and to eight passengers.

Rotherham.—The Council are to provide a service of tramcars between Sheffield and Templeborough.

Salford.—There was no municipal tramway service for two days this week owing to a strike of drivers and conductors against the employment of women inspectors.

On Monday evening the men accepted the Tramway Committee's suggestion that the dispute should be referred to arbitration by the Committee on Production, and pending the award the women inspectors are to be withdrawn from the cars. The men reported for arrive on Tuesday morning.

Tramway Employment Substitution Scheme.—The Executive of the Municipal Tramways Association has made an agreement with the military authorities as to a substitution scheme for tramway employees.

Under the arrangement all fit men under 30 years of age except specially skilled men in responsible positions in municipal tramway undertakings are to be released for military service. The tramway authority of each municipality will supply to the War Office a list of men who have already left their service and taken up military duties and another list of men of military age at present employed on the system, with particulars of age, occupation, &c.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says the Prahran and Malvern (Victoria) Tramways Trust has commenced the manufacture of its own car bodies.

Hitherto these have been built mostly in Adelaide and Sydney. Six cars are in course of construction, and it is expected that a saving will be made on the average prices hitherto paid, viz., £515 per body. The trucks also are being made by the Trust in Melbourne, but cast-steel is being used instead of forged steel, as in the imported trucks, no forging machinery of sufficient weight being available in Australia. The truck frames and wheels are being manufactured by Charles Ruwolt Pty., Richmond, Victoria.

At a recent meeting of Wellington (N.Z.) Council plans for the construction of a lift system between the lower levels of Wellington City and Wellington Terrace were approved. The lift is in the form of an inclined tramway and is to cost about £5,000; the length of the viaduct will be 5 chains; and the height attained about 150 ft. The gradient will be 1 in 2·36, and the viaduct will carry two lines of rails, enabling two cars to be used. The winding gear will be operated electrically.

India.—Simla Corporation has decided to adopt the proposal of its electrical engineer to offer specially cheap rates for the months November to March inclusive for current for heating and cooking.

As current for heating is only required in the winter there is no likelihood of this extra load being super-imposed on the summer peak load. The demand for electric heating this winter is stated to be in excess of what it was last year. It has been found that electrical energy at half an anna (½d.) per unit compares favourably with the cost of coal and wood fires for heating and with charcoal fires for cooking. The Public Works Department of the Government of Bengal announces that the annual conference of electrical inspectors will be held during the present month at the Indian Museum in Calcutta. Representatives of the Bengal Chamber of Commerce, the Indian Mining Association and the Calcutta Trades Association have been invited to attend.

MISCELLANEOUS NOTES.

Anglo-Swedish Trade Journal.—A special Celebration Number of this journal has been issued to commemorate the tenth anniversary of the foundation of the Swedish Chamber of Commerce for the United Kingdom.

The book contains excellent portraits of the Hon. President, Hon. Vice-President, President, former Presidents and Vice-Presidents, Secretary, Treasurer and others; short biographical sketches of the founders and chief supporters of the Chamber, a history of the work of the Chamber and its Committees, statistics showing the increase of the membership, the business done, &c. It is issued from the offices of the Chamber, 5, Lloyd's-avenue, E.C., at 2s. 6d. net (post free).

Appeal for Aged Seamen.—The Royal Alfred Aged Merchant Seamen's Institution is making an earnest appeal to help the committee of this old sailors' charity to answer urgent "signals of distress" from hundreds of hard-pressed mariners. Contributions should be sent to the Institution at 58, Fenchurch-street, London, E.C.

British Industries Fair.—The arrangements for holding the British Industries Fair of 1917 are complete, and forms of application for space are being issued by the Board of Trade.

The Fair will be held from Feb. 26 to March 9, 1917, at the Victoria and Albert Museum, and in the great hall and certain galleries in the Imperial Institute building. The Fair will be confined to the same trades as last year—*i.e.*, toys and games, earthenware and china, glass, fancy goods, stationery and printing.

The Glasgow Corporation are organising a Fair at Glasgow, which will take place concurrently with the Board of Trade Fair in London, and will include certain trades not comprised in the London Fair. The Glasgow Fair will include textiles, domestic chemicals, foodstuffs, &c. Over 20,000 invitations to each Fair will be sent to oversea buyers by the Board of Trade, those to firms in non-European countries having been already despatched, and another 80,000 invitations to the Fair in London will be issued to the buyers in this country before Feb. 24 next year.

Calendars and Diaries.—From the British Thomson Co. (Ltd.) we have received a neat hanging calendar, with monthly tear-off sheets.

Messrs. Charles Letts & Co. have sent us a neatly bound copy of their "Peerless" calendar and diary for 1917. With the diary, which is a convenient size for the vest pocket, is an accident assurance coupon.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding up of 383 businesses controlled by alien enemies.

Included in the latest list are:—Decauville & Co., 31 and 32, Broad-st.-av., London, E.C., late 10, Eastcheap, E.C., makers of portable railways (Controller: G. S. Pitt, 140, Leadenhall-st., E.C.); John zum Felde & Classen, 150-151, Fenchurch-st., London, E.C., East India merchants (Controller: H. E. Syer, 99, Cheapside, E.C.).

With regard to the Harburg & Vienna India Rubber Co. (Ltd.), the Controller, Mr. C. W. M. Kemp, has applied for a release. Objections to the release may be sent to the Board of Trade by Dec. 23.

The Controller of Burstinghaus & Co. (Ltd.) has also applied for a release. Objections by Dec. 27.

Claims against Greenwich Time (Ltd.) are to be sent by Jan. 20 to Mr. S. F. Stephens, 12 & 14, Arthur-st., London Bridge, London, E.C.

Industrial Reconstruction.—At a recent meeting of leading representatives of employers and trade unions, important resolutions on trade after the war were passed. Among these resolutions were the following:—

That the cordial and whole-hearted co-operation of employers and employed will be the most important element in the success of any scheme for dealing with the re-instatement of the men of the Forces and munition workers in civil employment, and the general redistribution of labour after the war, and for handling any subsequent problem of unemployment or labour dislocation.

That no machinery now in existence can adequately deal with the reinstatement in civil employment of the present forces.

That powers should be obtained from Parliament to set up without delay a Central Statutory Board to regulate and supervise (*a*) the reinstatement in civil employment of the present forces; (*b*) the settlement in normal employment of civilian workers now in Government or controlled establishments; (*c*) any general redistribution of labour arising out of the war.

That not less than two-thirds of the members of this Central Statutory Board should be representatives of employers and employed in equal numbers (such members being appointed by the Crown from associations of employers and from the trade unions), the remaining members to include representatives of Government Departments, &c.

That where a trade union, by arrangement with employers' associations, is capable of placing its members in employment, it should be competent for the Central Board, if it deems it to be in the national interest, to delegate to the trade union in question the responsibility of dealing with the reinstatement of its own members.

That local boards should be established wherever necessary to assist the Central Board. Such local boards to have the same proportionate representation as is provided for the Central Board.

Scottish Electricians' Wages.—The arbitrator in the dispute between the Electrical Contractors' Association of Scotland and the Electrical Trades' Union as to the demand for an advance of 2d. per hour for the members of the union employed in the Glasgow district has awarded ¾d. per hour to electricians and armature winders. The increase is to begin on the first pay-day after the issue of the award.

Sunday Labour.—In a statement recently issued by the Ministry of Munitions it is stated that there is no advantage in Sunday labour.

It is stated that some months ago the Health of Munition Workers Committee found that overtime and Sunday labour had been widely adopted in the munition factories on account of the heavy demand for output. The results were, however, disappointing with regard to the increase of output. The Committee's investigations led to the conclusion "that there are limits to hours of labour beyond which no commensurate output is obtained," and that "except for quite short periods continuous work is a profound mistake and does not pay—output is not increased."

The Hours of Labour Committee was thereupon formed within the Ministry of Munitions to deal with the situation, and already much effective work has been done with the goodwill of both employers and workers The Committee have approved the terms of the new Munitions of War General Order recently made by the Home Office, under which the hours of labour for women and girls have been reduced to a maximum of 60 per week, and the hours for boys under 18 to a maximum of 63 per week, except when employed on the overtime system, when a maximum of 65 is sanctioned. Already 120 controlled establishments have discontinued Sunday labour. It has also been discontinued in all national shell and national projectile factories, except for work needed for the rectification of shells or the cleaning of shops. A general order has, moreover, been issued throughout the north-east coast district prohibiting Sunday labour save for necessary repairs or work of quite exceptional urgency.

Will.—The late Sir James Sivewright, who died on Sept. 10, left estate of the value of £98,784.

The bequests include £10,000 to the Senatus of the University of Aberdeen, and £5,000 to the Committee of Milne's Institute, Fochabers, to be invested and held in perpetuity for providing bursaries for students coming from the county of Moray.

TENDERS INVITED.

Telegraph and Telephone Material.

Tenders are invited by Jan. 10, 1917, for the supply and delivery to the POSTMASTER-GENERAL'S DEPARTMENT, STATE OF WESTERN AUSTRALIA, of telephone instruments and parts (W. A. Schedule No. 497). Tender forms, specification, &c., can be obtained at the Commonwealth Offices, 72, Victoria-street, S.W. *See also an advertisement.*

The Deputy Postmaster-General, Perth (Western Australia), also requires tenders by 3 p.m. Jan. 10 for various Telephone Switchboard Parts (schedule 534 W.A.) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General, Perth, W. A.

Turbo-Alternator, Condensing Plant, Motor-Generator, Motors, &c.

DURBAN Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-alternator and Condensing Plant. Specification (No. S.238) from Borough Electrical Engineer.

DUNEDIN (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

CAPE TOWN (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

Electricity Supply Concession.

A concession is offered by the Government of GRENADA for generating and supplying electricity for lighting and power purposes in the town of St. George's and the residential suburbs. The concession will be for 30 years, renewable in periods of 20 years thereafter, the Government to have the right to purchase at a price to be fixed by arbitration. The contracting firm will be allowed to import materials free of duty. Particulars from the Colonial Secretary, Grenada, British West Indies, to whom tenders by Dec. 31

Electrical Supplies, &c.

TOXTETH PARK Guardians require tenders by noon Dec. 28 for three months' Electrical Supplies, Ironmongery, &c. Forms of tender from the Clerk, 15, High Park st., Liverpool.

Tower Wagon.

WIGAN Tramways Committee require tenders by noon Jan. 8 for the supply of a 30 H.P. Motor Tower Wagon. Particulars from the General Manager.

Boilers & Induced Draught Plants.

MANCHESTER Electricity Committee require tenders by 10 a.m. Dec. 28 for the supply and erection of Water-tube Boilers and Induced Draught Plants at Stuart-st. station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Meters, M. D. Indicators, &c.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Feb. 19 for supply of meters, maximum demand indicators and feeder regulators. Specifications, &c., from the Electric Lighting Dept., Town Hall, Sydney.

Tramway Materials, &c.

ABERDEEN Tramways Dept. require tenders by noon Dec. 25 for 12 months' supply of Stores, including Iron, Steel, Bolts and Nuts, &c. Forms of tender from the General Manager.

Electric Crane and Coal Transporter Plant.

The N.S.W. RAILWAY AND TRAMWAY DEPARTMENT require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

TENDERS RECEIVED AND ACCEPTED

BARNES.—The Council has accepted the tender of the Macintosh Cable Co. (at £289) for laying 600 yds. of cable.

BLACKPOOL.—The Council has placed an order for a motor generator for testing purposes with the Electric & Ordnance Accessories Co.

CAMBERWELL. The Council has extended for one year from March 31 next, upon present terms, their contract with the Private Telephone Co. for the maintenance of private telephones.

LEEDS.—Messrs. T. Harding Churton & Co. are supplying apparatus for charging battery switchgear for the electricity department at £180.

LEEK.—The Council have accepted the offer of Crossley Bros. for the supply of a Rees rotary pump at £58.

REIGATE. The Guardians have placed an order with Tamplin & Makovski for electric cable at £175, and for an electric motor at £20.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

◆

India Rubber, Gutta Percha & Telegraph Works Co. (Ltd.)

The fifty-third ordinary general meeting of the company was held on Wednesday, MAJOR [illegible] (Chairman) presiding.

The SECRETARY (Mr. A. P. [illegible]) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, I wish first to make a reference to the loss of our cable-ship "Dacia," which is briefly mentioned in the directors' report. Although an old ship—she was built in 1867, and acquired in 1872 from [illegible] the pioneer of Atlantic telegraphy—she was still a valuable vessel for her work, the cable machinery being as good as, if not better than, that of any cable-ship afloat. In her time she had laid cables in the West Indies, on the coasts of Chile and Peru. She had seen service in the [illegible], the Mediterranean, the West Coast of Africa and North America. Fortunately, in her last voyage, she had performed the [illegible] work for which she had been chartered, and when she was [illegible] ... [illegible] ... comparatively ... [illegible] ... [illegible] ... without ... [illegible] ... Silvertown ... [illegible] ... contract for the ... [illegible] ... for her, the directors decided to ... [illegible] ... [illegible] ... [illegible] ... the world from Senegal to Mozambique, on the West Coast of Africa, from New York to Havana, San Francisco to Honolulu, Sydney to Auckland, and Manila to Shanghai. The question of acquiring another cable-ship, with all modern requirements, is engaging the attention of the directors.

You will notice that the directors have put £50,000 to the reserve fund, which stands at the same figure as it did immediately before the war. Persan and the foreign branches did very well during the year under review. It must be remembered, however, that the French works are liable to the French War Tax, and that this will reduce the available profits. What that tax or the English War Taxes will amount to we do not know. As stated in the report, the re-issue of our debentures in March last entailed a considerable cash expenditure, together with a liability for additional interest in the future, the present value of which amounts to about £30,000. In order to make it possible to undertake work for the British and French Governments, it has been necessary to limit our output in other directions. This has entailed a loss of trade in the only market which will be open to us after the war, the manufacture of aeroplane tyres, for example, having now largely replaced our former business in motor tyres. Considerable difficulties are likely to be experienced in re-occupying the lost ground, and this is a matter which also ought to be held in view by the authorities when imposing war taxation. We feel confident, however, that we shall be justly treated by the Government. To relieve the congestion of work at Silvertown, and to meet the increased demands for material, the directors have acquired land at Burton-on-Trent, and a factory has already been erected there. It is hoped that after the war we shall be able to devote the works at Burton to a great extent to the production of those articles of which, before the war, Germany had obtained a practical monopoly. The Chairman then moved the adoption of the report and accounts, and the distribution of the dividend set out in the report (abstracted in our last issue).

Mr. C. H. GRAY seconded the resolution.

In reply to questions, the CHAIRMAN said the extra expenditure in issuing the debentures was about £28,000 in cash, and it was covered in the accounts. With regard to the future war tax, they had no apprehension. There was a carry-forward of about £40,000, and £50,000 had been placed to reserve. With regard to the French war tax, the double tax ought not to fall upon the company, and they believed it would not. The Burton property was freehold, there was a siding from two railways, and there was also a canal running along the works.

Mr. C. H. GRAY said with regard to labour Burton was a very good position. In reference to taking business formerly done by Germany, the directors would not attempt to take anything from the Germans at present which they could not produce at the pre-war prices of the Germans. They already knew there were many lines that they could manufacture at Burton which would fulfil those conditions.

The motion was then adopted. Col. A. Weston Jarvis was re-elected a director, and the auditors (Turquand, Youngs & Co.) were re-appointed.

A vote of thanks to the Chairman, directors, staff, employés and chief officials closed the proceedings.

BLACKPOOL, ST. ANNES & LYTHAM TRAMWAYS CO. (LTD.)—The traffic receipts for the past year were £46,893. A sum of £10,123 was paid to Blackpool Corporation. Traffic expenses were £7,818, general expenses £3,742, general repairs and maintenance £7,535, power expenses £5,046, and rent of leased lines £2,294, the available balance being £11,714. The directors recommend the trustees for the debenture holders to distribute a full year's interest of 5 per cent. upon the debenture stock, this being on account of arrears to date.

BRITISH COALITE CO. (LTD.)—Mr. W. J. Fisher, J.P., who presided at the meeting on Tuesday last, said that the forecast he made at the last meeting—that the Barnsley plant would have been working in March last—had been upset. The preliminary work of excavation had been hampered by unfavourable weather, while it was only by steady persistence that they succeeded in obtaining some of the principal items of their plant. Another cause of delay had been the difficulty of obtaining suitable workmen. However, a few weeks should see them through that difficulty, as when the plant was at work very few men would suffice to keep it going. Their work was being watched attentively—indeed, jealously—by the interests engaged in the high-temperature distillation of coal. The general sense of the interesting discussions on fuel economy at the meetings of the British Association at Newcastle in September was that if the nation were to derive full benefit from its wealth in bituminous coal it would have to be carbonised at low temperatures, thereby effecting an enormous saving in their greatest national asset. It was in that direction that the company had been for so many years a pioneer. They had every confidence that so soon as the Barnsley plant had proved itself they would have requests for similar works all over the United Kingdom. The value of £160,000 placed upon their inventions and patent rights must be treated as merely a hypothetical figure. Inasmuch as they received £30,000 in ordinary shares from the Barnsley Company alone, it was obvious that when a widespread demand set in for their process that figure might represent merely a fraction of the actual value.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The net revenue for the year ended June 30 was £134,964, and with £6,666 brought forward and £70,000 transferred from reserve the available total is £211,630. After paying debenture interest and dividends on 5 per cent. cumulative perpetual preference stock there remains £6,859 to be carried forward. The capital expenditure of the railway and subsidiary companies during the year was $134,900, compared with $875,558 in previous year. The reduction in the population, the reduced spending capacity of the citizens, the continuance of the unfair competition of Jitney cars, together with the greatly increased cost of all supplies, are responsible for the decrease in revenue. Since Jan. 1, 1916, the Jitney competition has been less acute, but it is estimated that these cars are still depriving the company of earnings amounting to $350,000 a year. The earnings from freight show an encouraging increase, and this class of traffic promises to become an increasingly profitable part of the business. The net earnings for the first four months of the current year show an increase of over £30,000, and the directors are not without hope that the profits of the current year will be sufficient to cover the debenture interest and also the dividend on the cumulative preference stock without further trespassing on the reserve fund. It is proposed to elect Sir William Mackenzie (president of the Toronto Railway and Winnipeg Electric Railway Companies, &c.) as a director of the company.

MELBOURNE ELECTRIC SUPPLY CO (LTD.)—The report for the year ended Aug. 31 states that the Treasury authorised the issue of the balance of 125,000 ordinary shares of £1 each in Australia and to Australian stockholders only, and that 102,137 shares were taken up and subsequently converted into consolidated ordinary stock. To provide for future expansion, a resolution will be submitted at the forthcoming meeting for the increase of the capital of the Company by £750,000, divided into 50,000 preference shares of £5 each, and 500,000 ordinary shares of £1 each, the latter to be converted, when fully paid, into consolidated ordinary stock. A resolution will also be submitted for increasing the borrowing powers of the directors by £250,000. During the year £144,404. 17s. 3d. was expended on additional land, buildings, plant, mains, &c., and the total expenditure is now £1,256,038. 0s. 7d. The area of the suburban districts in Melbourne covered by the company's statutory powers is approximately 71 sq. miles, with a population of 366,000; and a supply is now available in 566 miles of streets, an increase of 10 miles during the year. 1,[illegible]22 new consumers were connected making the total number 27,713, an increase of 20 per cent. over 1914-15. The power supply increased by 15 per cent., the electric motors connected being equivalent to 20,106 h.p. The total connections, including lamps, motors, heating and other apparatus increased by 22 per cent.; the total units sold by 36 per cent. and gross revenue by 24 per cent. The gross profit from the Melbourne and the Geelong undertakings amounted to £142,315. 6s. 1d., compared with £117,676. 19s. 4d., an increase of 21 per cent., compared with an increase of 13 per cent. in the previous year. After payment of debenture interest and management and general expenses at the London Head Office, and after allocating £5,400. 6s. 3d. to debenture stock sinking funds, £1,800 to income certificate service fund, £20,000 to general reserve, £15,000 to reserve for income tax and excess profits duty, the credit balance is £72,476. 7s. 4d. Deducting the dividend on the 7 per cent. first cumulative preference shares for the first half-year, the interim dividend of 5 per cent. on the consolidated ordinary stock and the interest on the partly-paid ordinary shares (already paid), the available balance is £48,061. 19s. 4d. The directors recommend payment of the dividend on the 7 per cent. first cumulative preference shares for the half-year ended Aug. 31, 1916 (paid in September), a final dividend of 5 per cent., tax free, on the consolidated ordinary stock, making 10 per cent. for the year (£18,750), interest on partly-paid ordinary shares (£2,698. 11s. 8d.), leaving to carry forward £21,366. 7s. 8d. To this balance must be added £40,777. 16s. 3d. brought forward from last year, making a total credit balance of £62,144. 3s. 11d. to be carried forward, subject to any further demands in respect of excess profits duty. The directors are glad to say that the business of the company continues to be well maintained notwithstanding the adverse influence of the war. There is an increasing demand for light and power from all classes of consumers, including numerous firms in Melbourne and Geelong engaged in the manufacture of war munitions and requisites.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—At an extraordinary meeting last week it was decided to increase the capital of the company to £200,000 by the creation of 50,000 additional B shares of £1 each, to be issued as ordinary or preference shares. The chairman (Mr. F. H. Thornton, J.P.), in moving the adoption of the resolution to increase the capital, said that in October, 1915, the company had issued £110,000, and a month later, owing to increased business, a call was made for £40,000 to meet the great expansion of trade. That amount was practically subscribed, and almost all of it had been spent in purchasing the site of 10 acres for new buildings and in making the extensions necessary to enable the company to meet the great requirements of the boot trade for power. Those demands were increasing. A new 500 kw. alternating set had been erected, and mains had been laid in the outlying parts to give h.t. current to manufacturers. There was no room for more plant at the present works, and the additional capital was required for extensions now being made at the new works, where current would be generated at high voltage and transmitted to the present works, which would become a transforming station. The new issue had the sanction of the Treasury and Ministry of Munitions. The issue would be at par, and there was hardly ever a time when a better investment was placed before the public of Northampton. The directors estimated that the extensions would enable them to save 6,000 tons of coal a year, and that (at 10s. a ton) would give £3,000 a year, which was 6 per cent. on the £50,000. It was proposed to erect a 3,000 kw. set, which was far larger than anything they had, and that would be a great saving, while they would also have the advantage of the river water for condensing.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—At the meeting last week the chairman (Mr. J. M. Falkiner) said that the company was under Government control, and that the size of an already gigantic undertaking had been quadrupled. The amount set aside for depreciation had been increased. A company of world-wide extent and vast complexity of manufacture like their company was handicapped by heavy standing charges and foreign expenses. They were not free to discuss figures in detail. Their output had enormously increased and was increasing. Since the last meeting the production of war material had steadily improved. Sunday work, except for matters of extreme urgency, had recently been abandoned at the request of the Government. That regulation had come as a great relief to everyone. It had become obvious that work on seven days a week was physically impossible over protracted periods. Either the work or the workers must suffer by too long hours. On the whole, an increase of industry and regularity was noticeable. Though there was still much room for improvement and some deplorable slackness, yet things were better than they were, and that was due partly to the force of example of a vast body of conscientious workers, and partly to the influence which the unions were bringing to bear on their members. What was technically known as "dilution" was being gradually extended. For their acquiescence and assistance they acknowledged their obligation to the trade unions, and they hoped for their ungrudging help in carrying the principle further during the war. The number of women workers had largely increased, and their efforts merited very high praise indeed. They were doing all they could to improve the conditions of labour, both male and female, by the establishment of canteens and clubs. Welfare workers were devoting special attention to the women. He would like to take the opportunity of offering special thanks to the staff. They had grappled with a bewildering expansion; they had worked early and late, Sundays and weekdays; with entire self-sacrifice and cheerfulness. He associated warmly in that commendation their foremen and their conscientious workers, men and women. He believed that the relations between the workers and the management were at least as cordial as in other firms of anything like their magnitude. It was possible that both sides were beginning to understand each other better, and were more ready to make mutual concessions, however temporary. He hoped that understanding might continue.

CITY NOTES.

MEMORANDA (Dec. 20).—Bank rate 6 per cent. (since July 13, 1916). Consols, 55. Consols Pay Day, Jan. 4. Stocks and Shares Ticket Days Dec. 28 and Jan. 11. Pay Days, Dec. 29 and Jan. 12. Price of Silver, 36 13/16d.

BUENOS AYRES CITY & SUBURBAN TRAMWAYS CO. (LTD.)—The report for the year 1915 states that the construction of the line between Olivos and San Isidro has been finished, but the level crossing over the Central Argentine Railway at Olivos has not yet been built, and the line beyond that point has not been opened.

BUENOS AYRES LACROZE TRAMWAYS CO. (LTD.)—The gross receipts for the year June 30 were $5,883,262, decrease $217,389; working expenses $3,895,787, increase $135,005. The balance was $1,987,475, from which must be deducted debenture interest, &c., leaving $644,519. To reserve, $32,225; to the directors, $32,225; dividend $625,000 (against $1,000,000); to next account, $35,483 (against $83,638).

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.)—The accounts for year ended Sept. 30 show, after payment of debenture interest, a loss of £230, reducing the credit balance of £26,581 brought forward to £26,351, which will be carried forward.

MANILA ELECTRIC RAILROAD AND LIGHTING CORPN. (LTD.)—A dividend of 1½ per cent. ($1.50 per share) for the quarter ending Dec. 31 has been declared on the common capital stock.

TUCUMAN TRAMWAYS, LIGHT & POWER CO. (LTD.)—The accounts for the year ended June 30 show a net profit, after meeting interest charges, of £7,306, thus reducing debit balance forward to £35,210.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS (LTD).—The directors have declared a final dividend of 3 per cent. (being at rate of 6 per cent. per annum) on account of the dividend accrued on the 6 per cent. preference shares.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec. 19, the following as the present basis prices of—

New Metals.	Per lb.		Per ton
Solid Drawn Brass Tubes	18¼d.	English Lead	Nominal.
Solid Drawn Copper Tubes	22d.	Antimony	Nominal.
		Old Metals.	Per ton.
Brazed Copper Tubes	22d.	Clean Copper Scrap	£120 0 0
Brazed Brass Tubes	20¼d.	Clean Brass Scrap	70 0 0
Brass Wire	17¾d.	Braziery Copper Scrap	102 0 0
Copper Wire	22d.	Old Lead	27 0 0
Rolled Brass	17½d.	Old Zinc	40 0 0
Brass Sheets	17¾d.	Hollow Pewter	130 0 0
	Per ton.		
Copper Sheets	£187 0 0	Black Pewter	95 0 0
Spelter	54 5 0	Gun Metal	101 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Dec. 19, the following approximate prices of Scrap Metals:—

	Per ton.		Per ton.
Scrap Brass	£76 0 0	Tea Lead	£27 0 0
Clean Copper	130 0 0	Old Zinc	43 0 0
Braziery Copper	100 0 0	Hollow Pewter	140 0 0
Gun Metal	105 0 0	Shaped Black Pewter	100 0 0
Old Lead	30 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £84; Commercial Tinman's Solder, £105, Blowpipe Solder, £115.

ELECTRICAL COMPANIES' SHARE LIST.

We give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 19.

Shrs.	Last Dividend	Name.	Price, Tues., Dec. 19	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	6%	Bournemouth & Poole E.L. Ord.	8½	7 1 2	Mar., Sept.
10	4½%	Do. 4½% Cum. Pref.	[illegible]	5 16 2	Feb. Aug.
1[illegible]	6%	Do. 6% Cum. 2nd Pref.	[illegible]	6 1 6	Feb., Aug.
[illegible]	[illegible]%	Brompton & Kensington Ord.	6[illegible]	7 9 6	Mar., Sept
[illegible]	7%	Do. 7% Pref.	[illegible]	5 9 10	Mar., Aug
St	4%	Central Elec. Supp. G. Deb. S	7[illegible]	[illegible] 3 1	..
St	4%	Charing Cross West End & City Debs	[illegible]	5 0 8	Jan., July
[illegible]	2/3	Do. 4½ Pref.	[illegible]	6 13 4	..
[illegible]	5%	Do. Ord.	[illegible]	7 2 10	Aug., Feb
[illegible]	4½%	Do. City Pref.	3[illegible]	6 18 6	J[illegible] Dec
[illegible]	4%	Chelsea Elec. Supp. Co. Ord.	[illegible]	6 19 [illegible]	Mar., Sept
St	4½%	Do. do. Debs.	87	5 3 5	Jan., July
1[illegible]	8%	City of London Elec. Lt. Ord.	11[illegible]	7 4 0	Feb., Aug
1[illegible]	[illegible]	Do. 6% Pref.	[illegible]	6 1 6	Mar., July
St	[illegible]%	Do. [illegible]% Deb. St.	9[illegible]	[illegible] 4 [illegible]	J[illegible] D[illegible]
St	4½%	Do. 4½ [illegible]	7[illegible]	5 11 0	J[illegible] Dec
10	7%	County of London Ord.	[illegible]	7 8 9	M[illegible]
10	[illegible]%	Do. 6% Pref.	[illegible]	6 1 6	Feb., Aug.
St	4½%	[illegible]	8[illegible]	[illegible] 5 11	Jan., July
St	4½%	[illegible] D[illegible]	[illegible]	[illegible] 6 6	May, Nov
St	4½%	[illegible] 4½% D[illegible]	7[illegible]	6 2 10	J[illegible]
[illegible]	7%	K[illegible] & K[illegible] O.	[illegible]	6 18 3	Feb., Aug
St	4%	Do. D[illegible]	7[illegible]	[illegible] 6 4	Jan., July
[illegible]	6%	L[illegible] 6% Pref.	4[illegible]	[illegible] 18 2	..
St	4%	Do. 4[illegible] Debs.	8[illegible]	4 1[illegible] 10	Jan., July
[illegible]	3%	Metropolitan [illegible]	[illegible]	[illegible] 1 [illegible]	Mar., A[illegible]
St	4½%	Do. 1st Mort. D[illegible]	[illegible]	[illegible]	Jan., July
St	5%	M[illegible] 1st Mort. Deb. St	[illegible]	[illegible] 1 0	Jan., July
[illegible]	6%	New[illegible] & D[illegible] D[illegible]	[illegible]	6 0 [illegible]	Mar., Sept
St	[illegible]%	New[illegible] T[illegible]	[illegible]	[illegible] 11 11	Mar., Sept
1	6%	North Met[illegible] [illegible]% [illegible]	[illegible]	[illegible] 11 [illegible]	Apl., Oct
[illegible]	[illegible]%	S[illegible] London E.S. Co.	[illegible]	[illegible]	Mar., Sept

dividend [illegible] interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price Tues., Dec 19	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	6	6 13 4	Feb, Aug
5	7%	Do. do. Pref.	5¾	6 1 9	Feb, Aug
St.	3½%	Do. do. Debs	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	67½	6 15 2	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations	1¼	6 8 0	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5¼	6 7 3	Mar, Sept
5	4½%	Do. 4½ Cum. Pref.	3 15/16	5 13 0	Jan, July
		Electric Railways and Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St	6%	Do. 6% Cum. Pref.	74½	8 1 1	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	64¾	6 3 4	..
St.	4%	Do. do. Assented Def. Ord.	70⅛	5 13 8	..
St.	4½%	Do. 4½% Pref.	82¼	5 9 1	Jan, July
St.	4%	Do. 4% Deb. St.	74¼	5 7 6	Jan, July
St.	4%	City & S. London Deb.	67	5 19 1	May, Nov
St.	5%	Do. Pref. 1896	70¾	7 1 4	Feb, Aug
10	1½%	London Electric Ry. Ord.	2 9/32	6 5 6	Jan, July
St.	4%	Do. 4% Pref.	61½	6 10 1	Mar, Sept
St.	4%	Do. 4% Debs.	68¼	5 17 3	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	25¼	3 19 2	Feb, Aug
St.	3½%	Do. 3½% Pref.	55	6 3 0	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	53	6 5 0	Feb, Aug
St.	3½%	Do. 3½% A Debs.	61	5 12 1	Jan, July
St.	3½%	Do. 3½% Debs.	63½	5 10 3	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16¼	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	74	5 9 0	May, Nov
St.	4½%	Do. 4½ First Pref.	68¼	5 7 8	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	105¼	5 13 6	Jan, July
St.	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	75	5 6 8	Jan, July
St.	4%	Do. 4% Guar. Stock	65½	6 2 2	Mar, Sept
		Electric Manufacturing, &c.			
1	15%	Babcock & Wilcox Ord.	2¾	5 9 1	Apl, Oct
1	6%	Do. 6% Pref.	1 15/32	4 9 4	Apl, Oct
1	7%	Brit. Aluminium Ord.	1½	4 13 4	Mar
100	5%	Do. Prior Lien Debs.	91¼	5 9 7	Jan, July
1	6%	Do. 6% Pref.	15/16	6 8 0	Jan, July
5	17½%	Brit. Insulated & Helsby Ord.	11¼	7 6 3	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5	6 0 0	Jan. July
[illegible]	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	[illegible]	6 12 5	Mar, Sept
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2¾	5 5 6	April
100	6%	Do. 6% Prior Lien Debs.	100½	5 19 9	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	67½	5 3 9	Jan, July
5	20%	Callender's Cable, &c., Co. Ord.	12½	7 16 10	Jan, July
5	5%	Do. 5% Pref.	4¼	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	87	5 3 5	June, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	6 17 2	Sept.
5	..	Edison, Swan Co. A. £3 pd.	[illegible]/16	..	Feb, Aug
St.	4%	Do. 4% Deb.	61	6 11 2	Jun, Dec
1	7½%	Elec. Construction Ord.	1½	7 5 5	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	68	5 17 8	Jan, July
10	10%	General Electric Ord.	13 7/16	7 8 10	July
10	6%	Do. 6% Pref.	9¾	6 3 1	June, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	16 1/16	6 4 5	Feb, Aug
5	4½%	Do. 4½% Cum. Pref.	4	5 12 6	..
St.	4½%	Do. 4½% Db.	88¼	5 2 0	Jun, Dec
10	10%	India Rubber, G.P. &c., Ord.	13⅝	7 6 9	Feb, Aug
10	5%	Do. Pref.	7⅝	6 11 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	37¼	6 7 2	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	1⅞	6 13 4	May, Aug
1	5%	Do. 5% Pref.	13/16	6 3 1	May, Aug
St	4%	Do. 1st Debs.	76⅛	5 5 1	June, Dec
100	4½%	Do. 4½% 2nd Debs.	98½	4 11 4	June, Dec
St.	4½%	Willans & Robinson B. Cm. Pref.	44	9 7 6	..
St.	4%	Do. 1st Mt. Deb. St.	59	6 15 7	..
		Telegraphs.			
St	30/0	Anglo American 6% Pref. Ord.	95½	6 5 10	Fb,My,Aug,N
St.	1½%*	Do. Def. Ord.	23½	6 19 11	Fb,My,Aug,N
[illegible]	4%	Commercial Cable 4% Debs.	70¼	5 14 1	Ja, Ap, Jly,O
10	5%	Cuba Submarine Ord.	8⅜	5 19 5	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6	6 13 4	Ja,Ap,Jly,O
St.	8%	Eastern Tel. Co. Ord.	140½	5 14 1	Ja,My,Jly,O
St.	3½%	Do. 3½% Pref.	61½	5 13 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	72¼	5 10 6	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77¼	5 3 7	Feb, Aug
10	8%	Do. Ord.	14⅝	5 13 3	Ja,Ap,Jly,O
10	22%	Gt. Northern Tel. Co. With Coup. 11	37¼	5 18 1	Ja, My, Jly
25	13%	Indo-European	51⅜	6 7 2	May, Nov
1	10%	Marconi's Wireless Tel. Co.	2⅝	3 9 7	April
1	7%	Do. 7% Pref.	2 7/16	2 17 5	July
10	⅜%	West India & Panama Ord.	1[illegible]	3 12 7	May, Nov
10	6%	Do. 1st Pref.	7⅜	8 2 9	May, Nov
10	8%	Western Telegh. Co.	13 13/16	5 14 10	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	72	5 10 3	June, Dec
..	4½%	Western Union 50-yr. Bds	99¼	4 10 10	May, Nov
		Telephones.			
1	6%	Monte Video Teleph. Ord.	[illegible]	6 12 5	Nov
1	10%	Oriental Telephone Ord.	2 3/16	4 11 5	Apl, Oct
St.	4%	Do. Db. St.	78¼	5 1 7	Jan, July
St	4½%	Teleph. Co. of Egypt Db. St.	82	5 9 9	Jan, July
5	8%	United River Plate Ord.	6 9/16	6 1 11	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅜	5 14 3	Jan, July
St.	4½%	Do. Deb. Stk.	80¼	5 16 6	Jan, July
		Financial and Investment.			
1[illegible]	6%	[illegible] Teleph. & Trust	12¼	4 16 0	Sp,Dc,Mr,Jn
10	6%	D[illegible] % Pf.	10¼	5 18 6	Sp,Dc,Mr,Jn
100	5%	M[illegible] Companies' C[illegible]	85¼	5 11 9	Ja,Apl,Jly,O
[illegible]	4%	Do. $1[illegible] Pref.	70	5 14 3	Ja Apl,Jly,O
100	6%	Su[illegible] T[illegible]	125	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide E[illegible] Supply [illegible]	4 13/16	6 1 6	Mar, Sept
St	5%	Do. 5% D[illegible]	94¼	5 5 10	Jun, Dec
10	6%	Bombay E[illegible] T 6% [illegible]	1[illegible]	5 17 1	..
St	4½%	Do. 4½% [illegible]	8[illegible]	5 [illegible]	Jan, July
[illegible]	[illegible]%	Calcutta E[illegible]	[illegible]	[illegible] 1 [illegible]	May, Nov.
[illegible]	[illegible]%	Do. [illegible]	4[illegible]	5 16 0	Mar, Sept

* Plu[illegible] bonus.

THE ELECTRICIAN:

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NOTES.

Science and National Service.

It is too soon as yet to form any opinion of the steps likely to be taken by the newly-created Director of National Service. Mr. NEVILLE CHAMBERLAIN, if reports speak truly, accepted the position at very short notice, and without a very clear conception of the duties involved, and we trust that he will devote a reasonable interval of time to the necessary "clear thinking" before he issues his scheme. It appears to be generally anticipated that the nation will be invited to enrol themselves, at first voluntarily, but afterwards under compulsion, for National Service, but no suggestions have been thrown out as to how the duties which each member of the nation can best fulfil will be determined. The nation had an opportunity of offering such services at the time the National Register was prepared, and one would suppose that one of the first steps to be taken by the Director would be to survey the information thus obtained and to approach those who had already offered specific services rather than to commence the process *de novo.* However this may be, we do hope most seriously that any scheme of National Service will comprise better machinery for ascertaining the available scientific talent in the country and mobilising it in a more intelligent manner than at present. It is now generally accepted that the lack of encouragement of scientific effort in the past and the utter ignorance in many quarters of its possibilities in the present, have constituted one of the greatest handicaps to this country since the outbreak of war. In the early stages the utilisation of the services of scientific men was entirely ignored. Those of military age were quickly drafted into the Army, and the loss to the future of the many brilliant and promising lives will not bear contemplation. During the past months there have been signs of a more intelligent outlook. Committees of leading scientific men have been formed to assist the Ministry of Munitions and the Admiralty. The Advisory Council to the Committee of the Privy Council on Industrial Research has done a great deal to foster scientific effort in the manufacturing field, and the formation of the new Imperial Trust for the Encouragement of Scientific and Industrial Research, following LORD CREWE's statement to the deputation from the Board of Scientific Societies on December 1st, gives hope of better things. At last, it seemed, this movement was crystal ising into a definite organisation with the funds and powers to develop research on a large scale.

◆

THERE is a danger that in a sudden, not to say frantic, call for further national sacrifice the success of this movement may be jeopardised, and that the futile errors that marked the early stages of the war may be repeated. We have already lost in the war a great part of the scientific youth of the country. We cannot afford to lose the middle-aged and physically unfit scientific workers as well, particularly at a time when many of them have at last gained a certain amount of recognition and are actually at work in the national interest. Let there be no mistake. Scientific men, engineers and others with special technical knowledge, are willing to make any sacrifice in the true interests of the country. But they claim, with justice, that their efforts in their particular field are of peculiar value at the present time and of even greater vital importance for the future. And they should not willingly acquiesce in being converted into farm hands or labourers at the bidding of some Tribunal on which science is not represented, and which has no conception of the part played by science either in industry or modern warfare. We hope, therefore, that in the new scheme of things there will be provision for the proper survey of the services of scientific men, that such services will at least be valued by a body with some claims to scientific knowledge, and that they will be utilised, in their proper sphere, more and not less effectually than at present. Let us hope that, come what will, we shall be saved from a repetition of the action of the National Convention which condemned the great chemist LAVOISIER to death with the words, "The Republic has no need of scientists."

Labour Exchanges and Staff Appointments.

FROM time to time complaints reach us regarding the unsatisfactory way in which the Labour Exchanges deal with inquiries for highly qualified men in the several branches of engineering. As a typical case may be given that of a controlled firm in want of a chief draughtsman. An advertisement in the following terms will be put into the engineering newspapers :—

> SENIOR DRAUGHTSMAN REQUIRED, to take charge of large drawing office. Heavy electrical engineering experience indispensable, and knowledge of turbo-alternators of large output desirable. Controlled establishment. No one on Government work need apply.—Apply, stating experience, salary and age, to nearest LABOUR EXCHANGE, mentioning this paper, and quoting NA POO 3.14.

Inquiry at the nearest Labour Exchange more often than not reveals that nothing whatever is known of the appointment in question by the man in charge. Frequently the applicant is catechised by a very superior and very young official. In view of this it is not a matter for surprise that those who have attained a certain position in the profession refuse to have anything whatever to do with the Labour Exchange. When it is stated that further particulars may be obtained by applying at the nearest Labour Exchange, in many cases it is found that the positions are filled before the particulars are generally available. An important appointment dealt with in this slip-shod manner may, and sometimes does, result in there being no applicant for the position. At a time when highly qualified men are necessary and are not forthcoming by the new method it occurs to us that it would be as well to be content with the old method, which, irrespective of its drawbacks from the point of view of the Government, did at least give reasonable satisfaction both to employer and employé.

The Darkening of the Streets.

We referred in our last issue to the discussion at the meeting of the Illuminating Engineering Society on December 15th, in the course of which Mr. L. Gaster mentioned the anomalies found in the present arrangements for street lighting. We think there will be general agreement with his view that the present devices for screening the lights are crude and uneconomical, and that there can be no justification for the great discrepancies in the amount of illumination prevailing in different districts. The trouble arises through two chief defects: Firstly, that the people under whose supervision the changes in street lighting are made have little or no knowledge of the technical side of illumination; and, secondly, that the measures taken are the result of more or less conflicting claims by different authorities, urging respectively precautions against hostile aircraft, the need for economy, and the requirements of safety and traffic. As a result the conditions in any district depend very much on which authority happens to get the upper hand. The darkening of the streets, in short, is one more example of our national habit of deciding important matters without obtaining expert advice. The present conditions are probably largely responsible for the remarkable increase in street accidents since the war began. In addition, their prejudicial effect on traffic during the busy hours constitutes a great economic loss. There is much to be said for Mr. Gaster's suggestion that the time has come when a properly constituted central authority, utilising expert advice, should be appointed to survey the problem as a whole. One of the chief duties of such a body would be the preparation of more specific instructions to secure more economical and efficient methods than at present, and a reasonable uniformity in practice throughout the London district.

Aerial Ferry at Niagara.—It appears that an aerial ferry has now been erected across Niagara. The ferry is driven electrically, travels above the whirlpool at a height of about 150 ft. and carries 36 passengers.

French Electrical Journals.—From the 1st of January our contemporaries "La Lumière Électrique" and "La Revue Électrique" will appear as one paper under the title of "Revue Générale de l'Électricité." It will be the official organ of the Union des Syndicats de l'Électricité, will be published weekly at 12 Place de Laborde, Paris, and will contain about 50 pages. The subscription price for the Postal Union will be 50 fr.

Pocket CO_2 Indicator.—A pocket CO_2 indicator has recently been brought out by the Bachrach Industrial Instrument Co., of Pittsburg. It works on the familiar principle of the CO_2 absorption by KOH. The instrument is designed for rather rough usage, and every part can be easily replaced in the event of breakage. It is reported that 17 to 20 analyses per hour can be made with the instrument. With ordinary care an analysis can be made with a maximum error of 2 per cent. The reagent is a solution of potassium hydroxide in water. Several hundred analyses can be made with one charge of the caustic. The device is compact and portable.

Process for Drawing Lamp Filaments.—A process for cold-drawn metallic filaments has recently been patented by Mr. K. Nishimoto, of Tokyo. Forming at first a consolidated stick of a mixture of tungsten and a small proportion of thorium, an alloy is obtained by uniformly heating the mixture at a sintering temperature and then gradually keeping its temperature at dull red heat. The consolidated stick is then subjected to repeated hammering or rolling until it becomes so ductile that it may be hammered into bars, rolled into sheets or drawn through dies into wires, much like the metals which are commonly treated in this manner at ordinary temperature.

Heating of Organs.—It is well known that if organs are to be maintained in good condition they must be kept free from damp. With this object in view an appliance has been placed on the market for supplying heated air to organs, a gas burner being used to supply the necessary heat. The appliance is described in the October issue of "A Thousand and One Uses for Gas." From the illustration that is given it is obvious that only a small supply of gas is necessary. It appears to us that some of those engaged in the manufacturing of electric heating apparatus might very well devise an electric heater for this purpose. The amount of energy required would not be considerable; the device would afford another outlet for electric energy over long hours, and there would be the further advantage that gas fumes would be eliminated.

The Development of Electric Steel Furnaces.—The "Journal" du Four Electrique et de l'Electrolyse gives some new facts which illustrate the great impetus given to the construction of electric steel furnaces. Since the outbreak of war over a hundred installations are known to have been put in, and the total number in the world now approaches 300, which is about twice the number existing in 1913. The United States is credited with constructing 50 last year and this country with 30 since the war began. Germany is said to have produced 130,000 metric tons of electric steel in 1915 as compared with 90,000 in 1914, and Italy is also making large additions. At a recent meeting of the Sheffield Society of Engineers and Metallurgists, the President remarked that the electeric furnace had come to stay, but they must have, by some means, cheaper electric current.

Mammoth Water Turbines.—The three single-runner Francis turbines installed by the Tallassee Power Company on the Yadkin River in North Carolina, with a guaranteed rating of 31,000 h.p. under an effective head of 180 ft. and 27,000 h.p. under 165 ft. at 154 revs. per min., are said to be the largest units yet built. The initial installation will consist of three vertical shaft single runner turbines of the rating named direct connected to alternating current 13,200-volt 36-cycle generators rated at 18,000 k.v.a. The generators are 28-pole units, and have an overload guarantee of 22,500 kw. at unity power factor, with an efficiency at 18,000 k.v.a. and unity power factor of 96·9 per cent. The turbine runner, which weighs 20,000 lb., is a single piece of solid bronze. A governor is used in which flyball actuated valves control the admission and discharge of oil to two operating cylinders that have piston rods running to the shifting rings. The total weight of the revolving parts and the reaction thrust of the loaded runner are carried on a Kingsbury thrust bearing.

War and Young Engineers. So great are the inroads being made by the war on the young manhood of the country that many of the engineering departments of our universities and colleges now count their students only in tens, where formerly the total on the rolls ran into hundreds. What is our loss in this direction is, as in many others, America's gain. As an example, the Engineering Correspondent of the "Daily Telegraph" quotes the recent admission figures to the College of Engineering of the University of Illinois. In all, no fewer than 1,113 students have taken up the study of one or other of the many branches of engineering, this total being made up as follows: Architecture, 116; architectural engineering, 167; ceramic engineering, 16; civil engineering, 190; electrical engineering, 266; mechanical engineering, 273; mining engineering, 25; municipal and sanitary engineering, 26; railway engineering, 34. The position as far as we are concerned, particularly when viewed from the after-war standpoint, is lamentable. Splendid young brains have been sacrificed in actual combat that might have been put to infinitely better national use.

OBITUARY.

The Hon. T. H. W. Pelham.—We regret to record the death of the Hon. T. H. W. Pelham, C.B., which occurred on Saturday, the 23rd inst. He held various Government appointments and for some time was Assistant Secretary (Harbour Department) of the Board of Trade. While at the Board of Trade he held many local inquiries in regard to Provisional Electric Lighting Orders, &c.

A. J. Ireland.—We regret to record the death of Mr. Arthur James Ireland, electrical engineer, who was for many years associated with the British Thomson-Houston Co., of Rugby. Mr. Ireland was 57 years of age.

PERSONAL.

Change of Government Honours. Among the honours conferred on the recommendation of Mr. Asquith on the occasion of his resignation are the following :—

The dignity of a Viscounty has been conferred upon Lord Cowdray and that of a Baron of the United Kingdom upon the Right Hon. Joseph Pease, M.P. Lord Cowdray is well known as the head of the firm of S. Pearson & Son (Ltd.), engineers and contractors, and Mr. Pease was until recently Postmaster-General.

The honour of Knighthood has been bestowed upon Ald. Evan Spicer. The new knight has a good record of municipal and social service to his credit, and he was chairman of the London County Council in 1906-7.

APPOINTMENTS VACANT.

An advertiser wants lady assistants for an electrical test room.

An experienced foreman armature winder is required for a.-c. and d.-c. winding department of Manchester controlled firm. *See advertisement.*

An assistant electrical engineer, with experience in testing meters and electrical instruments, is wanted by a London firm. *See an advertisement.*

An assistant electrical engineer is required for the Government electric light department, Federated Malay States. Salary £360, rising to £390, with duty allowance of £75 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, London, S.W. *See an advertisement.*

A meter and instrument tester is required by large electric power company in the Midlands. *See an advertisement.*

A shift engineer is wanted for the London district, with experience in the running of large generating stations. *See advertisement.*

An advertiser wants a first-class female coil-winder, with experience of high-class telegraph instruments.

INSTITUTIONS AND SOCIETIES.

Scottish Local Section of the Institution of Electrical Engineers.—At the meeting held on December 12th the following discussion took place on Mr. Peck's Paper on "The Parallel Operation of Electric Power Stations":—

Mr. W. W. Lackie (Glasgow) said that, with separate stations for traction and power, all the generating stations in Glasgow were run in parallel. They had had considerable experience in linking-up from 1898, when they took over Kelvinside station, to 1912, when they took over the stations at Govan and Partick. Where stations were of less than 3,000 kw. capacity it was a commercially practicable proposition to change consumers' lamps and apparatus to a pressure and frequency to suit the larger power station. If the 12 stations in the London area which were under 3,000 kw. capacity were dealt with in this way the number of stations in London would be practically halved, and linking-up for a considerable time would be limited to an exchange of energy at times of light load.

Mr. F. H. Whysall (Greenock) said he had only had one experience of linking-up in Greenock, and that was on a small scale with a hydro-electric scheme. He favoured the synchronous motor-generator, and thought they should be prepared to tackle its disadvantages. He thought that the technical considerations in connection with linking-up were easily surmountable, and such hindrance as really existed was commercial in its nature.

Mr. A. Page (Glasgow) said linking-up in Glasgow had not only effected considerable economies, but it had added to the security of the supply as regards continuity. It was well to make certain that the capacity of the inter-connecting cables was not only adequate to deal with the load to be transferred from one station to the others, but that there should be a margin of copper to deal with the fluctuation which in the case of, say, a tramway or railway load would be shared by the prime movers in the second station ordinarily dealing with a power and lighting load. Load should not be evenly distributed over the available plant, but should be put to the maximum extent on the most economical plant. He asked Mr. Peck to state his preference as between the induction type of regulator and the step-by-step type. The frequency-changers mentioned by the author must in some cases be huge machines.

Mr. E. Seddon (Edinburgh) said that for economical working synchronous motor-generators were the best form of coupling to adopt. To connect a single-phase station with a three-phase supply, the Scott connected three-phase to two-phase transformers was the best method to use.

Mr. Peck, in reply, said that linking-up between small stations of about 3,000 kw. could best be done by changing such stations to the standard frequency of the district. Small outlying stations should be turned into sub-stations for distributing purposes. Step-by-step regulators were more efficient than the induction type of regulator, which took a considerable current. The latter, however, gave uniform variation in voltage, and had the advantage of being motor-driven, and could be made automatic where necessary. The frequency converter would be cheaper than the phase converter of the motor-generator type with three-phase motor and two-phase generator.

Diesel Engine Users' Association.—At the December meeting of the Diesel Engine Users' Association Mr. Geoffrey Porter, A.M.Inst.C.E., was re-elected president for a second year. Messrs. R. W. Lyle and W. Fennell were elected members of the General Committee. Mr. Percy Still was re-elected as honorary secretary.

The hon. secretary made a general statement of the position of the association and of the work carried out during the year 1916. The total membership of the association to date is 79, being an increase of 31 Diesel engine users during the year. The total horse-power represented by the association has doubled during the year, being now 46,108 b.h.p., as against 23,984 b.h.p. at the end of the previous year.

A considerable amount of attention has been given during the year to the subject of the use of tar oils as fuel in Diesel engines. In view of the high price of imported fuel oil, and of possible shortage in the future consequent on the conditions brought about by the war, much stress has been laid on the importance of encouraging in every possible way the use of a home product as fuel. A considerable amount of useful experience has been obtained in the use of this class of fuel, and further trials are being made with various methods of using tar oil.

The important subject of lubrication was again brought before the association in a Paper read by Mr. George B. Vickers. The recent discussion on "Piston and Small End Lubrication in Diesel Engines" brought out further points of interest, and it has been arranged that Mr. Elliott A. Evans will at the meeting in January read a Paper on "Chemistry and Examination of Lubricating Oils."

ARRANGEMENTS FOR THE WEEK.

ROYAL INSTITUTION.

Meetings at Albemarle-street, Piccadilly, London, W. Six illustrated lectures adapted to a juvenile auditory, on "The Human Machine which all Must Work," by Prof. Arthur Keith, M.D., F.R.C.S., LL.D., F.R.S.

Saturday, Dec. 30th.
3 p.m. Lecture II., "Living Levers."
Tuesday, Jan. 2nd.
3 p.m. Lecture III., "Living Pumps."
Thursday, Jan 4th.
3 p.m. Lecture IV., "Living Bellows."
Saturday, Jan. 6th.
3 p.m. Lecture V., "Living Workshops."
Tuesday, Jan. 9th.
3 p.m. Lecture VI., "Living Wires and Central Exchanges."

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week:—

Officer for the Week.—Platoon Commander J. O. Cheadle.

Next for Duty.—Platoon Commander A. Gerard.

Monday, January 1st.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.25 to 8. Lecture on Telephones, 7.30.

Tuesday, January 2nd.—School of Arms, 6 to 7. Lecture, 7.15, "Street Fighting," Company Commander Hynam.

Wednesday, January 3rd.—Instructional Class, 6.15. Platoon Drill, Platoon No. 1.

Thursday, January 4th.—Platoon Drill, Platoon No. 7. Ambulance Class by M.O., 6.30.

Friday, January 5th.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill, 6.25 to 8.25. Lecture on Telephones, 7.30.

Saturday, January 6th.—Commanding Officer's Parade, 2.45, uniform, for Drill in Battersea Park.

Sunday, January 7th.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office) 8.15 a.m. Uniform, haversacks, water bottles. Midday ration to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

COLONIAL TELEGRAPHS AND TELEPHONES.*

BY R. W. WEIGHTMAN.

(*Concluded from page* 381.)

Summary.—After referring to British Post Office practice, the author deals with the appointment of engineers, with working staffs and sources of supply. He then considers telegraph and telephone administration in the Crown colonies, and amalgamation of railway telegraphs with postal telegraphs. The next section of the Paper is devoted to overhead construction. The telegraph and telephone systems of the Crown colonies, South Africa, Canada, Australia and New Zealand are described at some length, and in conclusion the important question of lightning protection is considered.

Canada.—The Bell Company have central-battery manual systems in their larger exchanges, and in exchanges below 500 or 600 lines they use magneto boards. They have no automatic exchanges.

The practice of the Manitoba Government Department is on similar lines. Their magneto boards are fitted with plug-restoring line signals of the eyeball type.

In Alberta and Saskatchewan the Government exchange at Calgary, Medicine Hat, Lethbridge, Regina and Saskatoon are equipped with the Strowger automatic system, as is also the municipal exchange at Edmonton. This latter exchange was started in 1907 with a 500-line installation, but is now for 10,800 lines, of which 9,300 are connected. It is spread over four exchanges and an area of roughly 20 sq. miles. All other exchanges in these two provinces are magneto except two central-battery manual exchanges at Saskatchewan.

Dry cells are used on all subscribers' magneto instruments throughout Canada.

The block and alley system of distribution is generally followed. The company are working towards an all-cable distribution in their exchange areas. On many small exchanges the main distribution is carried out entirely with aerial dry-core cable.

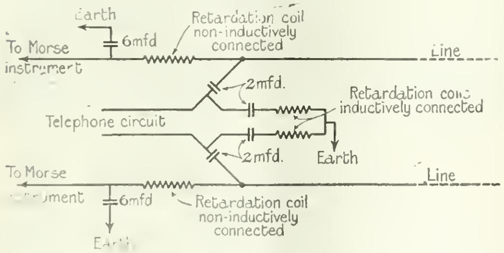
Earth
6mfd
Retardation coil non-inductively connected
To Morse instrument
Line
2mfd.
Retardation coil inductively connected
Telephone circuit
2mfd.
Earth
To Morse instrument
Line
6mfd
Retardation coil non-inductively connected
Earth

FIG. 5.—"COMPOSITE" SYSTEM OF SUPERIMPOSING TWO TELEGRAPH CIRCUITS ON TELEPHONE PAIR.

The methods of protection at subscribers' stations vary somewhat, but generally they conform to American practice. Circuits are divided into three classes, viz., unexposed, partially exposed and exposed. Unexposed stations are those that are not exposed to lightning or to contact with lighting or power circuits. A station is not considered exposed to lightning if it is served by aerial wires on poles for a distance of less than half a mile. At such stations no dischargers or fuses are provided. Partially-exposed stations are those that are subject to lightning, but not to contact with lighting or power wires. Carbon dischargers are fitted at these stations. Exposed stations cover all others, and carbon dischargers and fuses are fitted at these stations.

Superimposed telegraph circuits, which are usually leased to the telegraph companies, are arranged on both "simplex" and "composite" systems. The "simplex" is the well-known system which permits one Morse circuit superimposed on one telephone pair by means of repeating coils. The "composite" gives two Morse earthed circuits, which can be worked either single or duplex, and one metallic telephone circuit on one pair of wires. The theoretical connections of a terminal composite set are given in Fig. 5. For telephone signalling over circuits fitted with "composite" sets a [illegible] provided. The [illegible] ringing set is somewhat [illegible] to the simplex system. The telephone transmission loss due to the introduction of a repeating coil at each end of a telephone circuit on the "simplex" system is equal to about one mile of standard cable, while the loss on a circuit equipped with a "composite" set at each end is equal to about [illegible] mile of cable.

The minimum speech efficiency on the long-distance circuits ranges from 30 to 36 miles of standard cable. The general dryness of the climate contributes to a high standard being attained.

Long-distance lines are equipped with lightning dischargers on the poles at suitable intervals, and where these wires are taken into an office or testing station it is a common practice to place the dischargers one or more poles away on each side of the office. The "Chapman" discharger shown in Fig. 6 is a type much used for this purpose.

On main distribution frames carbon dischargers and heat coils are used by the Bell Company, but carbons and fuses are more generally provided by other administrations.

There is no through communication yet between the Eastern and Western shores of Canada. There is a break of 600 miles between Fort William and Kenora in which there is no telephone line at all, and the Rocky Mountains form another break between Alberta and British Columbia. The longest lines regularly in use in Canadian territory are those between Montreal and Windsor and Montreal and North Bay, distances of about 600 miles. Loading coils are in use on both open-wire and underground sections of the long-distance circuits. Communication is given with a large number of places in the United States through the trunk lines of that country, the longest distances being Montreal to San Francisco, 3,800 miles, and Toronto to San Francisco, 3,200 miles. (Communication has since been arranged between Montreal and Vancouver, via the American trans-continental line, a distance of about 4,000 miles.)

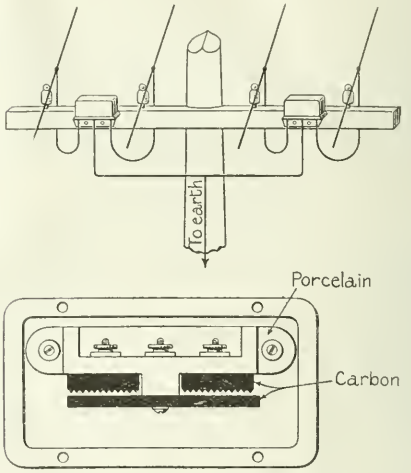

FIG. 6.—CHAPMAN LIGHTNING ARRESTER (CANADA).

The telephone development of Canada is higher than that in any of the other Dominions or Colonies. For the whole of the country the average number of telephones per 100 of the population is 6·5. In British Columbia the average is as high as 11, while in Manitoba and Alberta the figures are 10 and 8 respectively.

Australia.—Probably no country in the world has taken up automatic telephony so whole-heartedly as the Commonwealth. In 1912 the Chief Electrical Engineer personally investigated the systems then in use in America and Europe. His report, dated October 10, 1912,* deals in a very thorough manner with the comparison which may be made between manual and automatic systems. Since then important headway has been made, full automatic equipment has been installed in 10 exchanges, the largest of which is Perth with over 3,000 subscribers. Six other exchanges are in course of construction or approved, tenders have been invited for a further 18, and 14 others are under consideration. The exchanges so far opened are all equipped with the Strowger system, but both the Siemens and the Western Electric Company's systems are to be tried.

Both central battery and magneto exchanges are in use. Distribution from all the larger exchanges is effected by means of underground cables. On very small exchanges open-wire distribution is adopted. A good deal of aerial cable of both the dry-core and rubber types is installed, but its use is rigidly prescribed, as its erection is not economical in the Commonwealth where the estimated five years capacity is 50 pairs or over. On exchange distribution it is the practice to serve subscribers' premises by underground cable wherever this is warranted. Where cables are led to open wires for distribution they are connected through a pole distribution-box several types of which are in use. The practice laid down for the provision of protective apparatus is well thought out. At junction points between exposed and unexposed cables and wires, fuses and arresters are generally installed. Outside protection against lightning is not usually adopted, apart from exchange distribution lines, unless in the opinion of the local engineer such is warranted.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

* Postmaster-General's Annual Report, 1912-13.

There is a fairly extensive trunk system within the individual States, but the only capital cities as yet connected are Melbourne-Sydney (595 miles) and Melbourne-Adelaide (487½ miles). On both of these circuits Morse duplex is superimposed and worked regularly. Proposals have been put forward for a Sydney-Brisbane trunk circuit. On certain of the main lines the trunks are twisted, but on other main lines and on country lines the transposition system is in use, and this system is likely to be continued. Loading coils have not yet been introduced into the Commonwealth. The percentage of telephones to the population at the end of last year was 2·721.

New Zealand.—New Zealand was very early in the field, and many of the exchanges installed between 20 and 30 years ago are still in operation. Many of the larger exchanges have become quite inadequate for present requirements, and the question of substituting more efficient systems has been before the authorities for some years past. The introduction of the central-battery manual system was contemplated, and three Western Electric central-battery exchanges were installed, but the administration hesitated to introduce this system generally in view of the development of automatic systems. In 1911 the Chief Electrician of the department recommended the adoption of automatic exchanges for several of the principal towns, and the Western Electric Company's full-automatic system was decided upon. Contracts were entered into with this Company for exchanges for the Wellington and Auckland telephone areas, and for separate single exchange installations for Masterton, Hamilton, Oamaru and Blenheim. Masterton and Hamilton are being equipped for 800 lines, and Oamaru and Blenheim for 600 lines. The ultimate capacity of each of these exchanges is the same—viz., 1,800 subscribers' lines, and 200 junction lines for special services.

At Wellington the system will have three main exchanges with immediate equipment respectively for 4,000, 2,500 and 600 lines (ultimate capacities 8,000, 4,000 and 2,000 respectively). In addition three sub, or "satellite" exchanges off the largest main exchange with capacities from 200 to 600 lines are contemplated, the ultimate capacity of the whole system being 20,000 lines, and accessory junction lines. At Auckland the arrangements will be on similar lines with four main exchanges, and two "satellite" exchanges, the total ultimate capacity being the same as at Wellington. Each system will have a common manual toll board situated at the principal exchange in each case. Subscribers' meters are not being installed at present, but provision is being made so that they can be put in either in part or whole at any time, and the meters when installed will register effective local calls only. A time alarm-signal is provided to indicate an earthed line, and also to show when a subscriber's line is being wrongfully held up. All exchanges are arranged for main line service, private branch exchange service and for party line service. There is every confidence that the system will adequately meet the very varied telephonic conditions of the country, and it is not too much to say that before many years have passed all the important exchanges throughout the dominion will be "automatic."

There is a considerable network of trunk telephone circuits. Nearly all outlying exchanges are connected with their larger centres, and some of the latter are interconnected. The longest speaking circuit is that between Wellington and Auckland, a distance of about 420 miles. This is obtained from two 400 lb. copper wires which are used for quadruplex telegraph purposes during the daytime. At night-time—after 6 p.m.—they are used as a telephone trunk circuit. In many cases telegraph circuits are superimposed on the telephone wires, and phantom telephone circuits are also obtained. The standard of speech on trunk lines is the equivalent of 30 miles of standard cable, and the introduction of loading coils is under consideration. The number of telephones per 100 inhabitants is 4·6.

LIGHTNING DISCHARGERS AND PROTECTORS.

The methods of protecting lines and apparatus from lightning and power currents as described in the preceding section are so varied that the author thinks the subject, which is a very important one, is worthy of special consideration.

No form of lightning discharger known to the author will save wires if they are actually struck by lightning; they may be merely severed by the discharge, or short lengths of wire may actually disappear, deflagrated by the current, and such cases are not of rare occurrence on open country lines. The discharges the engineer has to protect himself against are those due to induction. In addition to protection against lightning, safeguards against both heavy and light currents are also necessary in localities where lighting and power systems are in operation.

In Natal the author carried out a long series of experiments with the object of proving what types of protectors were best suited to the different working conditions there, and in the original Paper he describes the practice which he considers to be the best.

DISCUSSION.

Col. A. M. Ogilvie said this Paper was a good supplement to Mr. Llewellyn Preece's Paper, read before the Institution some time ago, as it covered the general standard practice of such a large number of colonies. Colonial engineers had difficulty in keeping abreast with standard practice, and also in getting supplies of apparatus and equipment. This was a weak point in our national organisation, which ought to be remedied after the war. Before the war the Post Office was entering upon a large scheme for increasing the research equipment and the standardisation of all equipment, and after the war he thought they should include in it work for the assistance of colonial services.

Mr. Llewellyn Preece said he thought the most important section of the Paper was that dealing with administration. In most parts of the world the telegraphs were taken over by the Post Office, and there was a chief administrator who was not a telegraph engineer, and if there was a telegraph engineer under him who was in no sense an administrator there would be a certain amount of chaos. Therefore, engineers should study administration. As the engineer got higher in his profession he became more and more of a manager rather than an engineer, and a pure engineer was of little use in the higher positions. A Paper by Mr. Orchiston, chief telegraph engineer in New Zealand, was read recently before the local institute there. It stated that in the early days there they charred the butts of the poles, but on one line in out-of-the-way spots the contractor forgot to char the butts. Ten years later some of the poles were falling down, but the only ones in really good condition were those which had not been charred. In consequence, the contractors were erecting poles unseasoned and untreated in any way. Mr. Orchiston said some of the poles were carrying telegraph wires a few weeks after they were growing trees. Those poles were erected in 1870. In 1908 it was decided to remove about 35 miles of the line on which those poles were used, and the bulk of the poles were in good condition—after 38 years—and some 85 per cent. of them were re-erected. He supposed none of our best creosoted poles in this country had been standing 38 years.

Mr. F. L. McBerty spoke on automatic exchange development. The growth of the telephone in the western part of Canada and in Australia and New Zealand had been rapid and free. The author spoke of the visit of Mr. Hesketh and Mr. Buckley to America to investigate automatic telephone exchange development. They made a thorough study of the best in telephone work, came to prompt decisions and well applied what they had discovered. The case of New Zealand was particularly striking, both as regarded the development of the telephone and the application of the most modern ideas in machine switching. From 1884 to 1894 the telephones multiplied sixfold, in the next two decades each threefold, for the six years ending 1914 the average rate of increase was 12 per cent., for 1914 15·3 per cent., and for the year ending the beginning of 1916 8·7 per cent. That rapid growth had given them the opportunity for quite modern development. It had brought the telephonic "saturation" for the Dominion of New Zealand to an average of 5 per cent., and in Wellington to 9·5 per cent., Auckland 6·5 per cent., Christchurch 6·3 per cent. and Dunedin 6·9 per cent. This compared very favourably with dense large areas in the United States. The decision to apply automatic working in New Zealand was reached by Mr. Buckley in 1912, and shortly after that contracts were placed for automatic exchange equipment for 30,000 lines = 55 per cent. of the lines connected in New Zealand. That covered all the large cities, and all but three of the cities which had 1,000 lines or more. There was in Wellington equipment for 1,000 lines on the Strowger system, and also 1,000 in Auckland, both working very well; about 20,000 lines were under construction on the Western Electric system in New Zealand. When the programme has been carried out, which would be in a short time, New Zealand would have the largest developed area of automatic switching in the world, and if the growth of the telephone area continued at the same rate it would keep its place in that respect for some time. Mr. Hesketh contributed an article to the June number of the "Annales" of the French Telegraph and Telephone administration, which gave the first published accurate information as to the cost of operating considerable automatic systems. He found it economical, being for a 4,000 line exchange 33·5 fr. per line per year, and for a larger exchange somewhat more saving could be effected. He said such working was able to save probably 25 per cent. of the operating charges in the exchange. He (Mr. McBerty) thought the economies offered by machine switching were not the main reason for adopting it. He gathered from conversations with Mr. Hesketh and Mr. Buckley that the main purpose was the improved quality of the service with automatic switching.

Sir William Slingo said it was pleasant to learn that the colonial engineers found the Post Office practice good to follow, although, of course, there must be variations under varying circumstances. Mr. Weightman had shown on the screen some poles which had a 4 in. spacing on the arms. Had they any winds, snow or leaves falling in those localities, and were there any joints in the wire between the poles? If any of those things happened on a British line they would get frequent interruptions. In one of the views he thought the stay wires were right across the railway. That would not be permitted here. With regard to Mr. Preece's reference to the age of poles, he could point to some in this country that had stood 40 years. The average was considerably less, but most poles were removed before their utility had ceased, because alterations were necessary. With regard to "geographical *v.* functional organisation," that was another way of saying "specialisation *v.* generalisation." Where the industry was big and involved many interests, one must specialise. The trouble of having to wait so long for stores could be overcome by having a reserve stock. He held a stock of £2,000,000 worth, although they had manufacturers at the street door. Sufficient stock for one year's consumption was kept. If poles were provided jointly by the railway and the telegraph administrations—as he thought they were in Australia—how was equity preserved when one of the two parties put up, say, half a dozen extra wires? They had not many iron poles used in England, as there were no white ants, elephants or bush fires to provide against. The factor of safety of 46 quoted by Mr. Weightman was no doubt good where the atmosphere conditions permitted, but with an 8 lb. wind pressure, and a ½ in. iced rope we had five times the load to be borne as compared with 17 lb. wind pressure pure and simple. A tubular reinforced concrete pole must be much lighter than a solid one, and he was rather of the opinion that a rectangular solid pole of the same cross-section as a tubular hollow one would not have any additional strength—certainly not additional strength commensurate with the additional weight.

Mr. E. O. **Walker** asked whether aluminium wire was used to any extent, and whether on the long distances mentioned in the Paper any particular spacing was effected between the wires to prevent interference by induction. He found that where there were heavy storms heavy iron wires were best. Copper and bronze would easily break during the monsoons. He had found iron wires still working after the poles had been blown down.

Mr. A. **Moir** said before discussing any method of jointing some agreement should be arrived at as to the meaning of the terms employed. In the air space joint the paper was carried right through and the joint was left quite free; in the boiled out joint liquid paraffin at a high temperature was poured upon the cables when they were first cut open at the jointing, and poured on again during the process of jointing. That was not a solid joint. In American practice a space was left in the sleeve of the joint, so that if necessary air could be passed through the boiled-out joint; the solid joint was filled with insulating compound. Mr. Weightman had described a solid joint, and at another point a boiled-out joint. Mr. Preece in his Paper described a boiled-out joint as a solid joint, and the discussion was thrown somewhat off the line. The solid joint was usually introduced at the end of an air-space cable, at the point where it entered an exchange, before the wires were spread out on to the jumper wires. He had no brief for either the boiled-out or the air-space joint, though the latter had a good many virtues and the former certain defects that were sometimes not fully recognised. Applying liquid paraffin at a temperature of 350 deg. or 400 deg. was, perhaps, a simple operation on a country road or in a subway, but in the crowded streets of a large town the risk to the public would be great, and there was also danger to the men standing in the manhole. On p. 24 of the Paper Mr. Weightman said: "Where the development can be fairly accurately estimated it is better to run the circuits through in a permanent manner to their respective terminations." He was with him, because the cable boxes were a source of risk. In Paris in 1913 he found they never allowed the paper to enter the test boxes. A solid joint was interposed in the air-space cables before the boxes were reached. The cables were partly in the sewers and partly in ducts along the highways, but overground chambers were interposed where the cables were led in for testing, and the cables were contained in air tight premises. That was carrying precaution to excess. In London that work was done fairly successfully. There were occasions where demands for private lines in an exchange area were so numerous that special connection arrangements had to be made. A sort of Clapham Junction was made to connect the various Government Offices at Whitehall. They found in Post Office work that the portable petrol driven [illegible] very efficient.

Mr. F. W. [illegible] said the author discussed the desirability of the electric lighting being in the hands of the telegraph and telephone engineers. He spoke of the complexities of the lighting systems. He (Mr. [illegible]) put the boot on the opposite leg. How anybody who was familiar with such intricate apparatus as an automatic telephone exchange could complain of the complexities of an ordinary lighting job he could not understand. The colonial telephone engineers should be congratulated on the excellent results they had obtained out of apparatus which must have been [illegible] their experience when they installed it. Looking after a common battery telephone exchange was not on all fours with looking after the batteries of an electric lighting plant, primarily because the boxes were large enough to contain more plates than were at first installed, and [illegible] to dispense with the large volume of acid that would otherwise be present with [illegible] plates in a box capable of holding 2½, [illegible] were put in, but the same range of gravity was not obtained between charge and discharge as there was in an ordinary battery; there was a practice of overcharging considerably to keep the gravity up, and colonial telephone engineers were to be congratulated on having in such [illegible] got the life of their storage batteries up to the average of batteries in this country. Mr. Weightman mentioned the use of [illegible] for telegraph work. He might have put the case more strongly [illegible] much better result should be got with secondary plant than with primary. Mr. Weightman said in some instances the charging was done from the mains and in some taken from motor generators. Charging from the mains was simpler and did away with the extra link. It was better than the motor generator for small sizes, but with 150 or 200 ampere-hours motor generators were used.

Mr. C. C. F. **Monckton** said he had only been one or two weeks in England from Fiji. Mr. Weightman's Paper should lead to considerable standardisation, but variations would be required in every Crown Colony depending upon labour conditions, and atmospheric conditions especially. In Fiji they were troubled with high cost of living and expensive labour conditions. They paid Fijians 2s. a day and for other trivial work they paid Indians who had been five years in the Colony also 2s. a day, and untrained Europeans, boys 9s., and men 12s. to 13s. a day. They were able to get a competent linesman very often from England at £200, rising to £250 a year. To get supplies in Fiji he had to look about two years ahead, and the votes for the expenditure might lapse unless he asked that the amounts might be revoted. The superintendent of telegraphs was responsible for the engineering work and was also responsible for sending out the telegraph, telephone and wireless accounts, collecting telephone rentals, &c. Expensive labour and hurricanes had to be reckoned with, but the really governing factor, he thought, was the poor house construction. They used in the towns iron bark poles from Australia, but in some places they had narrow streets with balconies jutting over them, and there they used iron brackets fixed to the houses. When a hurricane occurred a good many galvanised iron roofs flew off the houses—sometimes they flew about 100 yards and they would go through 60 wires practically like a knife through cheese or butter. During a hurricane just after he arrived in Fiji the roof was blown off a wireless operator's quarters and it came down on the stay tighteners and severed them. Since that he had reduced the number of overhead wires as much as possible, and he was putting down 13-pair armoured cables. The iron bark poles were very heavy, and in the country where transport was more difficult they used tubular poles. Where spans were long he followed the wireless practice. Over a river span of 440 yds. he used 7/19 silicon brass wire, which was very satisfactory. He noticed that the creepers did not grow on their iron bark poles, which were used square, and without stay wires. They had a creeper called "mile a-minute," and if they put a stay wire on to a pole they had to send a man frequently to clear the creepers away; but with iron bark poles without stay wires the creeper only grew up 2 ft. or 3 ft. and then crawled back on itself. For the first four of the five years he had been at Fiji there was practically no lightning, but last season it was troublesome, and he was trying the Siemens vacuum arresters along the line. The lightning struck the galvanised iron roof, in one case which he investigated, and went through the woodwork of the house and out through the telephone wires.

Mr. D. H. **Kennedy** said 30 years ago he was a humble beginner in the same northern telegraph office where Mr. Weightman was an admitted expert, and he had then and ever since regarded him as the ideal telegraphist. He (Mr. Kennedy) had concentrated on the one point selected also by his esteemed chief—the matter of jointing cables. Dealing with the boiled out joint, the author said "The splice on a dry-core cable is undoubtedly its weakest point, but this form of joint when carefully made is so reliable that breakdowns are of very rare occurrence. It is in almost general use in the United States," and in dealing with Australia he said "the Post Office method of jointing and drying out dry-core cables is followed." There was no comment. Speaking paradoxically, the matter of boiling out joints was becoming a burning question, and London engineers had some doubt as to whether the method followed was the best one in the circumstances. It offered the facility that when trouble occurred the dry compressed air could be turned on and the trouble removed quickly, but the cost in a large city would be very considerable. In a recent issue of Preece's "Telegraphy" it was stated that this method was practically confined to the British Isles, and that the American system was on the other lines. Would Mr. Weightman favour them with notes on the respective merits of the two systems?

Mr. W. **Aitken** said in the part of the Paper dealing with outside construction one was rather surprised to see some relics, such as Bright's shackles, the insulator which was given prominence as an illustration of the use made of leading-in insulators. He thought there was an error as regarded the barrel insulator. It should be credited to Canada. He believed he was the first to point out the necessity for the use of leading-in insulators in June, 1896, and, with the introduction of permanent batteries on line wires, his design of 1897 was adopted by the National Telephone Co. and some hundreds of thousands were used by them. The new method adopted by the Post Office of Purves and Sinnott was an excellent design, embodying the spirit of his original invention. The fundamental function of the leading in insulator was to prevent leakage of the current to earth, and he would like to ask Mr. Weightman what was the result when the two wires were brought to two knobs on the same insulator. It seemed that to a small extent there was leakage from wire to wire. He rather differed from the author in regard to the use of the "ring off" system in Suva. He did not think it was correct practice to give a subscriber anything to do after he had attained his desire. He thought the correct form was the system he designed in 1898 which was adopted by the National Telephone Co. to replace call wire systems. He held that an inferior form was adopted. A ring through system, ringing off by replacing the receiver would be better. That met the objection that a subscriber would never learn to ring with the receiver in his hand. The author did not deal with train despatching, which was a most important feature of telephone operating in Canada and the

United States. At one point—either a terminal or intermediate point a despatcher controlled the whole of the traffic on his section of the line, which comprised from 20 to 50 stations on a species of party line. Every station had immediate telephonic access to the despatcher, and the despatcher could call any station, whether the receiver was off the switch or not. The Gill system was used in Montreal, and the Western Electric Co. had interesting systems on the market. One of the British railway companies was using a modification of that system on their railway, though not for train-despatching.

Mr. F. Gill said the author, in referring to American organisation, remarked that the organisation was divided into three sections, traffic, plant and commercial, but it was not correct to assume that the American organisation merely changed the names of the chief engineer into plant engineer. The organisation was split into three parts, but the chief engineer was put above, and he, in most organisations, dealt with the recommendations that came from the plant and traffic men. Could Mr. Weightman give any analysis of the trouble in regard to insulation in the Port of Spain. It was really a question of analysis. He had been dealing with that matter in a pretty warm country. He had repeated tests made. The humidity at 8 a.m. ranged from 85 to 95 per cent. and the average humidity of the tests was 90 per cent. The rainfall on some days was 4 in. and on other days 1 in. The percentage of lines which were not then fit for central battery work were from 1 to 8 per cent. He did not think there was going to be the least difficulty in that place in putting in the central battery. His opinion was that there was no comparison between the dry joint and the boiled-out joint. The latter was "streets" ahead of the former. If you had dry-air plant you could repair some faults, but if a fault was a bad one the cable had to be taken out. Analysis showed that the small faults occurred in the joints. The boiled-out joint would stand more bad usage than the dry joint, and the dry-air plant could be dispensed with. The boiled-out systen was more economical. Mr. Weightman said for distribution from the underground cable to the subscriber he liked 70 lb. copper wire, and he recommended it on account of low resistance, but it was not a question of keeping the line at as low a resistance as possible; the chief thing was good transmission. The voltage had to be kept within certain limits on an ordinary lighting job. The system should be designed to keep the subscribers' lines within 200 to 300 ohms: a large number of subscribers were within half a mile of the exchange and if 10 lb. cable were put in there was a resistance of 100 ohms. If 6½ lb. cable were used there were 42 ohms to spare, and with 5 lb. cable 12 ohms, and it was desirable to use these ohms and let them do the work at the main distribution cable. Mechanical strength was obtained by using iron and it could be done within the limit of resistance, utilising the spare resistance which was there; it would do it cheaper and the transmission loss was not such that you could not face it. The price paid for 70 lb. copper, when 60 lb. iron could be used for the particular case, would be more than would be paid if one desired to effect that transmission saving by applying the remedy in some other part of the system. The figures he had been talking about were pre-war prices. At present one did not like anything to go out that would prevent a man using the cheapest metal in the proper place.

Major Booth said he was rather surprised to see the barrel insulator recommended. It had dropped out of their service for ordinary line work, although just now they were demanding a great number, and manufacturers were hard put to it to supply them. He was chiefly interested in the question of high-speed apparatus. On p. 22, in reference to the Australian trunk lines, the author said "The maintenance costs of the apparatus are, however, found to be high, and the liability to error is considerable unless constant and expert attention is given." He would like to hear if anybody else had similar experience, as the system referred to was competing now with the duplex-multiplex systems referred to on another page—the Western and Murray multiplex and the Baudot. The Western Electric system had not been long enough with them to get figures out on maintenance matters, but there were a large number of cases in which it was used in America. It was interesting to see that the Baudot system in Ceylon was working on a circuit of 800 miles in length, but he did not agree that it differed essentially from the Post Office practice. The motor drive was a small matter, and the Post Office had that in some cases. The essential difference was that the system working from Ceylon had been duplexed. When the Baudot went to India it was worked as a duplex system, and would give connection by two or more channels without any difficulty, but it was not tri-duplex as it was in Russia. It had worked all right in this country, and the remark in the Paper about Ceylon showed that there also it could do good work. Turning to the Wheatstone. In Australia Mr. Hesketh raised the question some years ago of improving the service from Perth to Melbourne. It would have been a big expense to apply the duplex-multiplex, but, having the Wheatstone, he found he could adopt the Creed with small expense, and he did so and wrote to him (Major Booth) to say he got very good results. According to that Paper, Murray, Western Electric and Baudot could be used. That 1,800-mile line from Perth to Adelaide would be a thorough test of the duplex-multiplex system

Mr. H. W. Pendry said he strongly commended the idea of Colonial engineers paying official visits to other places to enable them to keep to a good standard of efficiency. Nothing that was virile was stationary. The expense of a visit to Europe or America, or both, would be more than recovered by the economies the officer would be able to effect and the increased efficiency of the system. It was his good fortune to be responsible for the installation of the Baudot system which did so well. It doubled the output which it was put forward in the requisition to get. It was an 800-mile line with a repeater and measurer, and at 400 miles they used a two-way mono which gave practically the effect of a duplex, without the trouble of a balance. He cut the repeater out straight away and got excellent results. The insulation of the line was so bad that if you sent out 40 milliamperes you often only got 10. After a time he followed along Major Booth's experience. They worked duplex on that line. The mono would often work duplex, where lines side by side would not. It was apparently accounted for by the fact that the alphabet compared so favourably with Morse. The mono only took the peak of the current, which prevented overlapping. With quadruple working they got a speed of 120 words. That could not be got on the Wheatstone. It would drop to 70 or 80. Native operators picked up the mono alphabet and sent messages after two or three hours, and in a month he had had operators turning out 50 messages per hour, though the average was three months. As to whether the Western, Murray or Mono should be selected, there was one thing to remember about the mono—how solidly it was built, which was an advantage for systems far from the sources of supplies. He had mono ribbons working which had been in use seven years and he thought they only cost about 2s. apiece.

Mr. G. F. Mansbridge said the trouble in getting supplies from manufacturers was sometimes due to lack of up-to-date knowledge on the part of the indentor, and sometimes to limited knowledge on the part of the man who supplied the stuff. He knew of a case where the nearest thing to a pole-changer which a particular store could supply was a "pole twister." The Post Office stores "vocabulary," which showed all the items which the Post Office telegraph and telephone services used, would help to overcome this difficulty. Delay was not always due to dilatoriness on the part of the manufacturer. It was often due to the administration wanting things differing slightly from a Post Office item. The author said the difficulty of the variation of speed of the motors when working with a Creed receiver was got over by the adoption of a larger motor. He did not think that the best way. The Wheatstone transmitter and receiver was a clockwork mechanism designed to run by weight and normally it would take 1½ watts; the rate of fall of the weight was equivalent to about 1⅓ watts, and to put on a motor giving a much higher torque and developing perhaps 10 times the power meant a great strain on the clockwork mechanism. The driving power should be kept down to the limit in the way of torque and power. The small motor should be re-designed so that it did not heat up so much.

Mr. J. E. Kingsbury said one had to remember what engineering works were being constructed for. One administration superintended the construction of materials and poles that it put over its own line, and another was an administration that would not connect any lines to its system until those lines had been properly constructed and they knew it. On the one hand they had an administration that recognised what the line was for—to be talked over—and on the other an administration which apparently regarded it as an ornament to the landscape. There was a tendency on the part of engineers to regard their own conditions as being so special as to require something quite different from anybody else. In one respect a Crown Colony did not differ from a city. The more people the telephone served the more good it did. No locality required to be treated so specially as to require a new system devised for it, or to use a system which was not the best in the rest of the world. Mr. Weightman, referring to a particular system, said it might be used in a particular case "because the commercial system is not very strenuous," but the telephone was an educative institution and it was strange how commercial a system became under the influence of a telephone system. Tropical engineers should devote themselves to the question of what modifications were required to meet their climatic conditions, rather than take the line of least resistance and say "My climatic conditions are such that I cannot use that which is the best anywhere else."

Mr. E. T. Williams said, after many years' experience in the Colonies he had come to the conclusion that one was not safe with overhead lines even if a maximum wind speed of 100 to 120 miles an hour was provided for. There was sometimes a tremendous force at 100 miles an hour in one direction and then it suddenly veered round in the opposite direction. He had seen whole lengths of line brought down in that way. He had tried to get a telephone company to put in the central battery in a colony where they got humidity of 100 per cent.; they would not do it, but he was glad to learn that we were coming to a time when they might install the central battery. Where the wires were lead-covered many of the troubles had ceased. Two wires could be joined by a lead strip. Where there was great humidity steel parts should not merely be galvanised but special precautions should be taken. The question of the use of copper wire was not merely an engineering problem. It was found in China that the Chinese would steal the copper wire. In a system he had to deal with in the North of China they got a great deal of fog which was worse than snow as regards humidity. They had also had trouble with ships which dragged their anchors and damaged the submarine cables to islands, but a limit had now been fixed within which no ship was allowed to anchor.

Lieut. McArthur said the functional organisation adopted in South Africa in 1912 was very successful, but much of the work undertaken had not been actively pursued owing to the war, particularly the lightning protection, and they were still somewhat in doubt as to the protector to adopt. Post Office engineers and also the technical staff of the Eastern Telegraph Co. were giving attention to the matter. They found the carbon vacuum protector had been the best for an inside protector, but he agreed with Mr. Weightman that outside protection was essential, and with their long-distance lines, that had given a good deal of trouble in experiments. In German West Africa the Germans had adopted a carbon vacuum protector with double plate discharge and suitable earthing device for cutting out the lines during heavy storms. Sir William Slingo asked about the stay wires in one of the slides shown. It was an optical illusion—the stays did not cross the railway. The automatic-clear system which was adopted in South Africa had been practically discarded. Up to 100 miles they had the magneto system and after that they were going in for the central battery. At present they had Ericsson 100-line lamp boards, which were very satisfactory.

A vote of thanks was accorded Mr. Weightman, who, after thanking the members for their kind reception of his Paper, said that, in consequence of the lateness of the hour, he would answer all questions in the "Journal" of the Institution.

B.T.H. ROTARY CONVERTERS.

(*Continued from page* 386.)

Booster Control.—This method of varying the direct-current voltage consists of inserting an alternating-current booster between the slip-rings and armature of the converter. With booster control the power factor is independent of the load and voltage, and consequently unity power factor can be obtained, or, if necessary, leading current can be drawn under any condition of load and voltage.

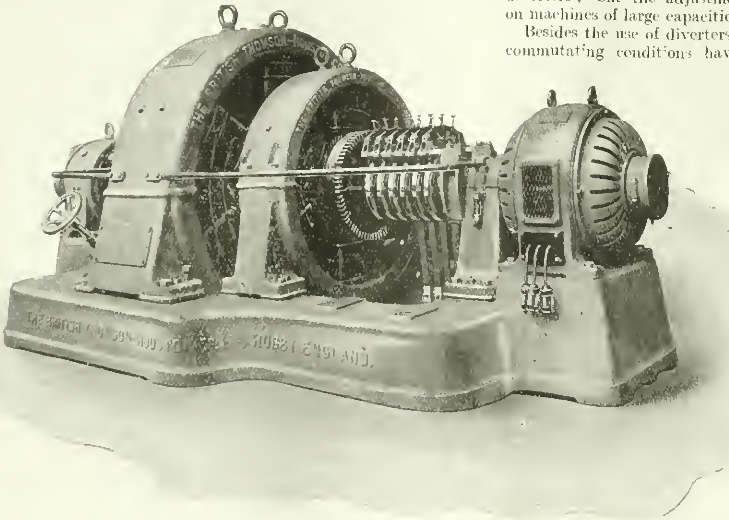

FIG. 8.—300 KW., 500 R.P.M., 25 CYCLES, BOOSTER CONTROLLED, SELF SYNCHRONISING ROTARY CONVERTER, WITH ALTERNATING-CURRENT STARTING MOTOR AND SEPARATE EXCITER.

This machine has been constructed to operate in conjunction with a Tirrill regulator, the direct-current voltage being maintained constant irrespective of the fluctuations occurring in the alternating-current supply voltage.

Machines with this control have been constructed for all capacities and frequencies and are installed where the voltage range required is larger than 10 to 15 per cent., or where independent control of the power factor is required at all loads and voltages.

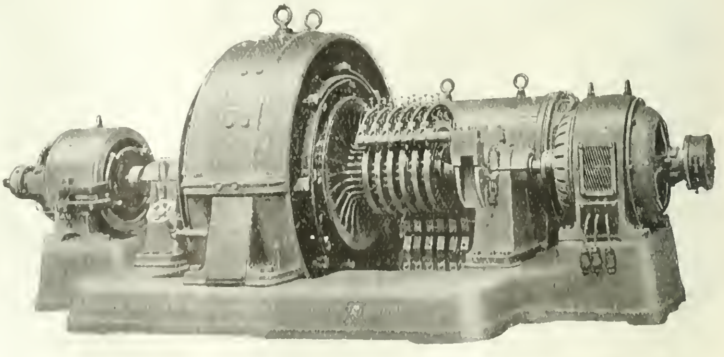

FIG. 9.—400 KW., 750 R.P.M., 50 CYCLES, INDUCTION REGULATOR CONTROLLED, SELF SYNCHRONISING ROTARY CONVERTER WITH ALTERNATING-CURRENT STARTING MOTOR AND SEPARATE EXCITER. (Induction regulator mounted on far side of bedplate.)

So long as rotary converters were constructed without commutating poles, or were of liberal design with commutating poles, the booster converter formed a compact, cheap, reliable and efficient type of converting apparatus. With the introduction of commutating poles, however, largely increased outputs have been obtained from a given size of machine, and it has been found in such cases that if the booster be used to vary the voltage over wide limits on full load the commutation has been seriously affected.

If the commutation of the booster rotary be set so that it is correct at the mid alternating-current and mid direct-current voltage, then when the booster is used to raise the direct-current voltage armature currents will flow in the rotary which magnetise the commutating poles, so that their effect becomes too powerful. When the booster is bucking armature currents will flow which de-magnetise the commutating poles and neutralise their effect, so that while the booster rotary may operate over small ranges of voltage with good commutation, the variation in voltage, if large, will cause the commutation to be seriously affected.

To overcome this difficulty diverters have been arranged so as to be connected across the commutating poles as the direct-current voltage is raised. It is often the case that on the higher voltages the converter is running on traction service, on which duty diverters may cause a flash-over. This can be obviated by fitting inductive diverters; but the adjustment of diverters generally, especially on machines of large capacities, is liable to vary.

Besides the use of diverters, other schemes for compensating the commutating conditions have been devised in which auxiliary windings have been fitted to the commutating poles, these windings being operated either with or without contactors in the main direct-current circuit. Many arrangements of this kind have been installed on commutating pole booster converters, as it has been found that without their assistance these machines will not carry their full-load current over the range in voltage necessary.

The foregoing methods of obtaining compensation can be avoided if booster-controlled converters be liberally designed; but when this is done it will generally be found that the induction regulator method of control, described later, is preferable and is of lower first cost.

Induction Regulator Control.—In this case the direct-current voltage is varied by inserting an induction regulator between the transformer and the rotary slip-rings. The regulator increases or decreases the alternating-current voltage applied to the rotary armature and so raises or lowers the direct-current voltage. Similarly to booster control, the power factor is independent of load and voltage.

This method of control is very similar in arrangement to booster control, and will perform exactly the same functions, with, however, the important advantage that the factors which control the commutating conditions of the rotary are independent of the amount of voltage variation. Machines, accordingly, can be supplied of the largest output for a given size without diverters or auxiliary windings on the commutating poles, and are capable of 30 per cent. voltage variation, and more should occasion arise.

This method of control was widely adopted some years ago, and although considerably more regulator-controlled converters have been installed than booster machines, yet the booster machine for some time proved the more popular, mainly on account of lower first cost, less floor space and simpler external connections. Recently, however, induction regulator controlled rotary converters have been produced with the regulator mounted on the converter itself. This arrangement takes up less floor space than former arrangements, and is approximately of the same cost as a booster machine. The regulator is connected between the alternating-current brush holders and terminal board of the converter, and there are no external connections to the regulator. The economical design of regulators of large capacity at first presented some new problems; but these have been solved, and, as mentioned previously, such sets have the important advantage that commutation is unaffected by voltage variation, the rotary converter being of the simplest and most robust design.

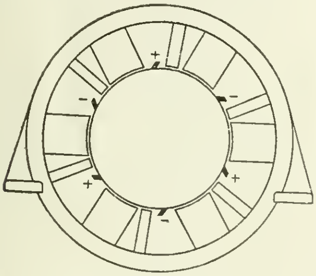

Fig. 10.—Diagram of Field Structure for Split Pole Rotary Converter.

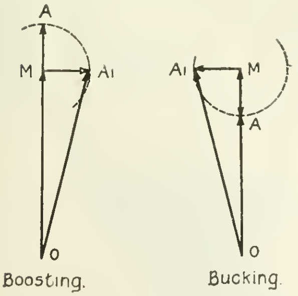

Fig. 11.—Vector Diagram illustrating Split Pole Control.

Induction regulator controlled rotary converters are often installed for correcting a low power factor, the machines being arranged for operating on 90 per cent. leading power factor at full load at any voltage.

Split-pole Control.—There are two methods of split-pole control, employing respectively a three-part pole and a two-part pole. The first method has not been used commercially to any extent on account of certain disadvantages inherent to the design.

The second method was patented by the British Thomson-Houston Company to overcome the difficulties of the three-part pole. This method of control up to the present has only been developed for 25-cycle work, and is suitable for a direct-current voltage range of 25 per cent. with constant alternating-current voltage; or with constant direct-current voltage a range of 25 per cent. on the alternating-current side.

With this method of control the main poles of the rotary are divided into two portions, the regulating pole and the main pole proper, as shown in Fig. 10. The main poles are excited similarly to those of the ordinary converter, whereas the regulating poles are arranged so that they can be excited either in the same direction as the main poles or in the opposite direction. The direct-current voltage between the positive and negative brushes is proportional to the algebraic sum of the flux produced by the regulating pole and that of the main pole. The alternating-current voltage between the slip-rings is not proportional to the algebraic sum of the fluxes, because they are placed at nearly 90 electrical degrees; but it is equal to the vector sum of the alternating-current E.M.F.s produced by the two fluxes. The design is such that the algebraic sum of the fluxes can be varied over a considerable range without greatly varying the vector sum of the alternating-current E.M.F.s generated by the two fluxes.

It has previously been pointed out that with constant E.M.F. applied to the rotary slip-rings it is necessary for the armature to generate a constant back E.M.F.; and in the split-pole converter these conditions are fulfilled—namely, that the armature generates a constant back E.M.F. at the slip-rings while the voltage on the direct-current side is varied over a considerable range.

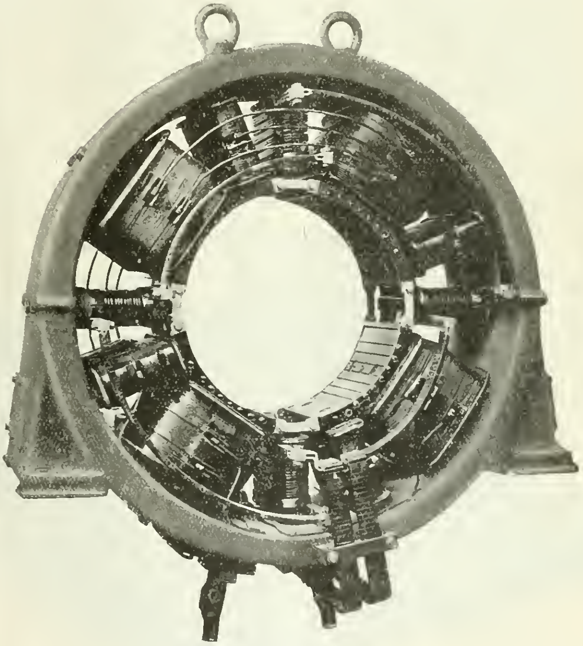

Fig. 12.—Magnet Frame and Windings of 250 kw. Split-pole Rotary Converter with Commutating Poles.

The maximum direct-current voltage is generated when the regulating pole is excited in the same direction as the adjacent main pole, and the lowest direct-current voltage is obtained when the regulating pole is excited in the reverse direction to that of the adjacent main pole. The diagrams in Fig. 11 illustrate this point. OM represents the direct-current voltage produced by the main pole. MA represents the direct-current voltage produced by the regulating pole. OA represents the resultant direct-current voltage.

OM can also represent the alternating-current voltage produced by the main pole, and MA_1 can represent the alternating-current voltage produced by the regulating pole, because the alternating-current voltage is always a fixed proportion of the direct-current voltage, each set of poles being considered separately.

The vector MA_1 has to be added vectorially to OM when alternating-current voltages are combined; and, as the auxiliary pole is practically at right angles to the main pole, the vector OA_1 represents the combined alternating-current voltage when boosting or bucking. It will be seen from the diagrams that, although the alternating-current voltage remains practically constant, the direct-current voltage can be varied over a wide range.

With this method of varying the direct-current voltage unity power factor can be obtained under any condition of load and voltage: also the control is effected in the armature of the rotary without the addition of a booster or regulator. This control is the simplest that has been devised where voltage variation is required independently of the power factor; and the wave shape of the B.T.-H. split-pole equipments can be guaranteed to conform practically to that of a sine wave, and not to introduce disturbing factors into any system.

This method of control is most suitable for small capacity 25-cycle machines, of which large numbers have been built.

(*To be concluded.*)

A UNIVERSAL RESISTANCE STANDARDISING BRIDGE.

BY C. V. DRYSDALE, D.SC.

In The Electrician for October 25, 1907, appeared a description of the combined Kelvin Carey-Foster standardising bridge devised by the writer at the instigation of Mr. J. H. Agar Baugh. The object of this bridge was to enable resistances of all values from the highest to the lowest to be compared with the greatest degree of accuracy and convenience, and to enable all these values to be determined in terms of a single standard. The bridge, as originally constructed by Mr. Baugh and used at the Northampton Institute, has proved quite satisfactory, but a few improvements suggested by experience have now been added, and the following is a description of the improved bridge constructed by Messrs. H. Tinsley & Co., at South Norwood, and used in their laboratory, with examples of a few of the practical measurements made with it. Fig. 1 shows the bridge as there set up.

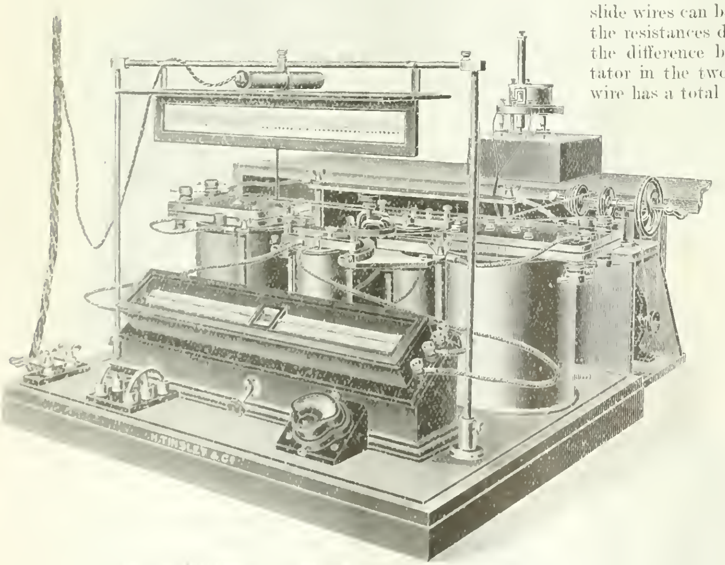

Fig. 1.—Universal Standardising Bridge with two 0·0005Ω Four-terminal Coils under Comparison.

The bridge will serve for measurements by either of the commonly used methods: (1) by the interpolation and deflectional method of the Reichsanstalt, or (2) the shunting method. Its chief feature, however, is the adaptation of the well known Carey Foster slide wire method to the Kelvin double bridge, and the adjustment of the slide wires so as to give the difference between the resistances under comparison directly in millionths of their value. By means of specially built-up standards and ratio-coils on Lord Rayleigh's principle, the bridge also serves for standardising coils of intermediate values, and for stepping up or down by ratios of 10 or of two to one.

The bridge with the two types of ratio coils, therefore, forms a complete standardising outfit for resistances of any value from a microhm to a megohm when a single known standard is available. Over the range from 0·001 ohm to 1,000 ohms, an accuracy of one part in a million or closer is obtainable.

The bridge proper, Fig. 2, consists of eight copper bars arranged in the form of a cross, and resting on an ebonite platform supported by four pillars, and under which an oil tank can be slid if required. Connection between the inner ends of these bars is made by a mercury commutator of the usual Carey-Foster bridge type. Two pairs of ratio coils p, q, p', q', are employed, which span across the front and back contacts respectively. The two resistances R and S to be compared are connected in series by their current terminals, while their potential terminals make contact with the side bars of the bridge. By turning the commutator half round, the connections between the potential terminals of the coils under comparison and the ratio coils are interchanged.

The most convenient and accurate method of test is to employ ratio coils with interpolation resistances as in the Reichsanstalt bridge, but, instead of working by deflections, to connect a slide wire across each pair of interpolations. These slide wires can be so adjusted as to give the difference between the resistances directly in millionths of their value, by taking the difference between the scale readings with the commutator in the two positions. In this form of bridge the slide wire has a total length of 50 cm. and resistance of 1 ohm, and the interpolations have such values that when shunted by this slide wire they represent 0·5 per cent. of the ratio resistance* (except in the case of the 1,000 Ω ratios, where they represent only 0·05 per cent.). Each millimetre of the slide wire, therefore, corresponds to 10 parts in a million of the ratio resistance, and a second slide wire is arranged as shown in Fig. 3, which increases this sensitiveness twenty-fold. The values of the resistances and interpolations for the various ratio coils and interpolations are shown in Fig. 3; and Fig. 4 is an external view of the ratio coil.

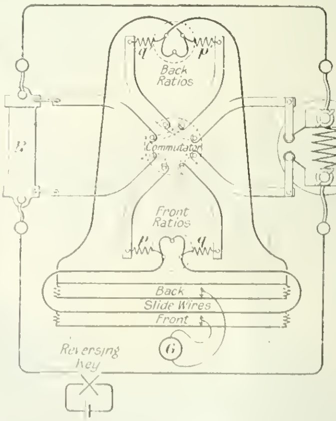

Fig. 2.—Connections of Standardising Bridge.

The slide wire arrangement, seen at the front of Fig. 1, has a sloping ebonite base on which the four platinum-silver slide wires are supported by heavy phosphor bronze springs. The double platinum-silver contacts are mounted on a carriage sliding on a removable silver-faced scale, and can be traversed by turning a handle at the front of the base. By pushing the carriage slightly to the back or front, the contact springs make contact either with the back or the front pair of slide wires, while at the same time one or other set of figures are exposed on the scale. The scale is divided in 500 mm. divisions, each divisions representing 10 millionths when the back contacts are employed, or 0·5 millionth with the front contacts, and a vernier is provided enabling readings to be taken to 1 part in 10,000,000.

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* The interpolations in the case of the 10 Ω ratios are each 0·0263 Ω instead of 0·0256 Ω as shown on the diagram.

Contact is made between the bridge wires and the interpolation resistances by heavy flexible leads as shown, and the connections of the ratios and slide wires can be immediately checked during the course of ordinary testing by shunting one of the resistances or one side of the ratios by a resistance of, say, a thousand times its value, which alters it by 999 parts in a million. The balance point on the slide wire should then alter by 500 millionths. Care must be observed when shunting the resistances under test when they are less than 0·1 ohm, as considerable errors can be caused through resistance of the main or potential contacts. In this case, either *both* front and back ratios should be shunted, or the resistance of the contacts should be approximately determined and the effect of the shunt calculated as in the appendix.

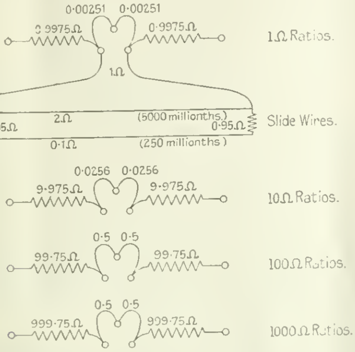

FIG. 3.—RATIO COIL AND SLIDE WIRE RESISTANCES.

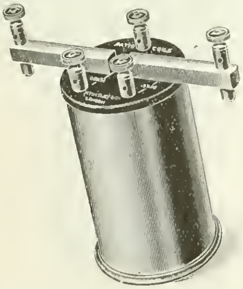

FIG. 4.—RATIO COIL WITH INTERPOLATIONS.

Each of the bridge blocks has ordinary screw terminals at its outer end, and in the case of two terminal coils they are simply connected by the mercury cups, while the battery connections are made to the terminals on the blocks. In their normal position the mercury cups are suitably placed for coils having a gauge of 160 mm., but for coils of the B.A. or other gauge the bars can be swung round to the required position. They can also be instantly lifted off the base for cleaning, and can be replaced by other bars for special tests, as seen later.

It must not be forgotten that since mercury has a specific resistance of nearly 100 microhms per centimetre cube, the resistance of a mercury contact 1 cm. diameter (the size employed in this bridge) increases by about 1 microhm for every tenth of a millimetre by which the flat contact is raised above the bottom of the cup. Special care is, therefore, taken to face off all the contacts to the same level, and to drill all the cups to the same depth, but at the same time it is considered advisable in most cases not to use ratio resistances of less than 10 ohms, so that small variations are negligible in effect.

THEORY OF THE DOUBLE-SLIDE WIRE BRIDGE.

The following simple theory of the bridge will be of service to those unfamiliar with it.

In the annexed diagrams (Figs. 5 and 6), R and S are the resistance to be tested and the standard resistance respectively.

P and q are the front ratio resistances, and $f=p+q=2p$ very nearly.

p' and q' are the back ratio resistances $f'=p'+q'=2p'$ very nearly.

l and l', m and m' the (small) resistances of the front and back potential contacts.

X the parallel resistance of the back connection shunted by the ratios p' and q'.

Then, with the connections as in Fig. 5,

$$i_1\left(R+\frac{p'+l'}{f'}X\right)=i_2(p+l),\text{ or }R+\frac{p'+l'}{f'}X=\frac{i_2}{i_1}(p+l).$$

With resistances commutated as in Fig. 6, the balancing point on the slide wire must be moved to the left by a resistance b, if $R > S$, and the back contact moves with it by a resistance b'.

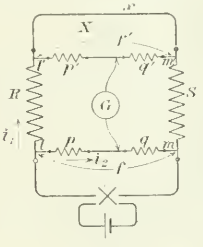

FIG. 5.

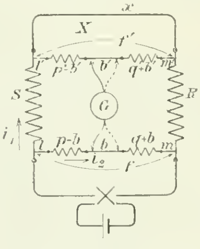

FIG. 6.

Then, by the same reasoning, $S+\frac{p'+m'-b'}{f'}X=\frac{i_2}{i_1}(p+m-b)$.

Subtracting, $R-S=\frac{i_2}{i_1}(b+m-l)-\frac{X}{f'}(b'+m'-l')$.

But $$\frac{i_2}{i_1}=\frac{R+S+X}{f}.$$

Hence, $$R-S=\frac{b+m-l}{f}(R+S)+\left(\frac{b+m-l}{f}-\frac{b'+m'-l'}{f'}\right)X,$$

and, since $R+S=2R$ approximately, $f=2p$, and $f'=2p'$,

$$\frac{R-S}{R}=\frac{b}{p}+\frac{m-l}{p}+\left(\frac{b}{p}-\frac{b'}{p'}+\frac{m-l}{p}-\frac{m'-l'}{p'}\right)\frac{X}{2R}.$$

Now, by the construction of the ratio coils and slide wires, $b/p=b'/p'$, and $b/p=\Delta$, the difference of the bridge readings in millionths.

Hence, $$\frac{R-S}{R}=\Delta+\frac{m-l}{p}+\left(\frac{m-l}{p}-\frac{m'-l'}{p'}\right)\frac{X}{2R},$$

which is the working formula for the bridge. This formula is equivalent to that given by Mr. F. E. Smith in a discussion in THE ELECTRICIAN of January 10, 1908.

When the differences between the resistances of the potential contacts are negligible compared with p and p', $(R-S)/R=\Delta$ simply.

The junction resistance X is only about 0·001 ohm in the actual bridge, and the differences $m-l$ of the resistance of the potential leads do not often in practice exceed 50 microhms, if care is taken to make the contacts to the bridge large and symmetrical. Hence, with 10 ohms front and back ratios, the simple relation is usually correct within 5 parts in 1,000,000 for all resistances above 0·001 ohm.

When this is not the case the resistances m, m', l, l' and X can be measured approximately (either on the bridge or by the aid of a millivoltmeter), and the corrections applied. But the most convenient method of working is as follows: First make a measurement with two pairs of ratio coils of the most suitable value (in the case of comparing resistances of 1 ohm or less, 10-ohm ratios front and back will be suitable).

Then, $$\frac{R-S}{R}=\Delta_1+\frac{m-l}{p}+\left(\frac{m-l}{p}-\frac{m'-l'}{p'}\right)\frac{X}{2R}=\Delta_1+e,$$
say where e is the correction for the contacts, &c.

Next, take a second measurement with front and back ratios each of one-tenth their former value (in this case, 1 ohm).

Then, $\frac{R-S}{R}=\Delta_2+10e$, since p and p' are each reduced to one-tenth, and m', m', l', X and R are unaltered.

So that $$e=-(\Delta_2-\Delta_1)/9,$$
and $$\frac{R-S}{R}=\Delta_1-(\Delta_2-\Delta_1)/9=(10\Delta_1-\Delta_2)/9.$$

By simply making these two measurements, therefore, the whole of the corrections due to contact resistances of every kind disappear, provided, of course, that they are constant. For resistances of 0·1 ohm and higher the back ratio has very little effect, and it is sufficient to change the front ratio only.

EXAMPLES OF MEASUREMENTS.

The following examples of actual comparison of resistances of approximately equal value will clearly show the method of working in different cases, and further examples will be given below of methods of comparing resistances of unequal value, and of stepping up and down.

In estimating the value of these measurements, it should be borne in mind that they were made in an ordinary works test room, the air temperatures being anything between 10°C. and 22°C., and frequently varying rapidly. The coils were kept approximately at their required temperatures by occasional heating with a bunsen burner.

Example I.—Intercomparison of three 100-ohm Coils Without Separate Potential Terminals. Current leads attached to bridge blocks. Ratios, 100 ohms front, 10 ohms back. Moving coil galvanometer, 600 ohms. P.D., 2 volts. Sensitiveness, 1·7 divisions on reversal for 1 in 1,000,000. Temperature coefficients, A = 17m, B = 10m, C = 21·5m per 1°C. (m = millionths).

Table I.—*Intercomparison of Three* 100Ω *Coils.*

Coils.		Temperatures.		Bridge readings.		Δ	Temperature corrections.		Δ at 20°C.	
Left	Right	T_1	T_2	D	R		T_1	T_2		
A	B	20·02	19·93	97·6	157·8	60·2	0·34	0·7	61·2	61·6
B	A	19·80	19·88	159·5	97·5	62·0	2·0	2·0	62·0	
A	C	19·98	20·03	95·3	161·2	−65·9	1·34	0·64	64·9	64·6
C	A	20·00	19·93	161·2	95·7	65·5	1·2	1·2	64·3	
B	C	19·98	20·07	127·3	132·3	5·0	1·2	1·5	3·3	3·2
C	B	19·90	19·91	132·6	129·4	3·2	0·9	9·0	3·1	

Hence $B-A=61·6m$, $C-A=64·6m$, from which $C-B=3·0m$, as against 3·2m by direct measurement. The agreement is therefore within 2 parts in 10,000,000. The six readings are given just as observed, without any selection.

Example II.—Intercomparison of Two 0·01Ω Standards with Potential Contacts of Different Resistance.—0·01Ω, No. 3,387 on left, 0·01Ω, No. 3,022 on right. T.C. = 28m.

The current leads were first connected to the bridge blocks, and a current of 58 amperes passed through the resistances by their potential terminals. The drop was taken by a millivoltmeter.

Front contact, 2·5 mv., m=43 microhms. Front contact, 9·7 mv., l=167 microhms.

Back contact, 2·5 mv., m'=43 microhms. Back contact, 8·5 mv., l'=146 microhms.

Back bar and connections, 6 mv.=104 microhms=X. Galvanometer about 20Ω.

Ratios.		T_1	T_2	D	R	Δ = $D-R$	Δ corrected for temperature.	
Front.	Back.							
10	10	19·97	20·29	115·8	112·5	3·3	12·3	12·0
10	10	20·00	20·35	115·0	113·2	1·8	11·6	
1	1	20·10	20·50	210·7	97·8	112·9	124·1	124·1
1	1	20·17	20·56	210·8	97·9	112·9	124·1	

By calculation, allowing for the resistance of the potential contacts, we have:—
$$\begin{aligned}\Delta&=\Delta'+\frac{m-l}{p}+\left(\frac{m-l}{p}-\frac{m'-l'}{p'}\right)\frac{X}{2R}\\&=12·0+\frac{43-16}{10}+\left(\frac{43-167}{10}-\frac{43-146}{10}\right)\frac{104}{2,000}\\&=12·0-12·4-0·1=-0·5m.\end{aligned}$$
But we have also—
$$\begin{aligned}\Delta&=\Delta_1'-(\Delta_2'-\Delta_1')/9,\\&=12·0-(121·1-12·0)/9=12·0-12·5=-0·5m,\end{aligned}$$
as before.

This shows the value of the method of eliminating the corrections for the resistance of the potential contacts, already described. The exchange of the ratio coils is easily effected, and renders all measurement of the resistance of the potential leads or coupling connections unnecessary.

Example III.—Intercomparison of Three Standards of 0·0005 ohm.—Front and back ratios both 10Ω. P.D. on bridge, 0·32 volt=80 amperes. The potential leads of all three standards were equal (about 50 microhms), so no correction was necessary. Temperature coefficient in each case, 25m at 17°C. Moving coil galvanometer, 20 ohms.

Table II.—*Intercomparison of Three* 0·0005Ω *Standards.*

Coils.		T_1	T_2	D	R	Δ = $D-R$	Δ at 17°C.		
Left.	Right.								
A	B	17·00	17·06	214·0	37·1	176·9	178·4	178·1	
		17·00	17·05	214·0	36·8	177·2	177·8		
A	C	17·02	17·02	201·1	50·2	150·9	150·9	151·0	178·
		17·02	17·02	201·3	50·2	151·1	151·1		
B	C	17·02	17·02	113·3	139·9	−26·6	−26·6	−27·3	
		17·05	17·10	112·3	139·0	−26·7	−27·9		

The agreement between the direct difference $A-B$, and that obtained from the two differences $A-C$ and $B-C$ is, therefore, within 1 in 1,000,000.

Example IV.—Resistance-Temperature Test on a 0·0005-ohm Standard.—10Ω front and back ratios. 0·32 volt on bridge = 80 amperes, value of standard = 10+25 (t−18).

Table III.

T_1	T_2	D	R	Δ = $R-D$	Standard resistance.	Resistance of coil.
18·0	14·4	2,474	2,499	25	−10	+15
18·0	17·4	2,422	2,545	123	−10	+83
18·0	18·9	2,406	2,560	151	−10	+114
18·0	20·4	2,382	2,579	197	−10	+157
18·05	23·0	2,356	2,613	257	−39	+218
18·07	24·15	2,337	2,625	288	−38	+250
18·07	26·0	2,320	2,642	322	−38	+284
18·07	30·3	2,277	2,680	403	−38	+365
18·07	33·7	2,247	2,714	467	−38	+429
18·07	36·9	2,226	2,735	509	−38	+471
18·07	39·8	2,215	2,748	533	−38	+495
18·16	44·2	2,910	2,772	582	−37	+545
18·17	47·2	2,180	2,780	600	−36	+564
18·18	45·2	2,190	2,775	588	−35	+550
18·77	38·4	2,227	2,740	573	−33	+480
18·30	41·8	2,205	2,760	555	−32	+520
18·35	38·3	2,228	2,740	512	−31	+480
18·40	34·4	2,254	2,717	463	−30	+433
18·50	30·6	2,280	2,689	409	−28	+381
18·40	24·4	2,350	2,620	270	−37	+233
18·05	21·2	2,376	2,594	218	−39	+179

The resistance-temperature curve plotted from these observations is shown in Fig. 7. It will be seen that the majority of the points lie on the curve within one or two parts in 1,000,000 (or 0·001 microhm in actual resistance), and that only one shows an error of more than 5 parts in 1,000,000, which corresponds to 0·2 deg. in temperature.

Build Up Standard and Ratio Coils.

These are an extremely important adjunct to the bridge, and form the readiest means of standardising coils of different values. Their principle is an extension of that of Lord Rayleigh's "beetle," five coils of relative values, 1, 3, 3, 3 and 1 being in series. If the three intermediate coils are put in parallel the combination is equivalent to 1, and it can be compared with either of the unit coils. If the three intermediate coils are equal within 0·1 per cent. (which is, of course, quite a rough adjustment) their resistance in series will be nine times their parallel resistance, to within an accuracy of 1 in 10,000,000. By standardising the three unit standards, therefore, we immediately have accurately known standards of 1, 9 and 11 units, which gives us both two 10-unit standards and two ratios of 10 to 1.

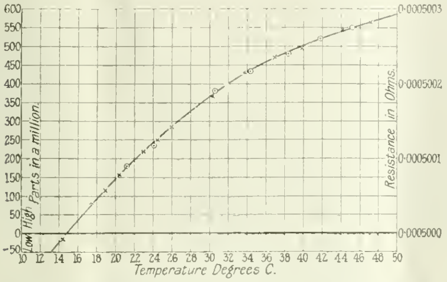

Fig. 7.—Resistance-Temperature Curve for 0·0005Ω Tarnac Standard Resistance Value. $+ 150 + 25\,(t-20) - 0{\cdot}36\,(t-20)^2$.

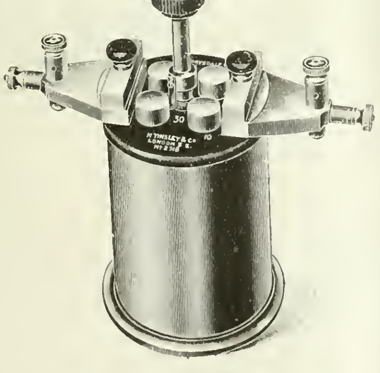

Fig. 8.—Built-up Standard and Ratio Coil 10-30-30-30-10 ω.

The build-up standard and ratio coils (Fig. 8) have been designed to utilise this principle with the greatest accuracy and convenience. They have heavy copper lugs with current and potential terminals, and mercury contacts of the 160 mm. gauge. Four massive circular copper blocks are mounted in a square between them, and these blocks and the ends of the lugs are faced off together, so as to be exactly flat and level. The upper surfaces of these blocks are amalgamated, and two heavy copper bars are provided, with amalgamated lower surfaces, which make the necessary connections with the minimum of contact resistance. A metal stem bearing an ebonite handle and a spring contact serves for the attachment of the galvanometer wire, when the device is used as a ratio coil, and the contact can be turned so as to press against the side of any one of the four central blocks, without interfering with the surface connections. Fig. 9 shows the positions of the copper bars (shown by thick black lines) for various values of the resistance and ratio, with the correction to be made in each case, in terms of the originally measured values, *a*, *b*, *c*, *d*, *e* and *f*.

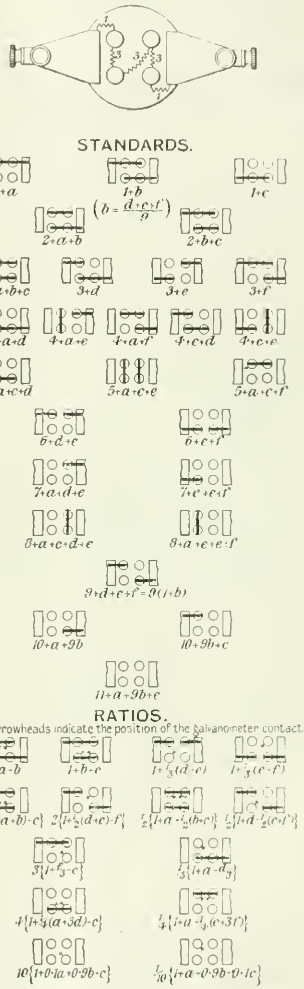
1
3
3
3
1
STANDARDS.
1
1+a
1+b
1+c
2
$\left(b = \frac{d+e+f}{9}\right)$
2+a+b
2+b+c
3
3+a+b+c
3+d
3+e
3+f
4
4+a+d
4+a+e
4+a+f
4+c+d
4+c+e
5
5+a+c+d
5+a+c+e
5+a+c+f
6
6+d+e
6+e+f
7
7+a+d+e
7+e+e+f
8
8+a+c+d+e
8+a+e+e+f
9
9+d+e+f = 9(1+b)
10
10+a+9b
10+9b+c
11
11+a+9b+e
RATIOS.
(The arrowheads indicate the position of the galvanometer contact.)
EVEN.
1+a-b
1+b-c
$1+\frac{1}{3}(d-e)$
$1+\frac{1}{3}(e-f)$
2:1
$2\{1+\frac{1}{2}(a+b)-c\}$
$2\{1+\frac{1}{2}(d+e)-f\}$
$\frac{1}{2}\{1+a-\frac{1}{2}(b+c)\}$
$\frac{1}{2}\{1+d-\frac{1}{2}(e+f)\}$
3:1
$3\{1+\frac{f}{3}-c\}$
$\frac{1}{3}\{1+a-\frac{d}{3}\}$
4:1
$4\{1+\frac{1}{4}(a+3d)-c\}$
$\frac{1}{4}\{1+a-\frac{1}{4}(e+3f)\}$
10:1
$10\{1+0{\cdot}1a+0{\cdot}9b-c\}$
$\frac{1}{10}\{1+a-0{\cdot}9b-0{\cdot}1c\}$

Fig. 9.—Connections of Built-up Standard and Ratio Coil.

(To be concluded.)

Largest Electrically-Driven Rolling Mill. According to "Engineering," the largest electrically-driven reversing rolling mill at present in operation in America is that of the Bethlehem Steel Company, at Lehigh. It is a 35-in. blooming mill. Altogether there are at work, or in course of erection, 18 electrically-driven reversing mills in the United States and Canada. According to Mr. Jefferies, of the Steel Company of Canada, the power required for a rolling mill owned by this company working much below its normal capacity amounts to 21·5 kw. hours per ton.

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SOME ELECTRICAL EVENTS OF 1916.

For a third time we come to the close of a year under the stress of war. If the average commercial man had been asked in August, 1914, how long the intricate edifice of commerce and industry in Europe would have rendered war possible he would probably have replied that the duration could not be long. Yet all the belligerent nations appear to have settled down to the unusual conditions that have arisen, and at least in this country a large volume of trade is still carried on in addition to that which is handled for munitions. Such trading, however, is difficult, owing to restrictions on copper, aluminium and plant of various kinds. In fact, freedom of action has necessarily been curtailed, and the number of firms controlled by the Government has now reached a high figure.

The relations of capital and labour during the last twelve months have been more cordial. But thoughtful observers are agreed that this state of things is chiefly due to the present abnormal conditions, and that it behoves every employer of labour to look forward to the time when peace comes once again and when the restrictions and rules that have been relaxed will again be enforced by the trade unions. A thoughtful address was delivered in March by Mr. HAROLD COX before the Institution of Civil Engineers, in which it was pointed out that there have been faults on both sides, and that it is most important for each side to realise the position of the other and to maintain a high output if the British Empire is to hold its position in competition with other nations after the war. Signs are not wanting that both capital and labour are beginning to realise the supreme importance of united effort. At an influential meeting held in September at the Mansion House in London, Mr. G. H. ROBERTS, M.P. (Lord Commissioner of the Treasury), spoke on behalf of labour and gave support to the view that the workers would do their share if their needs were only recognised. Negotiations are now in progress between the Parliamentary Committee of the Trade Union Congress and the Employers' Parliamentary Committee, and although the published programme of the former appears to us to be somewhat contentious, we trust that a way out will be found and that substantial good will result. The important point to bear in mind is that the whole situation should be considered at once, not necessarily with a view to final agreement at the moment (which is more or less impracticable, because we do not yet know what the after war conditions will be), but with a view to a free interchange of opinions and the realisation that neither capital nor labour can afford to disregard the claims and the difficulties of the other in the inevitable partnership between the two.

Another problem on which public attention has been focussed is the position of British trade after the war. Last year an Advisory Committee of the Board of Trade was appointed to suggest measures for securing certain branches of British industry after the war, and last January a report was issued by a sub-committee. Recommendations were made in regard to a number of subjects, such as research, patents and trade marks, copyright, tariff protection in certain cases, and the formation of a Ministry of Commerce. The Institute of Industry, which had been carrying on an active campaign for some time, acted upon a suggestion of Sir EDWARD CARSON, that consolidation was desirable, and called together other bodies with the object of forming a representative association for all the industries of the United Kingdom, sinking its identity in the process. The Central Association appears to have been the result, and then the Federation of British Industries Association, with Mr. F. DUDLEY DOCKER, C.B., as president.

In April the Board of Trade appointed two committees to consider the position of British trade after the war, the Hon. Sir CHARLES PARSONS being the chairman of the committee dealing with the electrical trades. A Reconstruction Committee was appointed by the Cabinet in July under the chairmanship of Lord HALDANE, to consider all after-war problems affecting the industries of the country. Further, in July, a committee was appointed by the PRIME MINISTER to consider four main questions, namely, the industries that are essential to the future safety of the nation, the steps that should be taken to recover home and foreign trade, the development of the resources of the Empire, and the means for preventing sources of supply within the Empire from falling under foreign control.

In June the Paris Trade Conference was held, and adopted important resolutions applicable to the war period, the reconstruction period and the peace period.

Leaving the subject of trade, it may be said that there has been an equally important movement towards the placing of technical research and technical education upon a satisfactory basis. When the Advisory Council of the Committee of the Privy Council was formed last year it was felt that the Council laboured under the disadvantage of not being sufficiently representative. This difficulty is now being overcome by the appointment of certain special committees. Thus, committees have been formed to deal with mining, one for non-metals, one for metals; similarly there are two committees dealing with metallurgy, one for non-ferrous metals and the other for ferrous metals. The Royal Society took the step of forming a Board of Scientific Societies, and recently a deputation of this Board to Lord CREWE, then Lord President of the Council, was well received, and it was announced that the Government intended in future to make considerably larger grants for research, apparently amounting to about £200,000 per annum, and to create a department for the purpose.

An interesting report was issued by the Council for organising British Engineering and Industry (formed by the engineers of Manchester), and dealt particularly with technical training.

The claims of pure science were urged by the Reorganisation Committee (formed in London by a number of scientists) in the early part of the year, and in September the PRIME MINISTER appointed a committee to consider the position of science in the system of education of the United Kingdom. As a result of such efforts it is to be hoped that science will in future hold a more recognised position in our schools than hitherto.

In the electrical supply industry the shortage of coal has given rise to much uneasiness at times. In March the Board of Trade announced that District Coal and Coke Supplies Committees had been formed, but this step does not seem to have afforded much relief. Unfortunately, the Government delayed far too long in taking the steps necessary to secure supplies of coal at reasonable prices. Later in the year a letter was issued by the Board of Trade stating that electricity and gas undertakings must reduce the consumption of coal used for the supply of light by 10 per cent. There was no suggestion as to how this desired result was to be attained, and it appears to us that a far more profitable step was the passing of the Summer Time Act, notwithstanding the criticism to which it gave rise.

The better utilisation of our coal is a subject which is attracting increasing attention. A report issued by the British Association dealt with many aspects of the question, and it is to be hoped that in due time such investigations will lead to less waste of this national asset. Low temperature distillation is once more receiving consideration, and the gas firing of boilers is coming more to the fore, the proposed installation of Coalite plant to supply power-gas to the Brighton electric power station being a case in point.

In the reading of Papers the Institution of Electrical Engineers was as active as could well be expected under the conditions of national stress. Among the work of a routine character that was carried through was the publication of the 7th edition of the Wiring Rules, and there were doubtless other activities of a confidential nature. An event of more general interest was the decision to expel enemy alien members, which was only reached after holding several meetings, at which most diverse opinions were expressed, and after a referendum to the members.

From what we have said it will be seen that purely electrical matters in 1916 have been largely overshadowed by questions of a wider character and more general application, but there has nevertheless been progress in certain directions, and with this we shall deal further in our next issue.

SOME CHARACTERISTICS OF CRYSTAL DETECTORS.

BY VICTOR A. HUNT AND LAURENS E. WHITTEMORE.

This Paper describes an investigation of the behaviour of certain crystal detectors, as used in wireless telegraphy, when subjected to varying conditions of temperature, pressure and humidity.

Since the most important use of crystal rectifiers at the present time is in wireless telegraphy, it was decided to undertake the investigation of the properties of four of these detectors under conditions similar to those of actual practice. Observations were made of the variations which occurred in the rectified current with changes of temperature, pressure and humidity. For the purpose we erected a sending station and a complete receiving station in different parts of the same building. Fig. 1 and Fig. 2 show simple diagrams of the two circuits. The detectors studied were galena, perikon, silicon and carborundum.

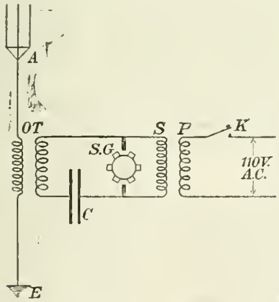

Fig. 1.

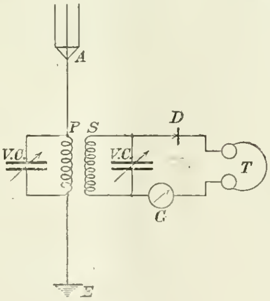

Fig. 2.

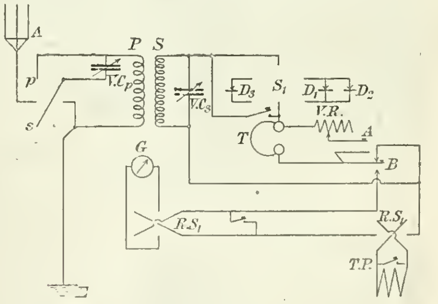

Fig. 3.

The sending station was arranged to emit a wave of about 500 metres. The normal current in the closed oscillatory circuit was 4·5 amperes, and the power consumed by the transformer was 240 watts. Such fluctuations as would be present in the power supply would produce only small variations in the galvanometer deflection at the receiving station.

The measurements of the current in the detector were made by means of a Leeds and Northrup ballistic galvanometer of 1,069 ohms resistance and having a sensibility of 0·0026 micro-amperes per millimetre. Fig. 3 gives a complete diagram of the connection of the receiving instruments. The signals were sent out from the sending station by closing a key at the receiving station. The time during which the current flowed through the galvanometer was determined entirely by the time during which the key *B* was closed. By means of the reversing switch RS_1 the direction of the galvanometer deflections could be changed. The switch S_1 was used to connect in an auxiliary detector with which to receive messages from other stations without disturbing the detector under test.

By far the most troublesome source of error encountered was "extra" E.M.F. of variable magnitude originating at the contact of the detector and causing a deflection of the galvanometer even when no signals were being received. To eliminate this a thermopile was inserted directly in series with the galvanometer, and was heated by the radiation from a 32 c.p. carbon filament lamp, the position of which was varied by moving it back and forth on a sliding track. Since the "extra" E.M.F. often reversed its direction it was necessary to use a reversing switch RS_2 in order that the E.M.F. of the thermopile might always oppose it. This arrangement made it possible to eliminate entirely all extraneous currents from electro-chemical or thermo-electric sources.

One observer confined his attention to the galvanometer. He first eliminated whatever "extra" E.M.F. was present by opposing it with the E.M.F. generated in the thermopile. This balance was secured by closing the key *B* and adjusting the distance of the lamp until the galvanometer showed no deflection.

The other observer then closed the key which put the sending station in operation, and, with stop watch in hand, pressed the key *B* for a certain length of time. The first observer then noted the maximum deflection of the galvanometer.

In making a test we did not attempt to secure the most sensitive adjustment of the detector, but tried above all to secure one which would remain permanent and which gave a clear, uniform tone. In order to subject the detector to the various physical conditions desired, we had constructed a box which consisted of a glass battery cell with a suitable brass cover.

To heat the detector we enclosed it in the box which was then immersed in cylinder oil of a high flash point and heated by a gas burner. In order to cool the detector we suspended it in a U-shaped Dewar flask which contained liquid air. The temperature obtained was measured by means of a pentane thermometer.

The pressure in the box was varied by means of a motor driven air pump and was measured with an open tube manometer.

The humidity of the air in the box was varied by varying the concentration of a sulphuric acid solution which was placed in the bottom of the cell.

RESULTS.

Galena.—The first physical condition which we varied was temperature. The galena detector was carefully adjusted and placed in the closed box which was then immersed in oil and heated. The galvanometer readings were then plotted against the respective temperatures. Fig. 4 shows one of these curves and is typical of those obtained with galena. In this as well as the other figures the dotted curves indicate the results obtained with other specimens or other adjustments. The rectification falls off very rapidly with the rise in temperature, approaching zero at 170°C.

We were much gratified with the uniformity of the readings which we were able to secure with galena, since we had feared that, on account of the light contact needed, a permanent adjustment could not be preserved.

One noteworthy fact in connection with the rectification by galena is that, although in most cases the current flows from crystal to point, it was found that, with some adjustments, the current would flow in the other direction.

It is a well-known fact that when a relatively large current, caused either by a heavy atmospheric discharge or by the spark at a sending station near by, passes through a galena detector, the rectification is impaired. It has occurred to us that a probable explanation of this phenomenon is the local heating of the contact by the passage of the current producing an effect similar to the heating described above.

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* From the "Physical Review," May, 1916.

Fig. 5 shows the effect of low temperature on galena. It will be noticed that at about −50°C. there occurred a decided maximum of rectification, which was corroborated by successive tests.

As a result of varying the humidity of the air in the closed box it was found that the presence of a very small quantity of moisture is sufficient to reduce greatly the rectification by the galena detector.

Subsequent experiments with silicon and perikon gave similar indications, but the effect was not so marked as in the case of galena. In the case of carborundum no appreciable effect was observed.

Perikon.—The perikon detector used consisted of a contact between crystals of zincite and chalcopyrite. The effect of temperature was more marked in the case of perikon than in the case of any other detector, as is shown in Fig. 6. Starting with a deflection of 3 cm. at about 55°C. for a three-second dash, the deflection passed off the scale of the galvanometer at a temperature of about 140°C. When the length of the dash was shortened to one second the deflection became 7 cm. but rose rapidly with the temperature reaching a value of 24 cm. at 210°C.

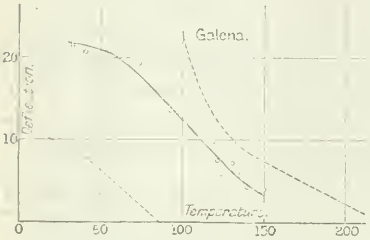


FIG. 4.

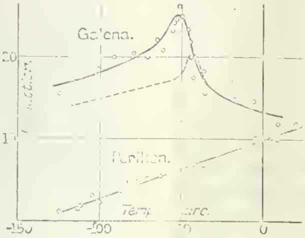


FIG. 5.

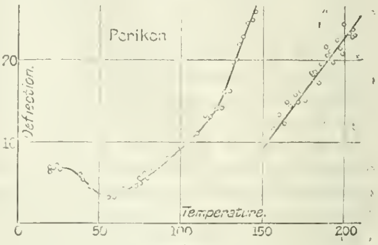


FIG. 6.

The curve obtained upon cooling the perikon detector (Fig. 5) was perfectly continuous with the heating curve, falling rapidly with the temperature. At no time was there any indication of a definite maximum or minimum of rectification within the temperature range which we used, from −120°C. to 210°C. Immersion of the perikon detector in liquid air caused a complete loss of rectification.

Silicon. The rectifying action of silicon was very erratic. This corresponds with the statements made by other observers in regard to the properties of that substance.

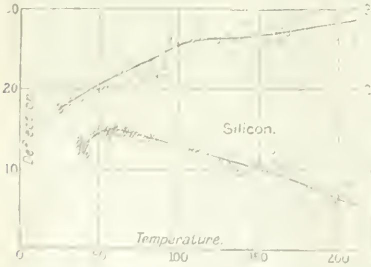


FIG. 7.

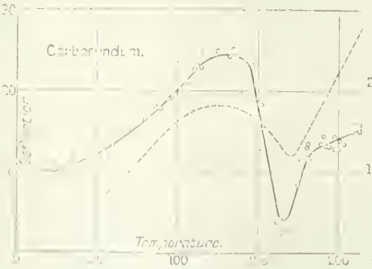


FIG. 8.

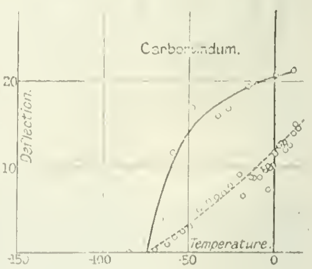


FIG. 9.

The variation in behaviour of different specimens is seen in Fig. 7. The conditions of heating were identical in obtaining both curves except that different specimens were used. In one case the rectification seemed to increase and in the other to decrease as the temperature rose.

In attempting to determine the effect of subjecting silicon detectors to low temperatures it was found impossible to obtain any consistent results. The rectification would change very rapidly when there was apparently no cause whatever, and it was very hard to retain a given adjustment, since the surface of the crystal became exceedingly hard and slippery at the low temperature.

When the silicon detector was completely immersed in liquid air the sound in the telephone receivers increased in the majority of cases. It is possible that in other cases the somewhat violent boiling of the liquid air destroyed the adjustment of the light needle contact.

Carborundum.—In order to secure a good adjustment with carborundum we found it necessary to use considerable pressure upon the contact point, consequently embedding the point of the steel needle below the surface of the crystal. The adjustment was very permanent and could not easily be impaired by vibration.

Upon heating the carborundum detector very peculiar results were obtained, as may be seen in Fig. 8. Successive tests showed that the rectification attained a decided maximum at a temperature of about 130°C. and from there fell off rapidly until a minimum was reached at about 165°C. Above that temperature the rectification again increased as far as the tests were conducted. Even when the glass containing box accidentally broke and the detector was immersed in the hot oil-bath its behaviour remained the same. This was probably due to the fact that the oil could not reach the actual contact between the crystal and the needle.

The cooling curve shown in Fig. 9 continued the lower portion of the heating curve. Rectification became zero at about −85°C. It was noteworthy that upon being warmed the detector largely regained its rectifying properties, the dotted curve showing this rise. In order to prove that the decrease in rectification was not due to an imperfect contact caused by the contraction of the needle and the detector stand, we tried repeatedly to secure a new adjustment at these low temperatures but found it impossible. Likewise immersion in liquid air proved disastrous to all rectification.

It was found that with each of the four detectors, as far as we could observe, change in air pressure had no effect upon the rectification. We were able to vary the air pressure from 25 cm. to 135 cm. of mercury. It is perhaps not surprising that no effect was observed within this range.

One of the peculiarities noticed in our work was that certain crystals did not always rectify the oscillating current in the same direction. With one adjustment the rectified current would flow from crystal to point and with another would flow in the opposite direction. Once, indeed, during a test on the effect of change of temperature upon carborundum the rectification actually reversed, although no change had occurred in the adjustment. The most common direction of rectification for silicon and for galena was found to be from the crystal to the brass point which was used. In the case of carborundum the ordinary sense of rectification was from needle to crystal. The perikon detector was the only one of the four which showed no reversal; always rectifying from chalcopyrite to zincite.

The "extra" E.M.F., to which reference has previously been made, is probably of galvanic origin. Although it might have been of thermo electric origin, due to local heating at the contact, it could not have been the result of a thermo junction caused by the difference in temperature between the detector and the outside circuit, since both leads from the detector were of copper, causing the junctions affected by the heat to oppose each other. In addition, the frequent reversal of this "extra" E.M.F. seems to preclude all possibility of its being due to a thermo-electric junction. This effect deserves further investigation.

It is possible that there are changes both in the condition of the surface on the crystal and in the body itself of the crystal during changes in the rectification. If both of these changes take place, as has been suggested by some observers, it is probable that the body effect predominates in the variations of rectification with changes in temperature which are most notable in the case of carborundum. In the case of humidity the surface effect probably has the most influence on the variation in rectification.

At certain times, when the rectification was especially good, a humming sound was heard in the receivers similar to the inductive hum often heard when the detector circuit was open. This seems to be evidence of the formation of a high resistance film on the surface of the crystal at the point of contact.

A DECIMAL MONEY SYSTEM.

BY G. O. PARSONS.

When we consider, in spite of the extreme handicap of cumbersome and antiquated systems of weights, measures and money, imposed by ourselves, our colonies and by Russia, that American and German merchants between them captured the pick of the whole of such home trade, we are bound to realise that, in matters commercial, there is no magic in decimal systems *per se*.

Now, although the capture of this trade by other nations proves that decimal systems cannot have the bearing on international trade some people would have us believe, yet the needless retention of complex and time-wasting methods of calculation well into the 20th century is, in itself, an index of national rigidity of mind—a state of affairs as serious as it is possible to conceive, for this nation is a democracy, and cannot progress if the majority of its citizens are non-observant and indifferent to improvement. We may be excused for boasting of our awakening during this awful war; but, after all, as a reputed Christian people, there is to be found in the parable of the talents condemnation of this awakening under the stress of circumstances.

It is admitted that for unadulterated commercialism the average Briton cannot be surpassed. This is fairly well illustrated by the sordid conduct of the electrical transport services of to-day. These services might easily be made a veritable Elysium of short rest for the millions who use them twice on each working day. Yet nothing more horrible can possibly be conceived than the daily journeys we are forced to take in gloomy and depressing vehicles, from which the little available, and therefore precious, daylight and sunshine are excluded by a vulgar system of advertising by transparencies on the windows and fan lights.

In regard to the reform of our systems of weights and measures, avowed metrological reformers place before us what they regard as a positive solution—namely, the adoption of the metric system as evolved by the French. As to money, there being no cut and dried foreign system that can be adapted to apply to our coinage, no definite lead is given. In the true unimaginative spirit of British conservatism, they merely only offer a suggestion—a suggestion which unquestionably owes its origin to "high finance," for a more absurd proposal to meet the requirements of every-day life of ordinary mortals could scarcely be conceived. Unless it is speedily withdrawn, and a scheme put forward based on a unit understood by the man in the street, it looks very much as if the time, money and material that has already been spent upon decimal propaganda will be entirely wasted. It is this foolish obsession of the British people in regard to the dicta of the exponents of high finance that is largely responsible for the rigidity of mind to which I have referred. As a fairly good instance of what such an obsession means, I quote the following from a leading article in one of your contemporaries (the italics are my own):—

"With regard to M. Planchon's letter, while we appreciate the ingenuity of his proposal, we maintain our view that the English sovereign must on no account be interfered with. *It has been for centuries our standard coin*, and is known throughout the world, while all our statistics have been recorded in terms of it; we must not touch the pound. We do not agree that with the pound and shilling we can form a decimal system; the retention of any multiplier other than 10 is absolutely fatal to the simplicity of the system."

Now, in all seriousness, it is scarcely possible to conceive greater confusion of thought than that exemplified in the above quotation. The writer of the article in question does not object to the substitution of our standards of weights and measures, which have, in fact for centuries recorded our statistics, but he is greatly alarmed at the idea of the disappearance of the pound sterling, a measure of value which has not yet reached its one hundredth birthday. He apparently admires the French decimal system in its entirety, with its 20 francs to the louis (the standard gold coin), and yet denies the practicableness of a British system with 20 shillings to the pound. Metrological reformers may well ask to be spared from their friends.

Once rid of the mesmeric influence of high finance, the decimalisation of our present money system presents very little difficulty. By imaginary transactions in the office with all sorts of systems, we speedily ascertain that, with pens, ink and paper, no difficulties are encountered; but when we play shop with our wives and children we realise that in the practical pursuits of everyday life we are up against a totally different problem, and consequently the man who is ignorant of the social conditions of the lower classes must have no say in this question. Clearly, it is the retail, and not the wholesale, trade, or banking fraternity, that dominates the situation. Failure to grasp that essential fact will lead to disaster. Do not be misled by mere platitudes. No country has ever had to face the difficulties that we shall be called upon to face if we decide to make the change, either to a decimal coinage or from our present heavy and dirty copper coins to nickel.

Any change, however small, in a monetary system must cause inconvenience to everyone, and among the less intelligent of the community much confusion. The extent of that inconvenience and the duration of the confusion will be in direct relation to the divergence that will exist between the names and measures of value of the coins in which the masses have been accustomed to think and make their mental calculations and those which are to take their places. In such circumstances it is fairly obvious that for us there are only two possible units. These are a coin of the value of 10d., which we might call a frank, after the French franc, and the present shilling. The question therefore is which of these two units will best meet the difficulties foreshadowed above, and after considerable throught and practice I have formed the definite opinion that there is only one possible solution, and that solution is the adoption of the shilling.

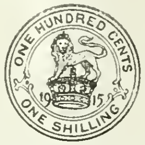
Dealing first with the unit I reject, it must be admitted that the frank scheme has many advantages—at least on the surface—because of the retention of the penny. Truly, the sovereign, half sovereign and bank and Treasury notes present awkward multiples of the unit, but that is nothing. The great defect lies in the fact that as we approach articles of higher value we begin to enter into terms of value to which we are not accustomed, and in this connection elderly people as well as the least intelligent must be considered. Then as to the penny. The old penny value has gone, probably for ever, and one result is the advance of penny goods, and other pennyworths, by percentages grossly in excess of the true rise in prices. One cause of this rise is the foolish unpopularity of the farthing, so that the jump is by half-pence. Then, again, the disappearance of the old penny value may mean a readjustment of the whole of the automatic machine industry, and this opens up a prospect for the quick adoption of clean and light nickel coins of a slight increase over the present penny value.

Now as to the shilling. For all practical purposes our present unit is the shilling, so after all why should we depart from it? We have already seen that the Frenchman is not confused because 20 francs go to the louis, and for the simple reason that he thinks in his unit, just in the same way that every American thinks in dollars, and not in eagles, although in his case 10 dollars only go to that coin. Here a great many people think in pounds; but the vast majority think in shillings, and, as I have shown, it is this vast majority that has alone to be considered, for no Government can compel intelligence.

After the game of shop to which I have referred, it will be fully realised that the simplest of all changes is that from shillings and pence to shillings, nickels and cents. In addition to being capable of almost immediate comprehension, this change provides a coin that may well represent the permanent addition to the present penny value without the injustice to the poorer classes that a unit of higher value would involve. It also gives a greater subdivision of the present penny value, which subdivision is essential unless a substantial increase of wages be given to the working classes. It must not be forgotten that, decimal systems or no decimal systems, the lower classes will always use simple fractions that apply to the number 12. The binary system is ingrained by nature. It is fostered by our divisions of time. It provides the easiest method of computing the cost of small purchases. These are the experiences of all countries throughout the world, and those countries with money units of high value would like to reduce them for those reasons. Hence, therefore, I have no hesitation in putting forward the following scheme as a definite and positive recommendation for a new monetary system for this country.

SHILLING-NICKEL-CENT MONETARY SCHEME.

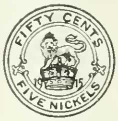
The Unit.



THE PRESENT SHILLING.
Divided into 100 cents. Written 1·00.

The following coins, until called in, good exchange :—12 pennies, 24 half-pennies, 48 farthings, 2 sixpences, 4 three-penny bits.

New Auxiliary Coins.



50 cent piece. Silver. Written 0·50.
The exact equivalent of the present sixpence.

The following coins, until called in, good exchange :—1 sixpence, 6 pennies, 12 half-pennies, 24 farthings, 2 three-penny bits.

25 cent piece. Nickel. Written 0·25.
The exact equivalent of the present threepenny bit.

The following coins, until called in, good exchange :—3 pennies, 6 half-pennies, 12 farthings, 1 three-penny bit.

The nickel. Nickel. Written 0·10.
Equivalent in value to 1¼d. Exchangeable for that sum.

The half nickel. Nickel. Written 0·05.
Two of these coins equivalent in value to 1¼d.

2-cent piece. Copper. Written 0·02.
Equivalent in value to ¼d.

1 cent piece. Copper. Written 0·01.
Two of these coins equivalent in value to ¼d.

Table for Odd Pence.

Pence to	Cents	to pence
¼	0·02	¼
½	0·04	½
1	0·08	1
2	0·17	2
3	0·25	3
4	0·33	4
5	0·42	5
6	0·50	6
7	0·58	7
8	0·67	8
9	0·75	9
10	0·83	10
11	0·92	11

The nickels would be made oblong, with rounded corners, to serve a double purpose—namely, to prevent confusion with silver and to avoid rolling in packing for the banks. Made round and perforated, they would only serve the former purpose. The 2s. piece, 5s. piece, 10s. piece and 20s. piece remain, like the shilling, as before.

On the day appointed for the change the sovereign would become automatically the 20-shilling piece. In a few months from that day it would lose its former identity, both at home and abroad. All existing notes and postal orders would be overprinted with their shilling values. No more cheques or bills of exchange would be drawn in £ s. d. All would be done in shillings and cents. The sixpences and three-penny bits would be withdrawn with all speed, and also the half-crown, because of its association with the sixpence. The two former coins would at once be replaced by others of equal value but with different names. The change in books of account can be made at leisure, and when made would be finished once and for all.

Then in regard to international exchange, what could be simpler than the shilling unit ? International exchange does not mean the exchange of gold coins, but that of paper. We are told that one reason, if not the chief reason, for the adoption of a decimal system is to facilitate international exchange. But if the sovereign is retained as the unit for international exchange in spite of decimal coinage based on a token unit, then obviously the position is as you were, from an international point of view. So much for the expert dictum "you must not touch the pound." Even so, however, a shilling unit would not touch the pound, and international exchange would then be on the basis of 100 shillings. This would be easier to grasp mentally than that of 100 florins, and quite as easy to compute on paper.

PHYSICAL SOCIETY.

A meeting was held on the 24th ult. at the Imperial College of Science, Prof. C. V. Boys, F.R.S., President, in the Chair.

A Paper

"On the Measurement of the Thomson Effect in Wires"

was read by Mr. H. R. Nettleton.

This Paper describes how absolute measurements of the Thomson effect may be made in wires. The theory is fully worked out and the sources of error likely to arise—owing especially to the smallness of the area of cross-section—are considered. The method is sensitive, consistent, and very rapid, and the ultimate object is to determine the Thomson effect at different temperatures in a number of metals, both rare and base, at the same time and with the same specimens finding their thermo-electric powers. The preliminary experiments of this Paper, testing the method, are with constantan wires of different lengths, with manganin, and with German silver.

Mr. F. E. Smith suggested that the method might have been modified by having two exactly similar systems arranged in opposite arms of a Wheatstone bridge, so that the current passed from hot to cold in one wire and from cold to hot in the other. Any change in the relative temperatures of the two wires on reversing the current would be indicated by the bridge being thrown out of balance. This seemed preferable to measuring the temperature of a wire by the resistance of another wire wound round it.

Mr. D. Owen thought the method was very satisfactory. Had the author thought of using electrical heating for the hot end in order to get smaller temperature gradients, in view of the high sensibility of the arrangement ? He thought the figures of Oosterhuis stood in need of verification. If the author could adapt his method to deal with crystals, such as were employed in wireless detectors, the results would be of very great interest.

Dr. R. S. Willows said that it was difficult to see from the equations which Mr. Nettleton had put down on the board whence the energy was derived in cases such as those mentioned in the Paper which Mr. Darling was about to read. In some of these cases dE/dT and d^2E/dT^2 were both zero. It would be useful if the method could be rendered applicable to substances with large temperature coefficients.

Prof. W. Eccles said he had hoped that the author would have explained just what the important points of the method were in a less abstract manner, with the aid, say, of diagrams of the temperature conditions along the wire before and after the current reversal.

The Author, in a written reply, thanks Mr. F. E. Smith for his suggestion, which, however, as regards sensibility, would depend on the value of the temperature coefficient of resistance, and might carry with it additional complications such as those which enter into King's experiments. In reply to Mr. Owen, the use of electrical heaters would simplify temperature coefficient work enormously, but unfortunately there are mechanical difficulties arising out of the facts that the solder fixing the wire must be applied from behind, and that, in order that the resistance of the wire may be measured as a low resistance in situ, the copper must be narrowed down, as shown at K in Fig. 2, leaving a very small bearing surface at N. The author still hopes that he may be able to overcome these difficulties, while ensuring at the same time that the difference of temperature U, measured by the thermocouple is substantially that between the extremities of the wire. He agrees with Mr. Owen that the results of Oosterhuis should be confirmed, as well as those of Aalderink, in view of the extraordinary conclusions to which they lead; at the same time, he has a very high opinion of the methods adopted at Groningue, and his own results on mercury some time ago were not very different from those of Schoute. In reply to Prof. Eccles, the author has himself felt the difficulty of explaining the essence of the method simply and satisfactorily. Graphs of the distribution of temperature afford little help. What is actually done is explained in a few words in section 2 of the Paper, though no simple proof of the formula is given. A "proof" of the formula $\sigma = R(C_2 - C_1)/S\mu$ is obtained very simply by equating the electrical heat produced per second per centimetre—viz., $C_1^2R/SL + C_1\sigma U/L$, when C_1 is passing from hot to cold, to that produced when C_2 is passing in the opposite direction—viz., $C_2^2R/SL - C_2\sigma.U/L$. This proof was omitted not so much because it assumes that σ, R and the temperature gradient are constant everywhere, and ignores emissivity, as because it neglects thermal conductivity, or assumes that Joulean and Thomson heat are propagated similarly. In reply to Dr. Willows, the method is equally applicable to wires of large temperature coefficient. Equation (2B) may then be applied, or equation (2C) if the resistance of the wire be measured directly while under temperature gradient, as suggested in section 4D. The author has no satisfactory explanation of the energy problems arising out of the researches in Holland, or those arising from Mr. Darling's experiments; in the absence of measurements of σ and π there are few data to go upon. In the case of Mr. Darling's experiments, it must be remembered that though with, say, the bismuth silver couple over the range 300°C.-500°C., both dE/dt and d^2E/dT^2 are zero, no additional energy or thermo-electric force is manifest. If the law of successive temperatures is true with Mr. Darling's materials a thermocouple composed of molten bismuth and silver with one junction at 300°C. and the other at 400°C. or 500°C., should show no E.M.F., corresponding to zero Peltier effects and equality of Thomson coefficients.

A Paper

"On the Thermo-electric Properties of Fused Metals,"

by C. R. Darling, A.R.C.S., F.I.C., and A. W. Grace, was read by the former.

One of the authors has for some time been investigating the possibility of using base metal thermocouples at temperatures above the melting point of one of the constituents. For this purpose it was necessary to determine whether any peculiarities in the thermo-electric behaviour of metals occur at fusion. In the case of lead, tin, zinc and cadmium there is no perceptible break in the continuity of the curves obtained. In couples containing bismuth, however, several cases were noted in which the E.M.F. remained constant for a wide range of temperature after the fusion of the bismuth. This occurs with silver, aluminium, iron or nichrom as the other element. Useful applications of this property are discussed. No attempt was made to construct a thermo-electric diagram from the results, as it would be impossible to obtain correct values of dE/dt at all parts of the curves, many of which show small flexures, without making more accurate measurements in the region of such flexures than was practicable.

Mr. A. Campbell, in a communication which was read by the Secretary, remarked that he had made similar experiments ("Proc." Roy. Soc., Edin., 1888) on Wood's metal, an alloy of bismuth melting at 73°C. The results of measurements against iron from 8°C. to 150°C., when reduced to a thermo-electric diagram, gave one straight line up to the melting point, and another straight line, of a different slope, above the melting point. He disagreed entirely with the author's remarks on the usual thermo-electric diagram. A diagram of the thermo-electric powers was most valuable, even though the lines may not be straight at the extreme temperatures. If anything is to be deduced from observed results, the first step is to plot the thermo-electric powers against temperature. Why the authors give results of tests against a whole series of metals is not clear. A set of tests against one metal would have been sufficient to fix the bismuth curve on the thermo-electric diagram, and all the other results could then have been deduced from the curves of the other metals already determined by more exact methods.

The President expressed himself puzzled by the results shown in Fig. 2. Up to the melting point of bismuth the different metals give with it increasing E.M.F.s. At the melting point, however, discontinuities occurred, and it appeared that if one eliminated bismuth by subtracting the ordinates of one curve from another, discontinuities would also occur at the melting point of bismuth, in the properties of the couples obtained by combining the other metals *inter alia*. This, of course, was not true.

Prof. Howe pointed out that there was not a marked discontinuity in the difference of the nickel and copper curves when this was plotted. The President's remarks held, however, in the case of silver with either of the others.

Mr. S. W. Smith pointed out that bismuth was abnormal in that it contracts on melting.

Dr. R. S. Willows mentioned that the metals lead, tin, zinc and cadmium, which had been shown to have no thermo-electric discontinuities at their melting points, happened to be those which, as Mathiessen had found, formed alloys with one another of which the specific resistance could be deduced from the percentage composition. He suggested that the discrepancy mentioned in the case of iron might possibly be due to the occurrence of some allotropic modification, in which case there was really a change in the substance, and it was unfair to extrapolate the thermo-electric diagram beyond the change point.

Mr. Darling, in reply, said he had no doubt that Mr. Campbell's remarks would hold if one could get out the proper thermo-electric diagram. Owing to the numerous little kinks which occur very sensitive temperature measurements are required. If really accurate diagrams could be obtained it might then be possible to deduce the properties of any bismuth couple from those of one, as Mr. Campbell suggested. They had tried this in a few cases, however, but did not get good agreement. He did not know whether the peculiarity of bismuth which had been mentioned was related to the phenomena which they had described. Bismuth was a freak metal in many respects. He was unable at the moment to solve the difficulty raised by the President. Their aim had been, primarily, a practical one, and they had not gone as fully into points of that nature as might have been desired.

PARLIAMENTARY INTELLIGENCE.

THE IMPERIAL INSTITUTE.

In the House of Lords last week Lord Sudeley called attention to the present position of the Imperial Institute and asked for a larger Government grant in order to enable the Institute to carry on its work.

After discussion, Lord Islington stated, on behalf of the Government, that the Executive Council of the Institute met quarterly, and its finance and general purpose committee met monthly. Committees had also been appointed to consider the needs and interests of the chief countries of the Empire. Each Dominion formed its own committee under the High Commissioner. The Union of South Africa and the Dominion of New Zealand had already appointed their committees. A large and representative committee had been arranged for India, and this committee had been charged by the Secretary of State to inquire into the promotion of inter-Imperial trade in regard to Indian raw materials. It was hoped also that the Commission inquiring into the extension of industries in India would have the effect of advertising the great resources in raw materials which that country possessed and its capacity to extend her inland industries.

Several technical committees were working in conjunction with the technical bureau of the Institute. One such committee, formed of representatives of Chambers of Commerce with leading merchants, manufacturers, merchants and scientific specialists, helped by several Fellows of the Royal Society, was working in connection with the utilisation of all raw materials. The scientific work of the Institute was directed mainly to supplying commercial information. It aimed at being a clearing-house for information as to the raw materials within the Empire and the utilisation of them for manufacturing purposes. Such a medium as the Institute was necessary for the realisation of the raw resources of the Empire and for furnishing the scientific ahd technical help required by the commercial community. It was first and foremost an Institute for commercial aims. It had shown successful results such as would not have been gained by a purely scientific laboratory with officials not in touch with commercial needs. Co-operation had been arranged between the Board of Trade and the Institute, and their respective spheres of activity had been arranged. The council of the Institute hoped to work in close co-operation also with the newly established committee of the Privy Council for scientific and technical research, which was charged with the distribution of considerable sums of public money. From that source the council of the Institute hoped to receive aid when more profound scientific and technical research was needed than that which they undertook for their primary commercial aim. The Institute had undertaken the investigation which proved the value of the coal supply obtained in West Africa, the rare earths from Ceylon used in manufacturing gas mantles, and of boxwood from South Africa of the kind formerly obtained from Turkey. With its limited resources and reduced staff the Institute had proved its necessity as an integral part of any scheme of Imperial development. He gave an assurance that the demand for further financial aid would be sympathetically considered.

LEGAL INTELLIGENCE.

Electric Lift Accident.

On Wednesday last the inquest held on Emily Booth, lift attendant at premises in Newgate-street, E.C., who was fatally crushed in an electric lift, was concluded. Evidence was given that deceased had been in the service for a month, and when she had brought a passenger down from the fourth to the third floor the cage suddenly ascended, and Miss Booth was pinned between the floor of the lift and the ceiling.

Mr. Thomas Wm. Corbin, electrical engineer, of Messrs. Price & Belsham, stated that he had visited the premises and found the lift exactly as it had been left after the accident. In conjunction with a representative of Waygood-Otis (Ltd.), he examined the lift, and found a leakage of electric current to earth. The result of the leakage was that the lift would move without the handle being operated and while the door was open. His opinion was that the lift would move at once, and that the leakage occurred just at the time of the accident. That was not a thing that could be guarded against, and the person having control and knowledge of the working of the lift would not recognise it until the accident happened. If the deceased had remained standing in the centre of the lift she would have been quite safe. He located the leakage close to the control handle. He stripped off the metal tubing in which the wires were fitted, and there discovered the leakage. The leakage occurred at a point where the tube went round a sharp corner. One of the wires had become bared and was touching the tubing. A long-continued but slight vibration would account for the break. The covering would be made of indiarubber, a soft material, which was not capable of absorbing the vibration. The abrasion of the outer covering had probably been going on gradually for years. It should have been manifest in the working of the lift, and it was probably made manifest for the first time when the accident occurred. The wiring was properly arranged. He did not think the controlling handle came into the question of the accident at all. There was no means of examining the wiring, and it was merely a conjecture on his part that the vibration did it.

Harold Gates, engineer, said he had never heard of a similar accident to a lift. Quite recently the lift had stopped owing to a dirty contact, which was remedied in a few minutes.

Mr. Charles H. J. Day, a director and engineer of Waygood-Otis (Ltd.), said the lift was put in by his firm 14 years ago, but they had had nothing to do with it for 10 years. He did not think there was a means of detecting a defect by ordinary observation, the wires being in a steel tube and beyond the range of vision. He did not know how such a thing could be provided against; he did not think an insulation test would be infallible, although it might show it. A leakage to earth in his experience was always spontaneous, and not like anything that suddenly developed. If an insulation test were made a fault might occur an hour or two afterwards. The test might reveal a weak spot and cause an accident. He did not agree with Mr. Corbin as to vibration, which would be absolutely infinitesimal. The defect had been suddenly produced. He did not know what was the life of covering or wiring; it depended upon the conditions. In a damp place it might last not more than a few hours, and in others a lifetime.

The jury returned a verdict of accidental death.

S. Taylor v. Dumbarton Burgh and County Tramways Co.

In the Court of Session, Edinburgh, recently, Lord Anderson gave judgment in this action for the recovery of £500 damages for injuries to pursuer's son (James, two years of age) through the alleged negligence of defenders' servants. The accident took place about 3 p.m. on Jan. 27 last. The company had sent a repairing tramway car for repairing an electric standard, and while the car was stationary opposite the standard a number of young children congregated and watched the workmen effecting the repairs. Most of the children were on the north side of the car, where the men were working, but pursuer's son was on the south side of the car stooping, and apparently gathering pebbles. He was close to the dashboard and just in front of the front wheel, and as the car was then started the front wheel on that side passed over the boy's right hand, cutting off two of his fingers and a part of a third. The company denied liability, and that their men were not in fault.

The Lord Ordinary now found for pursuer, and awarded him £150 damages, with expenses, holding that when the car was started the driver looked at the north side of the car to see that there were no children in the way, but did not look at the south side, and therefore failed to observe pursuer's child. That simple precaution to look at the south side was an obvious and reasonable one, and one which, in the special circumstances, should have been taken. Failure to take it rendered defenders liable.

Rating of Electric Tramways. At the London Quarter Sessions last week judgment was delivered in the appeal of the London County Council against the quinquennial assessment by the Holborn Assessment Committee on the tramlines in Finsbury and Holborn. The appeal, which occupied several sittings, was allowed, and the total rateable value in Finsbury was fixed at £6,527, compared with £9,770 appealed against. Costs were also given to the appellants, and an attempt is to be made by the parties to come to an agreement as to the assessment of the lines in Holborn, taking the decision in the Finsbury appeal for their guidance.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. M[illegible], Ellis & Pryor, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

1[illegible] [illegible]

12,1[illegible] Fa[illegible] [illegible] two or more [illegible]

[illegible] W[illegible]

1[illegible] B.T.-H. [illegible]

A [illegible] high-frequency [illegible]

16,36[illegible] Ta[illegible] [illegible]

16,44[illegible] B.T.-H. C[illegible] [illegible]

A [illegible] two electric current waves of different frequencies and of constant amplitudes, which consists in producing a fundamental electric current wave of constant amplitude and of a frequency intermediate between the frequencies of the said two electric current waves and varying the amplitudes of the pulsations of the said fundamental electric current wave to produce an electric current wave with amplitude pulsations which can be resolved into two electric current waves of constant amplitude, the one of a higher and the other of a lower frequency than said fundamental electric current wave.

16,464 Eborall. (Akt. Ges. Brown, Boveri et Cie.) Dynamo-electric machinery.
16,846 Brook & Bishop. Electric switches.
16,994 Berry. Electric heat radiators.
18,114 Wilson. Method of electric welding. (9/7/15.)

1916 Specifications.

572 Welbourn & British Insulated & Helsby Cables. Electric street pillar boxes and similar electrical erections. (13/1/16.) 102,163.
679 Mitchell. Mountings for electric switches and connecting apparatus. (15/1/16.) 102,167.
1,278 MacKay Copper Process Co. Electrolytic battery. (9/4/15.) 100,264.
2,114 Williams. Electric switches. (12/2/16.) 102,184.
2,478 Fildes. Electric conductor grips for relieving the connection of such conductors with electric fittings from pulling strain. (19/2/16.) 102,188.
2,896 Laidlaw. Electrical sounders, hooters or the like for telephone or other purposes. (26/2/16.) 101,753.
6,005 Burgess Laboratories. Dry cells and batteries thereof. (28/5/15.) 100,586.
6,329 Antonio. Telegraphic transmission devices. (3/5/16.) 102,214.
6,483 Campbell. X-ray apparatus. (7/8/15.) 101,143.

Comprises the combination in an X-ray apparatus with a stand and table tiltably mounted on the stand, of an X-ray tube mounted on the table so as to participate in the tilting movements thereof.

8,359 British Westinghouse Electric & Mfg. Co. (Westinghouse Electric & Mfg. Co.) Electric arc lamps. (13/6/16.) 102,221.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

November 28, 1916.

17,034 Manciati. Apparatus for signalling and stopping trains. (22/7/16, Italy.)
17,048 Farthing, Railing & Winstanley. Electric and gas-heating apparatus.
17,060 Akt. Ges. Brown, Boveri et Cie. Latching device for alternating-current electric magnets. (10/1/16, Switzerland.)
17,061 Akt. Ges. Brown, Boveri et Cie. Pivotal connection between alternating-current magnet and its armature. (10/1/16, Switzerland.)
17,068 Snowdon. Electric resistances.
17,074 Hamilton. Electric battery lamp.

November 29, 1916.

17,087 Hope. Electric switches.
17,111 Lane. Solenoid motor.
17,140 Dossor, Kent & Sharp. Rail and tram rail joints.
17,161 Hamburger, Lely & Philips Gloeilampenfabrieken. Incandescent lamps.

November 30, 1916.

17,170 Western Electric Co. High-frequency signalling. (1/12/15, U.S.)
17,189 Callender & Electric Improvements (Ltd.) Protection of electric supply systems with parallel conductors.
17,206 British Westinghouse Electric & Mfg. Co. (Westinghouse C. & M. Co.) Circuit-interrupting systems.
17,209 Berry & Markham. Electric switches.
17,212 Widegren. Controlling electric apparatus by wireless transmission. (20/12/15, Sweden.)

December 1, 1916.

17,231 Warsop. Trolley pole heads.
17,242 Williamson. Holders for arc lamp carbons.
17,244 Branson. Non-flashing trolley arm.
17,260 Crews. Portable telephone and signalling apparatus.
17,261 Campbell & Martin. Controlling electrically governors, valves, &c.
17,271 Norton. Electric switches.
17,273 Pearson. Cells for secondary batteries.
17,275 Cloake. (Cloake.) Flash lamps.
17,277 Widlake. Electric switches.
17,281 Leopard & Johnson & Phillips. Make-and-break switch.
17,286 Casbon & Doble. Attaching shades to electric light fittings.

December 2, 1916.

17,292 Cooper. Electric motors.
17,321 British Westinghouse Electric & Mfg. Co. Electric contacts. (21/1/16, U.S.)
17,334 Akt. Ges. Brown, Boveri et Cie. Time-limit relays. (3/1/16, Germany.)
17,340 Rodriguez. Polarised relays.
17,347 Richards. Treating marble to make it electrically insulating, &c.

December 4, 1916.

17,361 Murtagh. Cooling central electrode of sparking plug.
17,373 Storie. Jointing electric furnace electrodes.
17,388 Fournier d'Albe. Galvanometers.
17,393 Forster. Electrically-operated signal indicators for mines.

December 5, 1916.

17,415 Marlow. Commutator brushes.
17,433 Ewen. Electrically-heated gas jet.
17,450 & 17,453 Gill. (U.S. Light & Heat Corpn.) Systems of electrical distribution.
17,451 Gill. (U.S. Light & Heat Corpn.) Dynamo-electric machines.
17,452 Gill. (U.S. Light & Heat Corpn.) Storage battery systems.
17,476 Marconi's Wireless Telegraph Co. & Schoenberg. Multiplying frequency of electric currents.

December 6, 1916.

17,507 B.T.-H. Co. (G.E. Co.) Electrical discharge devices.
17,520, 17,521 & 17,522 Amps. Projectors, &c.
17,526 Rogers. Electric communicator systems.
17,527 Giddings & Read. Electrical projecting apparatus.
17,528 Armi[illegible] & R[illegible]. Dynamo-electric machinery.
17,529 Br[illegible]mann-Electricitats A.G. Conversion or simultaneous production of alternating currents of different frequency.
17,536 Na[illegible]. Current generators for telephonic, &c., calls.
17,539 Gil[illegible] El[illegible] [illegible]ity. (9/12/15, Switzerland.)

December 7, 1916.

17,553 Bill. Electrical switches.
17,572 V[illegible]. Electrical fire alarm.
17,588 B.T.-H. Co. (G.E. Co.) Electrical discharge tubes.
17,590 Allen & Wanklyn. Electric filament lamps.
17,593 Marks (S[illegible] Tel[illegible]n-Apparate Kabel u. Drahtwerke A.G.) Opening door bolts, &c., electrically.
17,603 Gi[illegible]. Detection of earth connections in electric cables.
17,6[illegible]6 Darker & St[illegible] & C[illegible] Dynamo-electric generators and reversing mechanism therefor.

December 8, 1916.

17,666 Th[illegible] Tran[illegible] (Lt[illegible]). Prevention of sparking in electric machines.
17,66[illegible] Elect[illegible] Metal Product[illegible] Co. Alloy. (29/9/16, U.S.).
17,681 B.T.-H. Co. (G.E. Co.) Dynamo-electric machines.
17,7[illegible] Lan[illegible] Ele[illegible] [illegible] cupboards, &c. (14/1/16, N.Z.)

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Electricity Supply in Australia. Judging by the recent report of the Melbourne Electric Supply Co., the demand for electrical energy, especially for power, continues to increase at a rapid rate in Melbourne and its suburban districts.

During the year ended Aug. 31 the company sold in the Melbourne suburban district nearly 24 million units, compared with less than 17½ millions in 1914-15, and over 1,500,000 units in Geelong, against 1,270,516. In Melbourne suburbs the company has 27,713 consumers, with connections equal to 23,901 kw. for lighting, &c. (against 19,932 kw.), and 20,106 H.P. in motors (against 17,609 H.P.), the total connections being 44,007 kw. (against 37,541 kw.). When it is remembered that the electricity supply undertaking in the City of Melbourne is owned by the Council, and that the total connections to the municipal plant are equal to about 25,000 kw., one can form an idea of the stage of development which the electric supply industry in the Melbourne area has reached. Last year the company's consumers increased by 20 per cent., its power supply by 15 per cent., the total connections by 22 per cent., the units sold by 36 per cent., and the gross revenue by 24 per cent. Owing to the growing demand for energy the directors propose to increase the capital of the company by £750,000, and the borrowing powers by £250,000.

* * * *

Rating of Machinery. Sir Algernon Firth, who presided over the meeting of the Machinery Users' Association last week, referred to the fact that we were now getting passed a considerable number of reforms which had been held up long enough.

He said the Board of Trade had been divided up, and we had got new Ministers for everything except commerce. Possibly Mr. Lloyd George would turn his attention to a Ministry of Commerce before long. Such a Minister was required to take an interest in the subjects which commercial men had been advocating for years.

Dealing with the Rating of Machinery Bill promoted by the association, Sir Algernon pointed out that in Scotland and Ireland machinery was exempted from rating, and it was unjust that the owners of machinery in England should have to bear a burden of rates on their machinery. As machinery owners they had to remember that enormous expenses had been incurred, in many cases out of what had been working capital, in putting down machinery for war requirements. Anyone who bought machinery nowadays had to pay 50 or 100 per cent. in excess of pre-war prices. Much machinery had been purchased in order to cope with Government contracts, and he thought there was a strong argument for an increased allowance in that respect. After the war they would be severely handicapped in their productive capacity owing to the high income tax and the keen competition of neutral countries. He believed there would be a scramble for new machinery after the war. There had been inquiries by the Board of Trade as to whether the allied countries should not have a preference in the supply of machinery. He thought that would be most unjust. We wanted to see the industries of our Allies restored, but at the same time we had to be fair to ourselves, and we must get the first right of supplying machinery to replace much of that which had been working night and day during the war.

* * * *

Empire Industries. Some time ago the Trade and Industry Committee of the Royal Colonial Institute forwarded the undermentioned resolution to the Governments of the Dominions and of Colonies not possessing responsible Government and of Crown Colonies having power to legislate, as well as to Chambers of Commerce, Boards of Trade, &c., in all parts of the Empire:

That, with a view to encouraging the establishment of new industries in the British Empire and giving a measure of confidence and security to capital to be embarked therein, as well as assisting the expansion of existing industries, the Governments of the Empire be urged to make it obligatory on all Government Departments, municipalities, railways, dock and harbour boards, gas, water and electric light corporations, and all such bodies spending public moneys, or enjoying charters from Government or other public authorities, to purchase Empire-made goods, and to place all contracts with British firms, exceptions to be made, by special permission of proper authority, only in cases where such a course is considered to be at variance with public interest.

In forwarding the resolution is was pointed out that it was unnecessary to emphasise that if it is made compulsory in each part of the Empire that Government Departments and municipal and other public bodies place contracts only with British firms, it would prove a strong factor in stimulating the establishment of new and the growth of existing industries as well as consolidating inter-Empire trade.

We are informed that the committee has now received very favourable replies from 25 of the Governments and from 18 of the Chambers of Commerce and Boards of Trade in the principal cities and towns of the Colonies.

* * * *

Trade After the War. A report by a committee of the Newcastle-on-Tyne Chamber of Commerce on Trade After the War, which will be considered at an early meeting of the Chamber, makes a number of interesting recommendations.

The report suggests that manufacturers in kindred trades ought to associate together for mutual advantage, and for introducing their productions abroad they should employ travellers having an intimate knowledge of the language of the country visited; but it is thought such travellers should receive assistance from British Ministers and Consuls.

It is also recommended that the metric system be taught in schools, with a view to its universal adoption, and other educational reforms are advocated.

The establishment of a Ministry of Commerce is strongly advocated, and also State-aided trade banks.

Reciprocal preferential trading should be created in the Empire, and the resources of the Empire should be developed and kept under control. Enemy aliens coming to this country should have to take out permits of residence. No hotels, &c., be allowed to employ servants of enemy nationalities, and similar restrictions should be imposed with regard to clerks, teachers, musicians, &c., to remain in force for at least 10 years. No enemy aliens should be allowed to own shares in British companies, and trading should be only allowed under licence and restriction, while alien commercial travellers should also be licensed.

As to the relations of capital and labour after the war, an early round-table conference of leaders of both sides is recommended.

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Business Libraries. The movement for the creation of commercial and business libraries is developing. Following the example of Glasgow Manchester Libraries Committee has now decided to form a commercial library and information bureau.

The directors of the Royal Exchange have expressed their approval of the scheme, and it is hoped that they will be able to place at the disposal of the committee the requisite accommodation in the enlarged Exchange building. The proposed library would contain reference books including business encyclopædias, statistical and trade year books, dictionaries of foreign languages, calculating tables and tables of foreign currencies and weights and measures, a collection of the best books dealing with the textile, engineering and other staple trades of Lancashire; books on commercial law, banking, accounting, advertising, office methods, business organisation, salesmanship, and the different commercial products; consular reports, Board of Trade publications, reports of chambers of commerce, commercial atlases and maps, railway and steamship route maps, railway and shipping publications, &c.; also commercial, financial and business papers and journals, telegraphic and cable codes, telephone directories for the principal towns of Great Britain and directories of various kinds. In addition the library would include the various trade gazettes issued by the Board of Trade and by the British Dominions and colonies, as well as trade circulars, &c. Another feature will be a file of clippings from the chief daily newspapers, foreign papers and selected trade journals, containing the most recent information on trade conditions, and so arranged by subject as to be instantly available.

* * * *

Trade Conditions in New Zealand. British manufacturers who export goods to the overseas dominions are recommended to see that they are marked "British made."

H.M. Trade Commission in New Zealand states that in a market such as New Zealand, where there is a keen desire to purchase British goods whenever possible, such a description would have a strong selling force.

There is at present great difficulty in obtaining supplies from British manufacturers, especially of electric tramway and lighting material and fittings. At Auckland tramway extensions are held up for want of material and equipment, and at Wellington electric light plant ordered 18 months ago in England has not yet arrived. The difficulty in maintaining old-established connections between British manufacturers and New Zealand are understood, but even if British houses cannot supply the goods, or not in such quantities as required, it is important to maintain the existing connection by regular correspondence and other methods,

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 18, 1916, *to* Dec. 23, 1916.

IMPORTS.

LONDON.—*U.S.A.:* Wire and cable, £255; elec. machinery, £1,142; unenumerated, £5,203. *Holland:* Elec. glow lamps, £1,878; unenumerated, £3,017. *Japan:* Unenumerated, £3,773. *France:* Unenumorated, £520. *Norway:* Unenumerated, £1,064.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £244. *Melbourne:* Elec. machinery, £349; unenumerated, £1,971. *Sydney:* Elec. machinery, £1,710; wire and cable, £133; unenumerated, £1,671. *Wellington:* Elec. machinery, £21; elec. lamps, 1,400 n.o.; unenumerated, £771. *Lyttelton:* Wire and cable, £164; unenumerated, £207. *Adelaide;* Elec. machinery, £116; unenumerated, £338. *Christchurch:* Wire and cable, £1,279; unenumerated, £1,056. *Brisbane:* Wire and cable, £884; elec. machinery, £39; unenumerated, £519. *Perth:* Unenumerated, £22. *Hobart:* Unenumerated, £180. *Dunedin:* Wire and cable, £642; unenumerated, £642.

AFRICA.—*Durban:* Elec. machinery, £95; wire and cable, £392; unenumerated, £321. *Cape Town:* Elec. machinery, £172; unenumerated, £593. *Port Elizabeth:* Elec. machinery, £195; unenumerated, £249. *East London:* Unenumerated, £266. *Napier:* Unenumerated, £61.

EGYPT.—*Alexandria:* Telegraph material, £730; elec. lamps, 2,658 n.o.; wire and cable, £828; unenumerated, £142. *Port Suez:* Unenumerated, £10. *Port Sudan:* Elec. machinery, £2,305.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £36; unenumerated, £421. *Calcutta:* Unenumerated, £112. *Madras:* Wire and cable £217; elec. machinery, £382. *Ceylon:* Unenumerated, £219. *Singapore:* Unenumerated, £111.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. machinery, £45; unenumerated, £27.

HOLLAND.—*Amsterdam:* Wire and cable, £1,358; glow lamps, £1,557; unenumerated, £100. *Rotterdam:* Wire and cable, £597; unenumerated, £52.

FRANCE.—*Paris:* Elec. machinery, £940; unenumerated, £691. *Dieppe:* Unenumerated, £491. *Boulogne:* Wire and cable, £315; elec. machinery, £1,100; unenumerated, £28.

CANADA.—*Toronto:* Elec. machinery, £253. *Montreal:* Unenumerated, £46.

SPAIN.—*Lisbon:* Wire and cable, £411; unenumerated, £228.

DENMARK.—*Copenhagen:* Elec. machinery, £26.

SWITZERLAND.—Elec. carbons, £549.

ITALY.—*Genoa:* Wire and cable, £14; unenumerated, £76.

U.S.A.—*New York:* Elec. machinery, £8; unenumerated, £1,053.

JAPAN.—*Kobe:* Unenumerated, £291.

FOREIGN GOODS (duty paid and free).

Paris: Elec. lamps, 224 n.o.; unenumerated, £220. *New York:* Unenumerated, £115. *Lisbon:* Unenumerated, £27. *Melbourne:* Elec. meters, £90; unenumerated £3. *Port Elizabeth:* Unenumerated, £20. *Bombay:* Unenumerated, £65. *Brisbane:* Unenumerated, £127. *Cape Town:* Elec. lamps, 254 n.o.

IN TRANSIT.

Melbourne: Elec. lamps, £1,045.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

ELECTRICITY SUPPLY.

EXTENSIONS.

Bedford.—Last week the Electricity and Street Lighting Committee submitted a report of the electrical engineer (Mr. R. W. L. Phillips) on a proposal to supply electricity for power and lighting to a factory near Bedford.

Mr. Phillips attached great importance to the advantage that would accrue to the undertaking by supplying the customer. The present turbine set had effected a saving of over 20 per cent. in coal consumption, but owing to the steady increase in the demand the older plant was daily having to be brought into operation for longer periods with a consequent falling off in economy. If another turbine were installed a further 20 per cent. saving in coal could be effected, equivalent to about £2,000 a year at the present prices of coal. If it became necessary to stop the turbine for repairs the coal bill would be increased by about £70 a week, and if it broke down, it would not be possible to cope with the present load. By accepting the new customer, plant could be obtained in the shortest possible time and on terms as good as would be obtainable for many years. The cost of the extensions would be £34,076, but the owners of the factory would pay the cost of the mains outside the borough (£3,800) and 25 per cent. of the cost of the mains in the borough and the transformers (£1,319). There would be a guarantee of a minimum revenue of £2,800 per annum for five years, and supply would be given at the ordinary rates for combined power and lighting. For £28,957 the capacity of the station would be increased by 1,560 kw. to meet the increased demand of 600 kw., the balance being available for other business.

The Committee recommend that the terms and conditions be approved, that the L.G. Board be asked to sanction a loan up to £30,000 for the works outside the borough and that the Board of Trade be asked to grant a licence to supply electricity outside the borough.

Consideration of the matter has, however, been adjourned.

Lancaster.—The L.G. Board has sanctioned a loan of £640 for booster plant, to be repaid in 15 years.

Luton.—The electrical engineer (Mr. W. H. Cooke) reports that in the near future it will be necessary to lay additional mains in the Langrave-road and Kimpton-road districts.

Radcliffe.—Application has been made to the L.G. Board for sanction to borrow £936 for additional expenditure in providing supplies of electricity for power purposes.

Shipley.—The Electricity Committee has instructed the electrical engineer, Mr. W. Redman, to report at their next meeting on a proposal to supply electricity in Baildon, giving figures of the probable cost, an estimate of the probable demand, &c.

GENERAL.

Bradford.—For many years electric supply consumers have been given a free supply of electric lamps, but the Electricity Committee has given notice to consumers of the intention to discontinue the supply after the 31st inst.

In future consumers will have their discounts increased in lieu of receiving free lamps.

Dover.—The Ministry of Munitions has asked the electric supply department to release further men for general service, but great difficulties are already experienced in the staffing of the department.

The electrical engineer, Mr. L. W. Woodman, reports that he has failed to obtain substitutes for an engine driver and a boiler attendant, and the two drivers are now doing 12 hours' duty. The Council have left the matter in the hands of the Chairman of the Electricity Committee (Coun. Walmisley) and Mr. Woodman.

East Ham.—The hirers of flame arc lamps whose contracts are in abeyance owing to the restricted lighting regulations have been permitted to use their lamps during the Christmas season at 4d. per lamp per hour for flame arcs and 3½d. per lamp per hour for single and closed lamps.

Electricity in Mining.—At the recent meeting of the Daggafontein Mines (Ltd.) it was announced that the directors had entered into a contract with the Victoria Falls & Transvaal Power Co. for the supply of electric power, the conditions of the agreement being similar to those made by Brakpan and Springs mines.

Increased Chasres for Electrical Energy.—Increases are being made in the charges for electrical energy at the following places:—

Dorking Urban Council recently received from Edmundson's Electricity Corporation a request for their sanction to a continuation of the increase of 10 per cent. in the charges for current (already in operation) and also to a further increase of 10 per cent. The Council adopted the Finance Committee's recommendation that a further increase of 5 per cent. for lighting only be approved.

Islington Borough Council have increased the charges for current by 10 per cent., making 25 per cent. over pre-war prices.

Paisley Council has decided to increase its charges for electrical energy by ½d. per unit for lighting, and a new scale for power has also been adopted.

Linking-up in Lancashire.—The inter-borough electricity supply scheme has been inaugurated at Accrington, Haslingden and Rawtenstall.

Haslingden has hitherto taken all current from Accrington, but owing to the increased demand for power at Accrington Haslingden supply is now given by Rawtenstall. In case of emergency Accrington can give a supplementary supply to Rawtenstall, or Rawtenstall can similrarly help Accrington.

Manchester.—At last week's meeting of the Electricity Committee it was reported that one day in the previous week over 800,000 units were consumed, the power load being 62 kw.

This is a record for the undertaking. It is estimated that for the current year the output will reach 183 million units, compared with 114 million units two years ago. A member of the Committee stated that if they had had the Barton plant at their disposal many new industries would have been permanently established within the city.

Ripon.—The Council have postponed their proposed application for a provisional electric lighting order.

St. Pancras (London).—Owing to the difficulty in getting cables and wires, no more private lighting connections are to be made during the war, and until the new plant at King's-road station is in operation only certain applications for power will be entertained.

The electric supply department has obtained a Government permit to obtain materials for repairs, &c., as under:—

Copper materials required for repairs essential to maintain the existing plant and the supply of electricity to the present consumers on condition that every three months detailed returns of the total quantities of various forms of materials obtained hereunder during the preceding three months shall be made to the Priority Branch. No materials obtained under this permit are to be used for any new plant, or for providing electric power to new customers or extending supplies to old ones.

The General Purposes Committee recommend that the salary of Mr. T. W. Merry, superintendent at King's-road station, be increased from £208 to £233 per annum, with a further increase a year hence to £250 per annum.

Southampton.—The mains on the western shore have been flooded three times recently, and remedial measures are to be taken, at a cost of £125.

The greatest difficulty is being experienced in getting spare parts of machinery, as makers are not allowed to put spare parts in hand without a special permit from the Government. Recently the electrical engineer (Mr. H. F. Street) reports that he wanted 1 in. diameter steel spindles for the coal conveyor, at a cost of less than £20, but though he had written to the Ministry of Munitions twice for a permit no reply had been received. That was, he thought, due to pressure of work, but he asked that strong official representation be made to the Ministry of Munitions on the matter, as electric supply stations are furnishing power to large numbers of factories, and they should be granted equal facilities for getting necessary spare parts as Government departments.

A satisfactory increase is reported in the load on the station, which is now closely approximating that of the winter before the war. Additional boiler accommodation will be required before or at the time the lighting restrictions are withdrawn.

Southend-on-Sea.—In a report the borough electrical engineer (Mr. R. Birkett) states that the capacity of the existing plant at the generating station and in the battery room was 3,220 kw., and that the demand upon the plant would, at the termination of the war, amount to 3,800 kw.

As a margin of 500 kw. will be necessary as a stand-by, Mr. Birkett thinks it will be necessary to take into consideration at an early date the desirability of acquiring two 750 kw. steam generators which could be installed in the existing floor space available, thus avoiding the expense of carrying out extensions to the engine room. A sub-committee of the Electric Lighting Committee is to consider the matter.

For the period of the war the charge for power to factories, &c., between 6 p.m. and 6 a.m. will be 1d. per unit, plus 10 per cent.

A recommendation by the Highways and Works Committee that notice be given to the Southend Gas Co. to determine the existing agreement for public lighting has been rejected by the Council, by 6 votes to 16.

Whitehaven.—It is proposed to increase the salary of the acting electrical engineer to £250 per annum.

TRACTION NOTES.

Edinburgh.—A report on the present position and future policy towards the tramways has been drawn up by the town clerk, Sir Thos. Hunter.

The report states that the tramway service can only be continued at the close of the lease in two ways: (1) By continuing the cable system, or (2) by installing a new system to supersede it. If the latter alternative be adopted, it will be necessary to provide 200 tramcars by July 1, 1919. In normal times this would have been difficult, but the work now would have to be done to a greater or less extent (if done at all) under war conditions. The Ministry of Munitions had placed an embargo on that work and the experts said that unless that was removed by July next the new cars could not be provided in time. There were other questions, including the supply of electric current for the tramways. The new electric station at Portobello was being proceeded with until stopped by the Minister of Munitions, but the present contracts form only one-fifth of the scheme. In the circumstances, could it be regarded as likely that the Corporation would be able to supply current for the tramways by July, 1919?

With regard to the continuance of the cable system for a time, Sir Thos. Hunter states that, even it the Corporation should be willing to obtain new cable cars, the same reasons made it impracticable in present circumstances. The only course open to the Corporation was to purchase the company's cars. There was no provision in the lease for the disposal of the rolling stock. The Corporation were not bound to purchase and the tenants were not bound to sell. The question must be settled by arbitration, but it depended also on the consideration whether they had an alternative open to them by which they could be ready to take over the service on July 1, 1919.

L.C.C. Tramway Employees.—At last week's Council meeting the Highways Committee reported that at a meeting of the Electrical Conciliation Board on Dec. 13 an agreement was arrived at in regard to applications for increased wages by employees in the electrical section of the tramways department.

The following increases were agreed upon: To conduit cleaners and gangers and assistant gangers of conduit cleaners, ½d. per hour; to bricklayers, ¼d. per hour (to be regarded, in the advance of ¾d. obtained under the agreement of Nov. 25, 1915, as war wages). The Highways Committee recommended that the agreement be accepted.

The Committee also recommended the adoption of a new scale of wages for apprentices and youths in the tramways department equivalent to an increase of about 2s. 6d. a week to apprentices and ½d. an hour in the case of youths.

Southampton.—The Tramways Committee has increased the salary of the manager (Mr. W. T. Robson) from £400 to £500 per annum.

Owing to the lighting restrictions the evening tramway service is to be curtailed.

As a result of the ticket stocktaking for the past year, tickets of the face value of £108 are unaccounted for, and after full investigation the tramway manager (Mr. W. T. Robson) thinks that the discrepancy is due to the transition from male to female employés. When women conductors were first employed in August, 1915, the ticket office staff was replaced by girls. Owing to the work being intricate, and in many cases far beyond the understanding of the women conductors taken on, mistakes in booking were extremely frequent, and were not always detected by the inexperienced ticket-room staff.

Mr. Robson states that girls are much more careless about losing tickets than the men were, although this fault has been greatly remedied of late by adopting stern methods. A ticket error book has now been adopted, which automatically prevents error through this cause. A great number of tickets were used in the women's training room, and at one time a large number of these were taken from stock and not booked up. There is now a double check on these tickets, and such a discrepancy in future is safeguarded against. The fact of omitting to send in tickets at the proper time may have resulted in many packs being missing during the stocktaking in April, and possibly next year when stock is taken a large number of the tickets short may be found. Mr. Robson is absolutely satisfied that there has been no monetary loss, and that the shortage is purely a paper one. The general habit of th girlse is to empty their bags and hand in everything they have got many of them being practically incapable of working out their waybills absolutely correctly.

Southend-on-Sea.—Application has been made to the Board of Trade for permission to use double-decked tramcars on the light railways.

In view of the difficulty of securing the necessary tyres, steel and other material required for maintaining and running the tramways, the electrical engineer (Mr. R. Birkett) has been authorised to purchase from time to time any material required, provided he obtains the sanction of the chairman.

Surbiton.—The Council have decided to purchase two electrically-propelled dust vans at £2,050.

For the current year the removal of house refuse in the district will cost £1,458, an increase of nearly £400 over 1914-15, and the Council were recommended to purchase two electrically-propelled dust vans at £1,025 each. A sum of £500 will be paid at once, and the balance by instalments spread over three years, with interest at 6 per cent. per annum. With two vehicles and five fillers the whole of the house refuse in the district could be collected once a week, and after the vehicles were purchased (at the end of three years) the cost of the dust collection would be about £530 per annum less than the cost of doing the work by the present system. In addition, the Council would have purchased the two vehicles outright, and would have a depreciation fund at the bank amounting to nearly £600.

York.—The Tramways Committee has been asked by the Education Committee to establish a parcels delivery service or to use a motor delivery van in order to reduce the number of errand boys engaged in "blind alley" occupations; but the Tramways Committee is unable to extend the existing system until after the war.

TELEGRAPH AND TELEPHONE NOTES.

Indian Government Telegraphs.—The annual report of the Indian Posts and Telegraph Department for 1915-16 contains the following informatiom:—

Inland telegrams show an increase over the preceding year of 1,158,289 (about 8 per cent.) in number, and Rs. 5,89,473 (about 6 per cent.) in value. State telegrams decreased 1 per cent., and private telegrams increased 7 per cent., and their total value 8 per cent. The outbreak of war checked the normal growth of this traffic, but the check was only temporary, and the total number of inland private telegrams is not appreciably less now thn it would have been in ordinary circumstances. Press telegrams increased 4 per cent., and their value 3 per cent., partly due to the war and partly to normal expansion of newspaper activities.

London Telephone Operators.—The Assistant Postmaster-General (Mr. Pike Pease) recently stated that, including resignations for the purpose of marriage, the number of telephonists in London who resigned during the past 12 months was 661 out of a total of over 4,000.

Radiotelegraphy in Brazil.—It is announced that radiotelegraphic communication is now available between Manaos and Porto Velho. There are 700 miles of forest intervening which precluded the erection of wires.

Reduction of Telegraph Rates.—The Great Northern Telegraph Co. notifies that on the 1st prox., the rate for telegrams to Iceland and the Faeroe Islands will be reduced to 4d. and 3d. per word respectively.

MISCELLANEOUS NOTES.

Birmingham Chamber of Commerce.—Formal possession has been taken of the block of buildings in New-street which will form the new premises of the Chamber.

Of the £50,000 appealed for about £30,000 has been obtained, and as soon as circumstances permit arrangements will be made for extending the work of the Chamber, including the formation of a commercial reference library.

Economies in Metals.—The Minister of Munitions announces that the recently appointed Metals and Materials Economy Committee which is presided over by Mr. C. W. Fielding, will

> "Consider and suggest the action necessary to secure economies in metals and materials as regards their use in munitions of war, taking into consideration matters affecting design, methods of purchase, stocks, import, distribution and control: with powers to take such evidence as may be necessary both from the Departments of the Ministry and from manufacturers."

Enemy Firms Wound Up.—The Board of Trade has ordered the winding-up of 391 businesses controlled by alien enemies.

The latest list includes: Motor Car Emporium (Ltd.), 11, Long-acre, London, W.C., dealers in motor cars; Mechanical & General Inventions Co. (Ltd.), 11, Long-acre, London, W.C., dealers in mechanical and general inventions; Salsbury Co. (Ltd.), 11, Long-acre, London, W.C., dealers in lamps and accessories; H. Traun & Sons, 25, Goswell-rd., London, E.C., manufacturers of ebonite and vulcanite goods; Massinga Synd., Ltd., 701, Salisbury House, London, E.C., rubber company. (Controller: A. B. Lucas, 19, Coleman-st., London, E.C.)

Exports to the Netherlands.—By an Order in Council contained in Tuesday's "Gazette," the exportation to the Netherlands is prohibited of all articles except those specified below, unless the articles are consigned to the Netherlands Oversea Trust and other authorised persons.

Exports of the following articles are permitted without restriction: Printed matter, empty receptacles returned to the Netherlands, worn clothing and other personal effects, live animals other than animals ordinarily used for human food, sanitary earthenware, pottery and common earthenware, books, dolls and toys (except electric torches), wooden clock cases, slates and slate pencils, &c.

German Industrial Council.—On Oct. 25 last it was decided to form the Zentral Verbandes Deutscher Industrieller, in order to take measures to organise and develop German industries after the war. The council consists of 54 members.

Municipal Loans.—The New Municipal Loans Act, authorises local authorities to raise money for discharging any outstanding, or for replacing any sinking fund money or other sums which may be used for purposes for which they had power to borrow, or for raising any further sums which the appropriate Government Department may authorise; and also to issue bearer bonds in neutral countries.

The new powers, which are for the period of the war and six months thereafter, will be useful to local authorities owning electric supply works and tramways, &c., as many extension schemes are being held up at present, and much capital will be required for these undertakings. The provisions of the new Act may also be applied to Urban Councils by the appropriate Government Department.

Sale of Cranes.—The Minister of Munitions has issued the following order:

No person shall until further notice sell or supply any crane, whether steam, electric, hydraulic or hand-driven, except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions.

Note.—All persons shall forthwith send in to the Director, TM 4 (Cranes), Ministry of Munitions, Armament Buildings, Whitehall-place, London, S.W., returns containing full particulars of all cranes, whether steam, electric, hydraulic or hand-driven, in their possession, or under their control, which may be for sale.

All applications for a permit in connection with the above order should be addressed to the Director, TM 4 (Cranes), Ministry of Munitions, at the address given, giving full particulars of the crane, maker's name, and number of machine, name and address of intending purchaser, price to be paid and the purpose for which the crane is required.

"Syren and Shipping" International Mercantile Diary, 1917.—We have received a copy of this book, which contains many tables and much useful information for those engaged in trade and commerce.

A special feature is the foreign exchange tables arranged so as to enable any sum to be converted, at any rate of exchange, to or from sterling. There is also a large collection of tables for converting British into foreign weights and measures. The whole of the tables are in the decimal system, and the publishers (Syren and Shipping (Ltd.), 91 and 93, Leadenhall-street, London, E.C.) claim that it is an "illuminating proof of how easily the decimal system can be adapted to the present British systems of currency and weights and measures." The Diary also gives geographical, vital, industrial and other statistics of the United Kingdom, the British Colonies and foreign countries, &c. The published price is 5s. net.

Training of Disabled Soldiers.—A school for training disabled soldiers has been established by the Newcastle-on-Tyne Electric Supply Co. with the active support of the Institution of Electrical Engineers. The school is at the Wallsend station of the company. Theoretical and practical training is being given in the control of switchboards, after which it is hoped to find permanent employment for a number of men. The period of tuition is four hours a day for six weeks. The men are to be under 35, and have fairly good use of their limbs, although the loss of an arm or a leg is not an obstacle to their employment. During the tuition period the men are being paid 25s. a week, and will subsequently earn 30s., with 8s. 6d. war bonus. At the end of another fortnight, when the men now in training have received six weeks' tuition, there will be vacancies for a fresh contingent.

Tribunal Cases.—At Hull Tribunal last week it was stated that tramway motormen were in a certified trade, but not necessarily exempt from military service. A motorman made a claim for exemption as in a certified occupation, but his claim was disallowed.

Before the Plymouth Panel of Devon County Appeal Tribunal last week the directors of the Dawlish Electric Light Co. appealed for the further exemption of their engineer-manager and secretary, Mr. Chas. C. Hodges (30), who had previously been given until Nov. 30. The military opposed on the ground that the man could be spared. Dr. C. N. Lovely (director) said every effort had been made to obtain a substitute without success, and Mr. Hodges was the only competent man they had. If he were taken they would be bound to shut down.

The military representative said there should be men disabled from the army available for such a post. Conditional exemption until May 1 was granted, leaving the question of substitution to the military.

At Glasgow an electrician in a theatre was granted exemption conditionally on his undertaking work of national importance.

TENDERS INVITED.

Telegraph and Telephone Material.

Tenders are invited by Jan. 10, 1917, for the supply and delivery to the Postmaster-General's Department, State of Western Australia, of telephone instruments and parts (W. A. Schedule No. 497). Tender forms, specification, &c., can be obtained at the Commonwealth Offices, 72, Victoria-street, S.W.

The Deputy Postmaster-General, Perth (Western Australia), also requires tenders by 3 p.m. Jan. 10 for various Telephone Switchboard Parts (schedule 531 W.A.) for the Australian Commonwealth, Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General, Perth, Western Australia.

Electric Light Wire.

The Victorian Railway Commissioners, Melbourne, require tenders by 11 a.m., Feb. 7, for supply of v. r Electric Light Wire (p. d. ½ per cent.). Particulars from the Contractors' Room, Victorian Railway Commissioners' Offices, Spencer-st., Melbourne.

Turbo-Alternators, Condensing Plant, Motor-Generator, Motors, &c.

West Ham Council invite tenders by 10 a.m. Jan. 11 for a Water-tube Boiler and a 3,000 kw. Turbo-alternator. Specification from the engineer and manager, Mr. J. W. Beauchamp, 84, Romford-road, Stratford, E.

Durban Corporation want tenders by 11 a.m. Jan. 3 for a 3,000 kw. Steam Turbo-alternator and Condensing Plant. Specification (No. S.238) from Borough Electrical Engineer.

Melbourne (Victoria) Council require tenders by noon, March 5, for supply of a 7,500 k.v.a. Turbo-alternator. Specification from the Town Clerk.

Cape Town (S. Africa) Corporation require tenders by noon Jan. 5 for supply of Electric Motors and Starting Panels. Specification, &c., from the Electricity Department.

The Australian Commomwealth Navy Department, Melbourne (Victoria), require tenders by noon Jan. 31 for supply of Dynamos, Switchboards, Motors, Balancers and Control Gear for Flinders Naval Base. Specifications from Director of Navy Contracts, Melbourne, and the Naval Staff Offices, Brisbane, Sydney, Birkenhead (S. Australia), Fremantle and Hobart.

Tower Wagon.

WIGAN Tramways Committee require tenders by noon Jan. 8 for the supply of a 30 H.P. Motor Tower Wagon. Particulars from the General Manager.

Meters, M. D. Indicators, &c.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Feb. 19 for supply of meters, maximum demand indicators and feeder regulators. Specifications, &c., from the Electric Lighting Dept., Town Hall, Sydney.

Electric Crane and Coal Transporter Plant.

The N.S.W. RAILWAY AND TRAMWAY DEPARTMENT require tenders by Jan. 3 for a 50-ton Electric Overhead Travelling Crane for Zarra-street power house, Newcastle (N.S.W.). Specification (No. 474) from the Electrical Engineer, 61, Hunter-street, Sydney.

TENDERS RECEIVED AND ACCEPTED

SOUTHAMPTON.—The Council has placed an order with the Chain Belt Co. for an elevator for a new coal bunker, at £78.

SURBITON.—The Urban Council have placed an order with Edison Accumulators (Ltd.) for the supply of two electrically propelled dust vans, at £2,050.

BRADFORD.—The following tenders have been accepted :—

Hadfield's (Ltd.), 12 sets of manganese steel points, £588 ; Brush Electrical Engineering Co., one 50 k.v.a. and two 300 k.v.a. transformers; Ferranti Limited, one 50 k.v.a. and two 300 k.v.a. transformers.

WOLVERHAMPTON.—The Electricity Committee has accepted the tender of the British Thomson-Houston Co. for a turbine-driven boiler feed pump at £421 and that of Ransome, Sims & Jefferies, at £630, for a 2½-ton Orwell Electric lorry.

NEWPORT (MON.)—The Council has placed an order with the British Westinghouse Electric & Mfg. Co. for converting plant and accessories at £1,615, and that of the British Thomson-Houston Co. for switchgear at £279. 8s.

ACCRINGTON.—The Council have accepted the tender of W. T. Glover & Co. for 220 yds. of 7/20 S.W.G. cable.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Adelaide.—Western Electric Co., 1,000 microphone mouthpieces, 3½d. each ; India Rubber Gutta Percha & Telegraph Works Co., 600 battery boxes, 2s. 4d. each.

Postmaster-General's Dept., Perth (*W.A.*).—J. R. W. Gardam, 1,949 ft. telephone cable, £2,450 per mile ; British Insulated & Helsby Cables, 7,915 ft. telephone cable £3,090 per mile, 672 ft. ditto £1,885 per mile, 2,470 ft. ditto £1,420 per mile, 1,233 ft. ditto £970 per mile, 3,200 ft. ditto £645 per mile, 600 ft. ditto £505 per mile, 1,320 ft. ditto £225 per mile, 2,640 ft. ditto £180 per mile, 22 Morse sounders 19s. 4d. each ; Automatic Telephone (Australia) (Ltd.), 96 terminal blocks, 12s. 6d. each ; E. A. Machin & Co. (Ppy.), 25 telegraph switches, 17s. 3d. each ; Diamond Engineering & Trading Ppy., 2,000 dry cells 3s. 7d. each, 300 ditto 2s. each, 500 ditto 1s. 4d. each, 200 ditto 1s. 5d. each ; W. T. Henley's Telegraph Works Co., 3 miles tinned h.d. copper wire, £34 per mile ; Alcock & Co. (Pty.), 12 lb. copper wire silk covered 4s. 6d. per lb., 4 lb. ditto 5s. per lb., 10 lb. ditto 5s. 6d. per lb., 3 lb. ditto 6s. per lb., 3 lb. ditto 6s. 6d. per lb., 3 lb. ditto 12s. per lb., 2 lb. ditto 15s. 6d. per lb., 5 lb. enamelled copper wire 2s. 6d. per lb., 1 lb. ditto 2s. 9d., per lb., 4 lb. ditto 3s. per lb., 6lb. ditto 3s. 3d. per lb., 3 lb. ditto 3s. 6d. per lb., 4 lb. ditto 3s. 9d. per lb., 2 lb. ditto 5s. per lb., 10 lb. ditto 12s. per lb., 2½ miles rubber insulated tinned annealed copper wire £13. 11s. per mile.

Commonwealth Railways.—A. H. McDonald & Co., 25 kw. generating set for Darwin Jetty, £973; British Insulated & Helsby Cables, 1,200 yds. stranded copper cable for Port Darwin, £180.

Victorian Railways, Melbourne.—Electrolytic Refining & Smelting Co., sulph. of copper, £50 per ton ; India Rubber, Gutta Percha & Telegraph Works Co., battery zincs (4 lb.), 4s. 4½d. each ; Edison Swan Electric Co., fibre conduit for Jolimont car shed, £3, 12s. 2d. per 100 ft.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Cardiff.—At the last meeting of the Electric Lighting and Tramways Committee the City Treasurer presented reports on the year's working of the electric supply and tramway undertakings for the year ended March 31.

The electricity department's accounts showed gross capital expendi-ure £305,775 (increase £7,585), of which £160,466 is outstanding. Revenue was £67,842 (an increase of £5,497 over the previous year), and working expenses were £38,931 (increase £1,368), leaving gross profit 28,911 (increase £4,129).

The capital expenditure on the tramways amounts to £813,849, of hich £445,296 is outstanding. Revenue was £167,793 (increase 3,111), and after providing for working expenses, £5,326 for employés n military service, and capital charges, there was a net surplus of 20,524, of which £6,916 has been placed to depreciation.

Dover.—At March 31 the gross capital expenditure of the electric upply department was £192,184 (increase £277), of which £136,286 outstanding.

Revenue was £23,586, working expenses were £13,572, and gross profit as £10,013. Interest required £7,593 and sinking fund £4,174. The et deficit (£1,754) is being met from the balance of £3,080 brought rward. Revenue per unit (from all sources) averaged 3·60d. (against 06d. in previous year), and total costs (other than interest and sinking und) were 2·07d. (1·75d.). Units generated were 1,868,532 and sold 572,6·4. The total maximum demand was 483 kw. a.c. and 350 kw.d.c.

Dublin.—The accounts of the electricity department for the year nded March 31 show total capital expenditure £857,350 (increase 2,594).

Revenue was £121,883 (increase £19,443), working expenses were 0,461 (compared with £50,444 in previous year), and after providing for pital charges, &c., the total surplus carried forward is £16,443. Total st per unit sold was 2·69d. (against 2·62d.), and average price obtained as 2·80d. (2·56d.). Units sold were 10,338,324 (9,519,545). Total aximum supply demanded was 7,228 kw. (7,486 kw.).

Edinburgh.—The accounts of the electric lighting undertaking for e year ended May 15 show gross capital expenditure £1,161,654 ncrease £19,487), of which £601,812 has been repaid.

Revenue was £139,136, and working and general expenses (including 792 paid to employés on active service and their dependents) were ,477, leaving gross profit £59,659, to which was added £8,075 taken m reserve to make up the £67,735 required to provide for interest 8,347), instalment towards liquidation of debt (£45,596) and income tax (£3,791). Units generated were 21,253,313 (compared with 21,656,606), and sold 17,373,558 (17,875,406).

Greenock.—There was a good attendance of members at the last meeting of the Greenock Electrical Society to hear Mr. James Nichol's Paper on "The Art of Wiring."

Mr. Nichol compared the different forms of wiring, and recommended steel tubing for ordinary work, but wood casing where ornamentation was desired. The wood casing would be stained or painted to suit the general scheme of decoration in the apartment. Many interesting points in connection with the details of electric wiring were discussed. The Paper was illustrated by lantern diagrams, and 17 members took part in the debate.

Hull.—The gross capital expenditure of the tramways department at March 31 was £623,402. Sinking funds amount to £183,623 and reserve fund to £141,985

Revenue was £162,926 and working expenses were £117,429 including £8,759 to employees on active service, interest required £17,678, sinking fund £10,203, loans redemption £4,894, contribution for street widening £3,117, and income tax £1,914, and the balance carried to appropriation account was £12,469, of which £10,000 is reserved for relief of rates and £2,469 for reserve. 53,734,387 passengers were carried, 4,072,342 car-miles run and the units used were 5,653,834 or 1·39 per car mile.

Paisley.—The accounts of the electricity department for the year ended May 15 show gross capital expenditure £231,634 (increase £14,831), of which £181,454 is outstanding.

Revenue was £31,348, and working expenses were £19,125, leaving gross profit £12,223 ; loan charges were £11,840, interest on bank overdrafts amounted to £100, and the surplus for the year was £337. Units generated were 5,406,279 (compared with 4,660,459 in previous year and sold 4,504,593 (4,036,611). Total maximum supply demanded was 2,302 kw. (2,698 kw.).

COMPANIES' MEETINGS AND REPORTS.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—At the extraordinary meeting last week the chairman (Mr. J. B. Braithwaite) explained that the annual general meeting was usually held in December, but owing to the sinking of R.M.S. "Arabia," the audited accounts from Adelaide for the past financial year had been lost. They could, however, safely recommend payment of the usual dividend and bonus on the ordinary shares. Duplicate copies of the audited accounts were now on the way home from Adelaide. A resolution approving of the final ordinary dividend and bonus, namely, 5 per cent. (making 10 per cent. for the year) and a 2 per cent. bonus (both tax free) was unanimously agreed to.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At the meeting on Friday the statement of the chairman (Mr. Horne-Payne) gave reasons for the fall in the income (from £370,000 to £258,000) and the increase in the expenses. There had been a reduction of 30 per cent. in the population of the district served by the company, and they had had severe and unfair competition from jitney cars. On the other hand, the cost of labour and all materials had greatly increased. From its geographical position, British Columbia had experienced a more severe set-back from the war and less benefit from war trade than any other province of Canada, the mining industry alone having derived substantial benefit, while such important industries as the shipping trade and the lumber trade had been practically paralysed. However, during the last six months those trades and commercial and industrial conditions generally had been steadily improving. The Provincial Government were assisting the development of the shipbuilding industry, and there seemed no reason why Vancouver and Victoria should not successfully rival Seattle and San Francisco in shipbuilding. There was an increasing export trade with Russia and the East, particularly in munitions, railway materials, &c., and it was believed that after the war the exchange of commodities with Russia across the Pacific would be permanent by established. The worst times were experienced towards the end of last year, and from now on they should see continued improvement.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.)—The chairman (Mr. Geo. A. Touche, M.P.) stated at the meeting last week that their main sources of power were the hydraulic stations and they had a reserve steam plant in the City of Cordoba. It was the irony of fate that, in a year when, owing to shipping difficulties, the price of fuel was disastrous, they should experience a drought such as had not been known for 21 years. Ordinarily they only used their reserve steam station as a stand-by, but last year they had had to generate a large proportion of the energy for the tramways and for public and private supply by means of steam. Prices of fuel and freights were higher than they had ever been. In the six months to Sept. 30 last the operation of their steam station cost about £23,000, against £540 in the corresponding six months of 1915, and of that £23,000 no less than £20,400 was the cost of fuel alone. Notwithstanding the bad times in South America the gross receipts were not only maintained, but increased; they amounted to £162,460 and constituted a record, comparing with £157,590 in 1915 and £160,420 in 1914. The expenses were £100,539, against £74,270 in 1915, an increase of £26,269; the net receipts were £61,921, compared with £83,320, a decline of £21,399. The gross receipts of the Light and Power Co. by itself were £90,577 (against £88,550) and the expenses £55,633 (against £30,906), an increase of £24,727, the net receipts being £34,944, (against £57,644), a decline of £22,700. The number of customers for light and power at the end of September last showed an increase of 7·38 per cent. over those of 1915; the number of lamps connected was greater by nearly 6 per cent. The number of units of current sold was almost identical with the number sold in the previous year, but the income per unit was 2¼ per cent. greater. On account of the steam operation, the cost per unit sold was nearly 81 per cent. more. The gross receipts of the tramways were £71,883 (against £69,040), increase of £2,843; expenses were £44,906, (against £43,360) but the ratio of expenses to gross receipts was 62·47 per cent. (against 62·8 per cent.). The net receipts were £26,977, against £25,680, an increase of £1,297. But for the additional abnormal operating expenses of the lighting and power business, the profit would be about £23,000, or £5,000 more than would suffice to pay the full dividend on the preference shares for the year. As it was, there was a small loss of £230, after meeting all fixed charges, including debenture stock interest and sinking fund, &c. The directors had no alternative but to defer payment of the preference dividend. The outlook with regard to the fuel situation was still too serious to enable them, with any prudence, to distribute the accumulations at the credit of profit and loss. The conditions last year were unprecedented, and they trusted they might never recur. They hoped for better things this year, but some use of the steam power station was inevitable.

COSTA RICA ELECTRIC LIGHT & TRACTION CO. (LTD.)—For the year ended June 30 the net earnings in Costa Rica, after charging all expenses incurred, amount to £10,210 16s. 7d., as compared with £21,662 5s. 3d. for the previous year. The net surplus profit for the year is £2,790 8s. 1d. and the directors propose to carry this amount to the credit of "Discount and Commission on Debenture Issue" account. In common with other countries, Costa Rica is suffering severely from the European War and the business has continued to be prejudicially affected by the interruption of exports, &c. Owing to ill-health the general manager in Costa Rica (Mr. W. N. Brand) resigned his position in July last and the chief engineer (Mr. T. E. [illegible]) succeeded him.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

ELECTRIC STORES (NOTTINGHAM) (LTD.) (145,555). Reg. Dec. 16, capital £[illegible] in £1 shares, to adopt an agreement with J. T. Kemp and H. E. [illegible], and to carry on the business of electrical engineers and contractors, suppliers of electricity, &c. Private company.

HUBBARD BROS. (LTD.) ([illegible]). Reg. Dec. 7, capital £5,000 in £1 shares ([illegible] 6 per cent. cumulative preferred), to take over the business carried on by [illegible] Hubbard at Basingstoke as Hubbard Bros., to carry on the business of mechanical, electrical, hydraulic and general engineers, agricultural machinery and implement makers, manufacturers of and dealers in motor cars, vehicles, &c. Private company. First directors are A. Hubbard, E. S. Hubbard and W. H. Hubbard. Secretary and solicitor, J. Smyth, Public Hall, Woking. Reg. office, Reading-road, Basingstoke.

MIDLAND DYNAMO & MOTOR REPAIRS (LTD.) (145,468.)—Reg. Dec. 5, capital £2,000 in £1 shares, to carry on the business of electricians, electrical, mechanical, telephone, motor and general engineers, repairers of and dealers in electrical apparatus, aeroplanes, airships, &c. Private company. First directors are B. Gill and G. Ward. Secretary, P. Haynes, 8A, Pocklington-walk, Leicester.

MIDLAND ELECTRIC CO. (SOUTHPORT) (LTD.) (145,444.)—Reg. Dec. 3, capital £1,000 in £1 shares, to take over the business carried on at Southport by T. E. K. Greenhalgh, as the Midland Electrical, Gas & Incandescent Co. Private company. Reg. office, 16A, Hill-st., Southport.

NEW SHIPSTON LIGHTING CO. (LTD.) (145,577)—Reg. Dec. 19, capital £5,000 in £1 shares, to take over the business of electricity supply works, &c., carried on by the Shipston Electrical Co. (Ltd.). Private company. First directors are W. D. Akers, J. W. Hence, H. Holtom, J. R. King, C. Stein, G. Turner and A. H. Jarrett.

T. W. PEARSON (LTD.) (145,385.)—Reg. Nov. 24, capital £3,000 in £1 shares, to adopt an agreement with A. E. Pearson, trading as T. W. Pearson, and to carry on the business of manufacturers, melters, and rollers of or dealers in steel, engineers, manufacturers of files, tools, machinery, electric or other plant, &c. Private company. A. E. Pearson is permanent governing director, subject to holding one-half of issued or allotted shares. Secretary, G. S. Rich.

T. P. POLLITT & CO. (LTD.)—(145,566) Reg. Dec. 18, capital £1,000, in £1 shares, to take over the business of electrical, mechanical and general engineers, contractors, &c., carried on as Pollitt & Co. Private company. First directors are T. P. Pollitt and Mrs. M. Pollitt. Reg. office: Fish Dock-road, Grimsby.

REUTER'S (1916) (LTD.) (145,416). Reg. Dec. 11, capital £200,000 in £1 shares, to take over the telegraphic business heretofore carried on by Reuter's Telegram Co. (Ltd.), to carry on and extend same, to obtain and supply wireless, telegraphic, telephonic and other news and intelligence, to carry on business as advertisement contractors and agents, to construct, purchase, hire or otherwise acquire and work wireless installations, telegraphs and telephones, &c. Private company. First directors are the Hon. Mark F. Napier (chairman), the Hon. Edmund Parker, Geo. Grinnell-Milne, Gerald W. Williams, Roderick Jones and John Buchan. Reg. offices 24, Old Jewry, E.C.

MORTGAGES AND CHARGES.

ELECTRICAL CONTRACTS & MAINTENANCE CO. (LTD.)—Particulars of £1,000 debentures, created Dec. 5, 1916, have been filed, whole amount being now issued. Property charged: Company's undertaking and property, present and future. No trustees.

ENGINEERING & ARC LAMPS (LTD.)—Memorandum of satisfaction to extent of £500 on Dec. 9, 1916, of debentures (dated May 26, 191 securing £6,000, has been filed.

VENNER TIME SWITCHES (LTD.)—Memorandum of satisfaction to further extent of £500 on Oct. 19, 1916, of debts dated July 10, 1911 securing £5,000, has been filed. (Amount outstanding £2,450.)

CITY NOTES.

MEMORANDA (Dec. 27).—Bank rate 6 per cent. (since July 13, 1916 Consols, 55⅜. Consols Pay Day, Jan. 4. Stocks and Shares Ticket Da Jan. 11. Pay Days, Dec. 29 and Jan. 12. Price of Silver, 36¼d.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units so to consumers during the five weeks ended Sept. 29, 1916, were 2,699,8 compared with 2,612,755 in the corresponding five weeks of 1915. T number of units sold during the four weeks ended Oct. 27, were 2,038,7 compared with 1,889,915.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following be struck off the Register of Joint Stock Companies unless cause to contrary is shown by March 5: Electric Stores, Ensign Advertising Hammersmith Welding, Engineering & Electrical Co., New Elec Rifle & Target Co., Panama Electric Light, Power & Traction Telephone Instalment System Co.

COMPANIES STRUCK OFF THE REGISTER. The following were str off the Register of Joint Stock Companies on Dec. 15:—

Commercial & Engineering Development Co., International Pow Light Trust, Rochdale Electro-Plating Co., Telcea Co.

The following were struck off the Register on Dec. 19:—Auto-Elect Auto-Flash Sign Co.; Cable Construction Synd.; Electric Mirror licity Co.; Flash Controller Co.; Grindell-Matthews Radiophone Sy Llanidloes Electric Lighting Co.; Radium Treatment; Scientific searches Co.; Turbiro Engine & Pump Co.; United Salt & Power Wireless Telephones.

STERLING TELEPHONE & ELECTRIC CO. (LTD.) We are info that the whole of the enemy shares of this company have been acq from the Public Trustee by Sir John Bethell, Bart., M.P., who has sented to act as chairman of the company. Sir Thomas Bethel Mr. C. S. Syrett have also been elected directors of the company.

SWISS ELECTRICAL COMPANIES. The Maschinenfabrik Oerlikon recently declared a dividend of 7 per cent. for the past year, com with 6 per cent. in the previous year, and the Brown, Boveri & Co. has declared a dividend of 6 per cent. against 5 per cent.

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NOTES.

Excess Profits for Electricity Supply Companies.

WE are glad to see that successful action has been taken by the Electric supply companies in appealing to the Board of Referees to increase the statutory percentage before excess profits are taken into account in the case of such undertakings. The provincial companies and some of the London companies (127 undertakings in all) were represented by Mr. H. B. RENWICK, and 10 other London companies by Mr. W. F. FLADGATE. The appeal, therefore, represented a total capital expenditure of about £25,000,000. The appeal was founded on a number of facts, all of which tend to make the earning of a substantial dividend by electricity companies an arduous task. First, there is the fact that the concession is terminable, and not only is it terminable, but the terms of the compulsory purchase are very uncertain and provide nothing for goodwill. The companies are subject to statutory limitations and obligations, and many of them who were pioneers were forced to spend their capital in a way which would now be considered quite unprofitable. Further, there is a point which is often forgotten—namely, that the capital expenditure throughout the concession is in advance of the profitable demand; therefore, part of the capital is necessarily earning no dividend. Lastly, there is always the uncertainty of obsolescence. It may be found that plant after a time is unsuitable, owing to advances of one kind or another, long before it has reached the limit of its useful life. The Referees appear to have appreciated the importance of these facts, and consequently the statutory percentage has been raised from 6 to $7\frac{1}{2}$ per cent. in the case of provincial companies and those in the London suburbs, and from 6 to 7 per cent. in the case of the other London companies. The concession is not as great as was expected, or as the circumstances would seem to warrant, but at all events we congratulate Mr. RENWICK upon the success of his initiative in organising this appeal.

National Education.

THE last number of the "Journal" of the British Science Guild contains a series of important suggestions regarding the organisation of our educational scheme, and we notice that similar reform schemes are being presented by the National Union of School Teachers, and other bodies. While we are aware of the defects of the cast iron organisation of some of the Continental educational schemes, particularly that in Germany, we think it will be generally acknowledged that our own educational system goes to the other extreme. There has never been any proper co-ordination of the higher and lower branches of education. What is needed is a scheme which will fill up these gaps in the educational ladder, and yet not destroy the natural instincts for freedom and initiative. This latter point is recognised in the programme of the British Science Guild. The most vital points in all these schemes is the continuation of education of youths after leaving school at the age of 14. At present there is a gap. Boys go to work, and readily drop the habit of acquiring knowledge. Thus, they become factory hands, and there is a lack of the intelligent foreman and manager class. Many really gifted boys, too, are attracted by the immediate prospect of earning wages, abandon their education, and thus much promising material is lost to the higher ranks of industry.

To remedy this condition it is proposed that employers should be required to grant facilities for part-time education, during working hours, between the ages of 14 and 17. Another step suggested is the creation of bursaries and scholarships to enable gifted youths to proceed to the universities. At present the facilities in this direction vary greatly according to the liberality of private individuals, and State aid is necessary to make the opportunities approximately equal throughout the British Isles. The same lack of uniformity in endowment is seen at the universities. The Report of the British Science Guild contains a list of salaries paid to professors in the faculty of science. It appears that whereas professors at Liverpool and Manchester receive on an average £853 and £888 per annum, the corresponding salaries at Southampton and Aberystwyth are only £320 and £325. The university and colleges of South Wales are mentioned as being particularly hampered by lack of funds. It is impossible to secure and retain able men for professors at salaries little above £300. It is also reasonable to contend that a pension should be attached to every professorial chair, so that the professor may be relieved of anxiety for the future, and be free to devote himself to education and research. The low salaries and absence of pensions merely lead gifted men to seek outside remunerative employment, with the result that the university suffers.

Expiring Patents.

The patents that will expire this year do not include so many of general interest as is frequently the case, but, on the other hand, there are some of more than usual importance. Among these may be mentioned No. 322 of 1903 which describes at considerable length the various mechanical details of the Edison accumulator, which have gone a long way towards securing the success which this cell has achieved. Apart from the details the specification does not refer particularly to the electrodes or the chemical actions underlying the electrochemical action of the cell. Patent No. 3,704, by Messrs. O. S. Bragstad and J. L. La Cour, describes the well-known motor converter, consisting of a combination of a synchronous machine and a rotary converter mechanically coupled together, the phases of the motor being connected in concatenation with equidistant points of the armature winding of the rotary. The resulting advantages are easy starting with alternate currents and a saving of material. Patent No. 15,599, due to Mr. V. Poulsen, describes the well-known development of Duddell's arc by placing it in hydrogen or in a hydrogen compound, so that higher frequencies are obtained, thus enabling the arc to be used for radiotelegraphic work. Lastly, patent No. 24,305 describes Sir Oliver Lodge's system for the deposition of fog and dust by means of rectified high-tension alternating currents.

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Merchant Shipping (Convention) Act, 1914.—The operation of this Act has been further postponed until Jan. 1, 1918.

Use of Aluminium in Germany.—It is stated that one result of the war in Germany has been the greatly extended use of aluminium for many purposes. Its use is one of the outstanding features of captured German motor contraction, being used for crank cases, gear boxes and even cylinder heads, rockets and shafts. The Germans are said to be able to produce aluminium very cheaply, largely owing to the mining of coal in occupied French territory by forced labour. The cheap production of electricity has also stimulated the development of electric motor vehicles, which are now being run with nickel iron batteries owing to the shortage of lead.

Utilisation of Water-power in Ireland. At a recent lecture before the Belfast Association of Engineers Mr. A. W. Brown suggested the transmission of power generated from the tidal rise and fall of the water at Strangford Lough and Lough Neagh to Belfast. Thus, at Strangford Lough there are 20 square miles of water available, the spring tides have a rise of 11 [illegible] and the neap tides a rise of 11½ ft., with a range of 7½ ft. About 20,000 H.P. could be developed for a period of 2½ hours, the power available varying from maximum to minimum every six hours. Large storage betteries would be needed, or extra water storage at Strangford Estuary and Magee Island could be designed. The ordinary navigation of the lough would not be interfered with.

Electrical Treatment of the Wounded. In a recent number of the "Lancet" Dr. W. J. Turrell describes various applications of electrotherapy at the Radcliffe Infirmary, Oxford. One interesting point is the treatment of unclean wounds by ionisation produced either by the application of salt solutions [illegible] by an electric current or by means of ultra violet rays. A[illegible] currents are now much used in treating certain [illegible].

Of considerable importance is the application of mild electric "shock" to stimulate the [illegible] the treatment is specially efficacious in those cases of [illegible] shock where the patient is under the delusion that he has lost the power of a limb.

However the [illegible] to cases of "shell shock" calls for discretion. In some cases [illegible] the patient is not at all benefited and indeed exhibits [illegible].

Currents are also a valuable means of testing the action of various muscles and the power of [illegible] movements which break down internal adhesions or the [illegible]. The static [illegible] generally [illegible] direction.

Copper Refinery in Canada.—The annual production of copper from existing mines in Canada was in the neighbourhood of 80,000,000 lb. in 1914, a little more than one-third of this being produced in Eastern Canada and a little less than two-thirds in British Columbia. The total copper recovered from ore produced in Canada in 1914 is estimated by Mr. McLeish, chief statistician of the mines branch, at 75,738,386 lb. In 1913 it was 76,976,925 lb. and in 1915 it is estimated as 102,612,486 lb. Most of the copper obtained from ores mined in Canada is recovered in refineries located outside Canada, and chiefly in the United States. According to an article by Dr. A. W. G. Wilson in the "Canadian Mining Journal," there appears to be an opening for the organisation of a very considerable commercial enterprise which might include among its activities any or all of the following principal departments: (*a*) copper smelter (treating about 500 tons of ore per day), (*b*) copper refinery (producing about 50 tons of copper daily), (*c*) zinc refinery (producing about 40 tons of zinc daily, including zinc in the form of oxide), (*d*) brass making plant, (*e*) rolling mills (for copper, zinc and brass), (*f*) bar and wire mill and (*g*) tube mill. It is suggested that the Pacific Coast of British Columbia, which will shortly be producing half the output of Canadian copper, would be the best site for a refinery.

Central Stations in U.S.A.—For the seven months ended August 31st, according to statistics compiled by the "Electrical World," income of the central station companies in the United States totaled $265,000,000, a gain of 15·3 per cent. over the first eight months of 1915; while the output of the stations was 14,400,000,000 kw.-hours, an increase of 22·6 per cent. Estimates based on the eight months indicate that the total income of the central station companies of the United States for 1916 will largely exceed $400,000,000, and that the total output will exceed 22,000,000,000 kw.-hours. The tremendous gain in output was general over the country. New England reported a gain of 14·4 per cent. in income, and of 36·2 per cent. in output, over August, 1915; the Atlantic states reported for the month a gain of 16·4 per cent. in income and of 25·5 per cent. in output; the central states showed increases of 17·3 per cent. in income and of 26·5 per cent. in output; and the Pacific and Mountain states made a gain of 9 per cent. in income, and of 19·7 per cent. in output. Based on the first eight months, the central electric light and power companies of the country in 1916 will be far ahead of any previous year, in volume of income and of output of current. While the central station companies of the country have placed orders since January 1 for 3,500,000 kw. in new generating equipment, or a 50 per cent. increase over that in use at the beginning of the year, they are not yet in position to supply the full amount of new industrial power business being offered them.

OBITUARY.

A. J. Ireland.—We regret to record the death of Mr. Arthur James Ireland, manager of the supply department and branch offices of the British Thomson Houston Co. (Ltd.), of Rugby, as briefly announced in our last issue. The sudden death of Mr. Ireland will come as a shock to his many business acquaintances in the electrical industry. He attended business in the usual way until Saturday, Dec. 16, when feeling slightly unwell he decided to remain indoors for a few days, anticipating his illness to be merely of a transitory nature. On Dec. 20 his physician diagnosed his trouble as due to gastric influenza, but not readily lending itself to treatment a specialist was called in for consultation on the 22nd., who, after examining the patient, decided that an operation must be performed, and this was done at 12.45 p.m. on Dec. 22. The patient never recovered consciousness, but died at 3.15 p.m. the same day.

It was the nature of the man to cheer up his family until the last moment, and as he was of unusually strong constitution it was hoped that this would assist him to pull through successfully. Mr. Ireland was born in Northampton 57 years ago. In 1879 he went to America, and subsequently joined the American Brush Co., of Akron, Ohio. He installed a number of "Brush" arc lamps in various parts of the West and in Texas, and at this was in the early days of electric lighting, his experiences in the Western States were not only varied, but often highly exciting. Leaving the Brush Co. he became associated with the Thomson-Houston Co., of

Llynn (Mass.), and when the Thomson-Houston Co. embarked on the introduction of their lighting system abroad, Mr. Ireland was appointed European expert to the Thomson-Houston International Co., who were engaged in carrying out various important contracts for arc lighting plant on the Continent. It was while acting as their representatives at Turin that he was summoned to England in 1885 to carry out work for Messrs. Laing, Wharton & Down, who had acquired the patent rights of the Thomson-Houston system in the United Kingdom. He was retained permanently on the staff of Messrs. Laing, Wharton & Down, acting as their chief engineer in connection with the installation of arc lighting systems at various places, including the installation at the American Exhibition at Earl's Court in 1887, and at the Italian Exhibition in 1888. Mr. Ireland, as chief engineer, took an active interest in the pioneer installations of the Thomson-Houston arc lighting at Taunton, Bath, Bristol and other centres in the West of England, and had charge of the installation to provide the grounds and buildings of the Military Exhibition at Chelsea with electric light. He also carried out some of the early work at the stations and goods yards of the Midland Railway Co. at St. Pancras, Leeds, Bradford and Derby. In addition to the above he was responsible for some of the early central station plant put down, such as at Weybridge, Fareham, &c. In 1890 the contract for lighting the eastern portion of the City of London was awarded to the Laing, Wharton & Down Construction Synd., and Mr. Ireland had charge of all this work, embracing the erection of a temporary generating station at Wool Quay, and later on supervised the erection of the first portion of the equipment of the main power house at Bankside, which was designed to furnish power to the whole of the City of London. He was also responsible for the complete installation of street arc lighting throughout the eastern part of the City, and the extensive system of underground mains laid down in that area, as well as numerous sub-stations which were erected to give a supply to private consumers. In 1894 the Laing, Wharton & Down Construction Synd. was turned into the British Thomson-Houston (Ltd.), and while acting as chief engineer for the latter, Mr. Ireland carried out important central station work in different parts of the kingdom, as well as the electrification of tramways in Dublin and elsewhere. In 1896 the supply business of the British Thomson-Houston Co. (Ltd.) (the successor of the previous two companies) became so extensive that Mr. Ireland was given entire charge of this work, becoming later also the manager of the various branch offices of the company. Since then he has continued to control this department of the company's business with uniform success.

Mr. Ireland was widely known and respected in electrical and manufacturing circles in the United Kingdom. He was a man of strong character, and all of those who were associated with him, or had any extensive relations with him, were always struck by his honesty of purpose and great sincerity. Not only his staff, but everyone who came in contact with him knew that his word could be absolutely depended upon. He was buried on Dec. 28 at Barnes New Cemetery. He is survived by a wife, son and daughter.

T. Fenwick Harrison.—The death is announced of Mr. Thos. Fenwick Harrison, who (with Mr. Heath Harrison) equipped the new Harrison engineering laboratory at Liverpool, at a cost of £41,000.

William Marriott.—The death of Mr. Wm. Marriott, late secretary of the Royal Meteorological Society, occurred on Dec. 28. Mr. Marriott was 68 years of age.

PERSONAL.

Lord Cowdray, President of S. Pearson & Son, has been appointed Chairman of the Air Board.

Mr. Chas. G. Wade has been appointed Agent-General for New South Wales.

The Sultan of Egypt has conferred the Order of the Nile, Second Class, upon Mr. S. H. Wells, Director-General of the Department of Technical, Industrial and Commercial Education in Egypt.

Amongst the New Year's Honours we notice that Mr. John Temple, Chairman of the Warrington Wire Rope Works Co., has been made a Companion of the Bath.

In 1852 Mr. Temple entered the telegraph service and in 1856 he joined the Atlantic Telegraph Co. and was on the staff of Sir Charles Bright. In 1869 he was engaged by Messrs. Glass, Elliot & Co., and afterwards by the Telegraph Construction & Maintenance Co., being engaged in laying cables in the Mediterranean. He returned to England in time to take part in the laying of the second Atlantic cable.

Gunner H. Ratcliffe (R.G.A.), formerly a tramcar driver with Burnley Corporation, has been recommended for a commission.

APPOINTMENTS VACANT AND FILLED.

An assistant engineer is required by Birmingham Corporation Electric Supply Department to assist in the preparation of specifications and plans for new buildings and the lay-out of new steam and electrical plant, &c. Forms of application from the Secretary of the Department, and applications must be sent to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Jan. 11. *See advertisement.*

A shift engineer is wanted in the London district, with experience in the running of large generating stations. *See an advertisement.*

An assistant electrical engineer is required for the Government electric light department, Federated Malay States. Salary £360, rising to £390, with allowance of £75 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, London, S.W.

Mr. Ernest A. Mills, of Birmingham, has been appointed chief engineering assistant at Leeds electricity department at a commencing salary of £350 per annum.

INSTITUTIONS AND SOCIETIES.

The Electric Vehicle Committee.—As a result of correspondence between the Electric Vehicle Committee and the Ministry of Munitions, a tentative arrangement has been agreed to by the latter under which the firms at present manufacturing electric vehicles in this country will be allowed, for the time being, to manufacture such vehicles for purposes of urgent national importance. The firms, however, are required to apply for a permit in the case of each order that they desire to put through their shops. The firms referred to are Ransomes, Sims & Jefferies, Ltd., Edison Accumulators Ltd., Electromobile (Leeds) Ltd., and Richard Garrett & Sons.

The Committee has received a notification, dated Dec. 29, from the Board of Trade, Department of Import Restrictions, stating that on and after the 29th ult., it will not be possible to consider the granting of Licences for the importation of motor cars or chassis, (1) if imported fully assembled, or (2) if imported in parts, unless permission to assemble has first been obtained from the Ministry of Munitions, and the application is accompanied by the licence so granted. The Board of Trade requests that immediate steps be taken to prevent the shipment of any further consignments of motor-cars, chassis and parts and accessories thereof.

ARRANGEMENTS FOR THE WEEK.

ROYAL INSTITUTION.

Meetings at Albemarle-street, Piccadilly, London, W. Six illustrated lectures adapted to a juvenile auditory, on "The Human Machine which all Must Work," by Prof. Arthur Keith, M.D., F.R.C.S., LL.D., F.R.S.

Saturday, Jan. 6th.

3 p.m. Lecture V., "Living Workshops."

Tuesday, Jan. 9th.

3 p.m. Lecture VI., "Living Wires and Central Exchanges."

MONDAY, Jan. 8th.

Institution of Post Office Electrical Engineers.

6 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Story of the Keyboard Perforator," by Mr. H. H. Harrison.

TUESDAY, Jan. 9th.

Engineers' Club.

7.30 p.m. At Albert-square, Manchester. Paper on "The Magneto in Peace and War," by Lieut.-Commander W. A. Bristow, R.N.V.R.

Scottish Local Section, Institution of Electrical Engineers.

7.30 p.m. At Princes-street Station Hotel, Edinburgh. Ordinary Meeting.

Liverpool Engineering Society.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Screw Measuring Apparatus." By Mr. A. Brooker.

WEDNESDAY, Jan. 10th.

Royal Society of Arts.

3 p.m. At John Street, Adelphi, W.C. Juvenile Lecture No. II. on "Electricity and its Application," by Mr. A. A. Campbell Swinton, F.R.S.

Yorkshire Local Section, Institution of Electrical Engineers.

7 p.m. At Philosophical Hall, Leeds. Paper on "Principles Involved in Computing the Depreciation of Plant," by Messrs. F. Gill and W. W. Cook.

Association of Engineers-in-Charge.

8 p.m. At St. Bride Institute, Bride-lane, Fleet-street, E.C. Paper on "The Design and Construction of Industrial Premises," by Mr. A. A. H. Scott, M.S.A.

THURSDAY, Jan. 11th.

Greenock Electrical Society.

7.45 p.m. At Masonic Rooms, 22, West Stewart-street, Greenock. Paper on "Factory Installation," by Mr. R. T. Paterson.

Institution of Electrical Engineers.

8 p.m. At Victoria Embankment, W.C. Paper on "The Principles Involved in Computing the Depreciation of Plant," by Messrs. F. Gill and W. W. Cook.

TRACTIVE RESISTANCES TO A MOTOR DELIVERY WAGON ON DIFFERENT ROADS AND AT DIFFERENT SPEEDS.*

BY A. E. KENNELLY AND O. R. SCHURIG.

Summary.—In this Paper is given a complete report on an investigation of tractive resistances of urban roads to a motor delivery wagon equipped with solid rubber tyres. The test truck is fully described with its driving mechanism and the storage battery which supplied the motive power. The results included in the Paper are (1) overall efficiency of truck mechanism and (2) tractive resistances of a number of typical urban roads. The components of tractive resistance for a typical road are also given.

The investigation herein described was carried on in the Research Division of the Electrical Engineering Department at the Massachusetts Institute of Technology, during the year 1915, under a fund contributed for researches on motor trucks,

Object of the Research.—The object of this research was to determine the resistance, including air resistance, offered to an electric truck by level urban roads of different surface varieties at standard truck speeds not exceeding 25 km. (15·5 miles) per hour. For this purpose the output of the storage battery on a test truck was measured, for both directions of travel, over standard road beds, at different controller speeds. From this output were deducted all the corresponding electrical and mechanical losses in the truck mechanism, as determined by laboratory tests. The remainder of the output was consequently attributed to (1) road- (2) air- and (3) wind-resistance. The wind-resistance was eliminated by averaging the results for both directions of running, leaving as the final result the sum of the road and air-resistances.

By "road resistance" is meant the horizontal force required to pull the truck, assumed as internally frictionless, over the horizontal road, in the absence of air. By "air resistance" is meant the horizontal force on the truck required to overcome the resistance of the air, assumed as quiescent in the absence of the truck. By "wind resistance" is meant the horizontal force on the truck necessary to overcome the resistance of the wind velocity, or that velocity of the air with respect to the ground which exists in the absence of the truck.

THE TEST TRUCK.

Through the courtesy of the manufacturer, a 1,000-lb. (450-kg.) worm-drive, single reduction electric truck, or delivery wagon, was placed at the disposal of the Research Division for the purposes of the test. Its specifications are as follow:

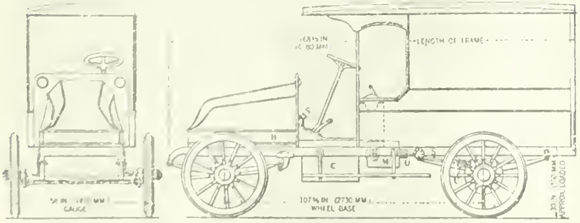

FIG. 1. SIDE AND FRONT ELEVATIONS OF TEST VEHICLE.

B = [illegible] 45 cells. M = Truck Motor.
C = [illegible] 15 cells. U U = Universal Joints.
[illegible] Motor and Worm Gear. S = Speedometer.

Load capacity 1,000 lb. (450 kg.) equipped with one d-c series motor

Overall length of frame	4,280 mm.	168½ in.
Width of frame	890 mm.	35 in.
Wheel base (i.e., distance between centres of front and rear wheels when front and rear wheels are parallel)	2,730 mm.	107⅝ in.
Wheel gauge	1,470 mm.	58 in.

The total weight of the truck, including motor, battery and body, but without load or passengers, was 1,200 lb. (1,910 kg.). Each of the four wheels was equipped with one solid rubber demountable tyre (manufactured for this type of delivery wagon) rated at 36 in. by 2½ in. (91·5 cm. by 6·35 cm.) and actually measuring about 35 in. (89 cm.) tread diameter, and 2½ in. (6·35 cm.) width of tread. The brakes were of the internal expanding type on each [illegible].

Fig. 1 is a drawing of side and front elevation of the truck. This type of electric truck is commonly used for parcel delivery service.

The transmission system was of the shaft type, the speed reduction between motor and rear wheels being accomplished by a single worm with worm-wheel, *i.e.*, the motor shaft is extended, through two universal joints, which allow for spring compression due to load and impact, to the worm *W*. Through the worm the rotation is transmitted to the worm-wheel which makes one revolution for every nine of the worm, or of the motor and transmit through the differential gear, Fig. 2.

Driving Motor and Controller.—The electric motor has the following specification: No. 282,666, E20, W 2, 32 amperes, 60 volts, 1,200 revs. per min. The manufacturers' test data for this type of motor are given in Fig. 3.

The controller is of the following description: Type S-35, form A. It is of the drum type, having four forward and two reverse speeds. The connection diagram of the controller and motor is given in Fig. 4. The operation of the controller is as follows:—

*Forward, point 1. Fields 1 and 2 in series, all starting resistance in series with armature and fields.

*Forward, point 2. Fields 1 and 2 in series, all starting resistance short circuited.

Forward, point 3. Fields 1 and 2 in series, but shunted by resistance R_2.

Forward, point 4. Fields 1 and 2 in parallel, starting resistance not used.

Storage Battery.—The battery consisted of 60 Type A-6 cells of the regular nickel-iron type, with a rated discharge capacity of 225 ampere-hours. The normal charge and discharge rate is 45 amperes, and the normal period of charge is seven hours at this rate. The average discharge voltage per cell is approximately 1·2 volts. The battery was placed in two compartments, one being 23 in. by 18 in. and 15 in. deep with 15 cells; another being 40 in. by 31 in. and 15 in. deep, with 45 cells. The entire battery with solution, trays and connections, weighs approximately 1,200 lb. (550 kg.).

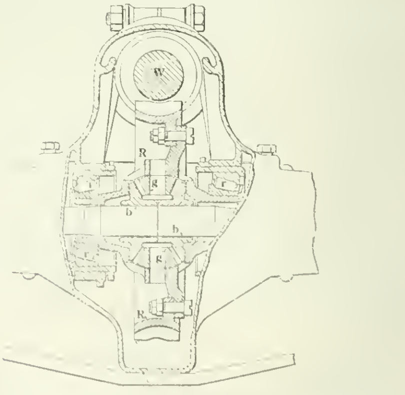

FIG. 2. SECTION THROUGH DIFFERENTIAL GEAR FOR WORM-DRIVE TRUCK.

W = Worm. R = Worm-wheel, ratio of worm to worm-wheel = 9 : 1.
gg = Gears attached to worm-wheel R. rr = Tapered Roller Bearings.
bb = Bevel Gears meshing with gg and connected to sections of rear wheel shaft.

EXPERIMENTAL PROCEDURE.

The tests made were of two kinds, namely—

(1) Road tests, over selected measured lengths of road, at different measured truck speeds, to determine the gross battery output; (2) Laboratory tests, to determine the overall efficiency between battery terminals and rear-wheel treads, at speeds and loads corresponding to the road tests.

Road Tests. The resistance (excluding air resistance), offered by a level roadbed to a moving truck, depends upon—

(1) The surface quality, *i.e.*, the smoothness, hardness and resilience of the road surface.

(2) The size of wheel and tyre quality, *i.e.*, the dimensions, smoothness, hardness and resilience of the tyre tread.

(3) The speed of the vehicle.

(4) The load or weight of the vehicle.

(5) The construction of the vehicle, *i.e.*, whether with or without springs.

In these tests variations in (2) and (5) were eliminated, by using the same vehicle and the same type and size of wheel and tyre throughout, which fairly represent standard average conditions for half-ton truck service.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

* Reverse, points 1 and 2, same as forward points 1 and 2, except that direction of current through series fields is reversed.

In order to investigate the effects of road surface quality on tractive resistance, stretches of nearly level typical urban roads were selected, with the aid of records in the Boston City Engineer's office. Runs were made with the truck over each selected stretch of road, at nearly constant speed by controller, and successively in both directions for each controller point, thus covering the range of speeds afforded by the controller. The effect of load in the vehicle upon the tractive resistance was also tried in a few cases. The car crew consisted of one driver and two observers. The first observer was stationed on the front seat, beside the driver, and noted the stopwatch times of start and finish as well as the readings of the speedometers during the run. The second observer was stationed in the body of the truck, and continuously took readings of voltage and current at battery terminals, by calibrated measuring instruments, these instruments being supported on cushions to minimise their vibration.

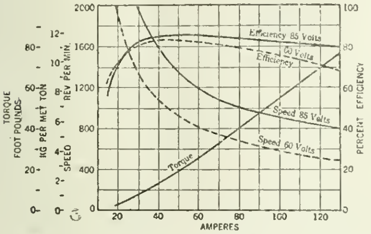

FIG. 3.—MANUFACTURERS' CHARACTERISTIC CURVES FOR AUTOMOBILE MOTOR.

60 volts—32 amperes—1,200 revs. per min. The two series field windings are connected in parallel with each other.

The length of the run between start and finish lines was determined by means of a tape line. The runs varied in length from 400 ft. (120 m.) to 2,600 ft. (790 m.). Wherever the grades of the test stretches were not obtained from the city maps they were measured directly, on special days, by the car observers, with surveyors' level and rod, in the regular way.

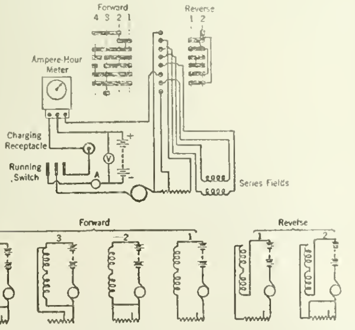

FIG. 4.—DEVELOPMENT OF CONTROLLER AND DIAGRAM OF CIRCUIT CONNECTIONS.

For each controller speed the car was run three times in each direction over the test section in immediate succession. By this method of running in alternate directions over the same section the effect of wind on car resistance was approximately eliminated.

A further correction, namely, that due to the change of kinetic energy imparted to the vehicle, between start and finish, became necessary, because the speed was not absolutely constant during the run, *i.e.*, a slight retardation or accelerating took place over the test stretch, in spite of the fact that the controller was not changed, that roads of uniform grade were selected, and also that the truck was started as far in advance of the mark as was practicable. The energy imparted to a truck which is accelerating includes not only that necessary to overcome its internal and external resistances, but also that definite amount of energy which is required to produce the acceleration. The latter portion of energy is known to be equal to

$$\frac{W}{2g}(v_2^2 - v_1^2) \text{ kg.-m.},$$

where W is the mass accelerated (kg.), v_2 and v_1 being the velocities in metres per sec. at end and at beginning of the run, respectively; g is the mean constant of acceleration due to gravity, *i.e.*, 9·81 m. per sec. This energy was subtracted from the total energy imparted to the truck.

Laboratory Tests.—In order to determine the truck-mechanism overall efficiency, from storage-battery terminals to tyre treads, as already referred to, the car was taken into the Lowell laboratory, the rear wheels raised from the ground, and belted each to a load-generator. The motor was then operated through the controller, at a number of speeds, the power being delivered to the load-generators and measured over a considerable range of speeds and outputs.

The speed of the rear wheels in these laboratory tests was measured by means of a magneto, belted to one of the wheel brake drums. It was also checked by means of a magneto coupled to one of the load generators. In order to ensure equality in speeds of the two truck wheels, under test conditions, so that the load might be equally divided between them, and that the conditions might correspond to those when the car runs on a straight path, a slip counter was inserted between the two generator shafts, so as to indicate, by the flashing of a light, if their speeds materially differed.

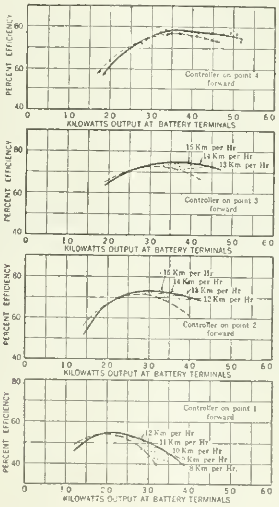

FIG. 5.—CURVES OF OVER-ALL EFFICIENCY OF TEST TRUCK.

With battery fully charged (full lines) and with battery partially discharged (dash lines). Dotted lines are drawn at constant rear-wheel peripheral speeds, as indicated; 69 alkaline cells, type A6, were used.

The load generators were separately excited. Their output was measured by a voltmeter and ammeters in their respective circuits. Separate tests were made on the load generators to determine their mechanical and electrical armature losses, under different load conditions. These losses added to the outputs gave the total generator inputs supplied through the driving belts.

The losses in the two driving belts were approximately determined by taking two successive light load tests, first with the regular heavy leather belts, and next with special light cotton belts of negligible power loss, but of very limited transmitting capacity. The difference between the inputs, in these two tests, measured the power consumed in the leather belts, because the other losses in the two tests were the same.

The friction losses in the front wheels (about 70 watts total), were also measured by belting them to the rear wheels through light belts in special tests. No allowance was made for any possible increase in wheel-bearing friction under increased gravitational pressures; but since all the wheels had roller axle bearings, such extra friction losses were probably very small.

The sum of the load generator-outputs, the armature losses, and belt losses, was taken as the car output at rear-wheel treads, at various measured inputs.

A detailed quantitative analysis of these various losses appears in the next section.

Results of Tests.

Although the primary object of this research has been a determination of tractive resistances to an electric truck, under the conditions previously defined, yet, incidentally the tests have furnished results of practical value of the overall efficiency from battery terminals to wheel treads of this type of electric car, under normal operating conditions.

Overall Efficiency of Driving Mechanism. Efficiency tests were made at each controller position for forward speeds. In view of the relatively large voltage variation of the truck battery, between full charge and partial or complete discharge, and at different current outputs, it was found necessary to perform efficiency-test runs, (1) at a fully charged battery and (2) at a partially discharged battery, (*a*) corresponding to high impressed voltage and (*b*) to a slightly lower impressed voltage. The results of the efficiency tests are shown in Fig. 5. It is seen that the condition of the battery has a considerable effect upon the results. Fig. 5 shows, besides efficiency curves at fully charged battery (full lines), and at partly discharged battery (dash lines), a number of constant speed lines (dotted). For example, the overall efficiency of the truck at 3,500 watts battery output, controller on point 2, and a truck speed of 13 km. per hour (8·1 miles per hour) is 71 per cent. It was for convenience in the handling of the data that the truck speed was chosen as the third factor necessary for the determination of the truck efficiency, rather than the battery terminal voltage. It should also be pointed out that none of the efficiency curves in Fig. 5 are drawn at constant battery terminal voltage, and that they are, therefore, only approximately comparable to the manufacturers' motor efficiency curves reproduced in Fig. 3. Such an approximate comparison shows that the efficiency of transmission between motor and rear-wheel treads is in the neighbourhood of 90 per cent. for this truck under the conditions tested. This high value may be attributed to the fact that the driving mechanism involves but a single speed reduction, between motor and rear axle, by a worm and worm wheel. The maximum values of over-all efficiency, including all mechanical and electrical losses beyond the battery terminals, are seen from Fig. 5 to be as follows, when an approximately fully charged battery (60 cells, type A 6) is employed:—

55 per cent., controller on point 1, forward at a battery output of 2,000 watts.

73 per cent., controller on point 2, forward at a battery output of 3,000 watts.

75 per cent., controller on point 3, forward at a battery output of 3,500 watts.

78 per cent., controller on point 4, forward at a battery output of 3,700 watts.

(*To be concluded.*)

SCIENCE AND EDUCATION.*

The present European crisis, it is remarked, affords a unique opportunity for impressing on all concerned with the executive functions of government, and with industry and commerce, the paramount importance of scientific method and research in national affairs.

In a memorandum on relations between the State and science, signed by many influential members of the British Science Guild, and submitted to the Reconstruction Committee of the Cabinet in July, the following statements are made:—

(*a*) The material prosperity of the civilised world during the past century is mainly due to the application of science to practical ends.

(*b*) While we stand high among all nations in capacity for original research as represented by the output of our scientific workers, this capacity has been comparatively little utilised in British industry.

(*c*) The State has neglected to encourage and facilitate scientific investigations or to promote that co-operation between science and industry which is essential to national development.

(*d*) Modern conditions of existence demand that instruction in science, and training in scientific method, should be a fundamental part of education.

(*e*) The present control of all stages of educational work, from the primary school to the university, mostly by men who have an inadequate appreciation of the meaning and power of science, is largely responsible for the unsatisfactory preparation commonly provided for the work of life.

It is suggested that a National Statutory Board of Science and Industry, the permanent staff of which should consist mainly of persons of wide scientific knowledge and business experience, should be formed.

Its functions would be very wide, including the promotion of co-ordination between manufacturers and available laboratories of research, and between scientific committees; the institution of suitably paid advisory committees of scientific men; the collection and publication of information of a scientific and technical character and the initiation of inquiries as to products and materials: the granting of financial aid when needed.

Such a Board would administer the scheme of the Privy Council Committee and take over certain functions of existing departments.*

Other recommendations made are that industrial undertakings assisted by the State should have on their boards of directors men having expert scientific knowledge of the business in question; that adequate remuneration and improved prospects should be offered by the Government, by municipal corporations and by manufacturers to men who have received a scientific training; that a knowledge of science should be required for appointments in the public service concerned with industrial, scientific and technical developments; that the educational courses in the public schools and the universities should be revised, and more attention given to scientific method in elementary and secondary schools.

In a second memorandum on "The Encouragement of Teaching and Research in Science in British Universities," attention is drawn to the wide variations in the salaries of professors in different universities throughout the Kingdom. Reference is made to a table prepared by Dr. W. Makower in 1914, from which it appears that Liverpool and Manchester head the list with average professorial salaries of £853 and £888 respectively, while Southampton and Aberystwyth come last with only £320 and £325 respectively. The provisions at the University and Colleges of South Wales are mentioned as obviously inadequate, both as regards salaries paid and arrangements for the teaching of science and the training of students in research; this is mainly due to the comparatively small endowments enjoyed by these institutions.

Among the recommendations made are:—

(*a*) That, subject to proper safeguards, appointments to Professorial chairs should be *ad vitam aut culpam*, and that on all electing bodies adequate provision for the presentation of the views of experts should be made.

(*b*) That a pension scheme should be arranged to provide pensions on a rising scale according to the length of service of the participant and enabling a professor to retire at a comparatively early age.

(*c*) That temporary and associate professorships should be abolished in state-aided colleges and universities and that professors in such institutions the title of Regius Professor should be given, their appointment or dismissal to be ratified by the Crown or its representative.

The report of the Education Committee and the Technical Education Committee on Elementary and Secondary Education contains a number of important suggestions, designed to supply the missing links between the elementary school and the university, to raise the age of study and to promote physical education and greater care for the health of children in elementary schools.

It is, however, urged that the system should not be too mechanical, and that the love of freedom in every child should be used and directed as a motive power to cause him to overcome difficulties for himself and acquire self-reliance.

An idea of the scope of the report will be gathered from the following list of recommendations:

Summary of Recommendations.

1. *The Oversight of Children Prior to School Age.*

Local Educational Authorities should be empowered to organise a system of voluntary service to care for the proper nutrition and hygienic conditions of those children from two to five years of age whose parents are unable to do so.

2. *Elementary Education.*

(*a*) There should be an efficient public elementary school within the reach of the children in every school area.

(*b*) The leaving-age should be raised to 14.

(*c*) In the early school years, the primary object should be the physical development of the children.

(*d*) Manual work and exercises involving initiative (such as drawing, manual work for boys and domestic subjects for girls) should be a prominent feature of the curriculum throughout the school.

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* Abstract of Memoranda incorporated in the "Journal" of the British Science Guild for November.

* This memorandum was prepared before the recent announcement of Lord Crewe, and the decision to separate the activities of the Privy Council Committee into a separate department under the title of "The Imperial Trust for the Encouragement of Scientific and Industrial Research."—Ed.

(*c*) From 12 to 14 years of age, while continuing the general education of the children, the curriculum should contain provision for subjects of a practical "vocational" character without any specialisation.

3. *Continuation Schools.*

(*a*) Employers should be compelled to give reasonable facilities within the hours of employment for young persons between the ages of 14 and 17 to attend suitably-equipped continuation schools for six hours per week.

(*b*) In the continuation schools, provision should be made for physical training and for continuing the general education of the children, in addition to the "vocational" instruction.

4. *Secondary Schools.*

(*a*) Adequate provision should be made for secondary education of a technical character for boys and girls between 12 and 16 years, in addition to secondary education which is mainly "literary" or "classical."

(*b*) Where the provision is at present inadequate, local education authorities should establish secondary schools of a high educational type, preparing for the universities and the professions.

5. *School Certificates.*

(*a*) Suitable "leaving certificates" (based partly upon the reports of the teachers) should be given to children who complete satisfactorily a full course either in the primary school or the secondary school.

(*b*) The leaving certificate from the secondary school should qualify for entrance into any British university or place of higher or specialised instruction.

6. *Scientific Method.*

In all schools, instruction should, where possible, be given by practical or experimental methods, and the scientific method of the laboratory and workshop should be employed, as far as possible, in the ordinary class-room.

7. *Higher Technological Education.*

(*a*) The efficient development of higher technological education demands :—

(*a*) Proper co-ordination upon a natural basis, both between the technical institutions themselves and between them and the universities.

(*b*) The encouragement, by more liberal Imperial grants, of higher technological training and research.

(*c*) The establishment of Faculties of Technology in universities situated in manufacturing centres.

(*d*) The organisation of technical education, so as to provide for the different requirements and conditions of the following types of students :—

(i.) The future leaders in industry and invention.

(ii.) Workmen, foremen and apprentices who are already engaged in industry.

(iii.) Boys between the ages of about 14 and 16, who intend to enter upon industrial work at about the age of 16.

8. *Extension of University Facilities.*

(*a*) There should be a wide extension of facilities permitting able students of limited means to enter the universities.

(*b*) The universities should further develop "tutorial" classes for working men and women.

(*c*) Funds should be granted to the universities to enable them to charge lower fees.

9. *Training and Position of Teachers.*

(*a*) In training colleges for elementary teachers, students should be given a larger measure of freedom and responsibility, and the whole system of training needs to be reformed, *e.g.*, by giving more time to manual training and practical subjects, and by causing less stress to be laid upon a certificate examination at the end of the course.

(*b*) Until salaries, superannuation schemes, and conditions of tenure in all branches of educational work are placed upon a more satisfactory footing, it will be impossible to attract or retain the services of many men and women best qualified for the profession of teaching.

10. *Registration of Schools.*

A survey should be made of all educational institutions.

11. *State and Rate Aid.*

Increased grants from Imperial funds should be made for educational purposes to the local authorities.

Addendum, Nov. 1916.—Since the above was drafted, organised long-period University Extension Courses, other than those known as "tutorial" classes, have increased in importance, and it is recommended that such courses should be further encouraged and developed (*see* paras. 8 (*b*), p. 25 and 8 (*b*), p. 27 *supra*).

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Applied Electricity for Practical Men." By A. J. ROWLAND. (London : The Hill Publishing Co., Ltd.) Pp. xiv.+375. 8s. 4d. net.

"Text Book of Elementary Chemistry," by F. Mollwo Perkin, Ph.D., and E. M. Jaggers. (London : Constable & Co.) Pp. viii.+381. 3s. net.

"Some Modern Methods of Ventilation with special reference to Public Buildings." By R. Grierson, A.M.I.M.E. (London : Constable & Co.) Pp. xiv.+187. 8s, 6d. net.

B.T.H. ROTARY CONVERTERS.

(Concluded from page 416.)

Starting of Rotary Converters. The following methods are available for starting rotary converters : (i.) Alternating-current starting by means of taps on transformers ; (ii.) induction motor starting, requiring separate synchronising ; (iii.) induction motor starting, self-synchronising ; (iv.) direct-current starting.

The first is the simplest method of starting from the alternating-current side, and is one which was adopted in many of the earliest machines. It had the advantage of being quick starting and self-synchronising, and it is still a satisfactory and economical method for small sizes of commutating pole machines up to, say, 200 kw.

With this arrangement the converter may run up with its polarity reversed, but this can easily be changed by means of a field reversing switch mounted on the frame of the machine. This method of starting was generally adopted in America ; but in the case of large machines without commutating poles, while sparking at the commutator during starting was permissible, this was no longer the case on commutating pole designs, and although direct-current brush-raising devices have been used to overcome this difficulty, they have not proved to be desirable additions to rotary converter commutators.

The induction motor method of starting was introduced to obtain low starting currents. Objections have been raised to this method, as it necessitates synchronising the rotary ; but it is the method which has been generally adopted in England for some time, and has given excellent results.

In the induction motor self-synchronising method the induction motor starts the converter and brings it up to synchronous speed. At this point the motor acts as a synchronising reactance, and allows the converter to synchronise automatically with the supply through the stator windings of the motor. As soon as the converter has synchronised the induction motor stator windings can be short-circuited, and the converter is then ready for paralleling on the direct-current 'bus bars. By this method any size of machine can be started without sparking of commutator or reversal of polarity, and be ready for paralleling on the direct-current 'bus bars within one minute without taking more than 35 per cent. of full load current from the high-tension mains. Fig. 13 shows an oscillogram taken during the starting of a 1,000-kw. rotary converter, and records the alternating current taken from the line (No. 2), together with the voltage across the induction motor stator windings (No. 1). The time taken to self-synchronise and to short-circuit the induction motor windings was 45 seconds ; the point at which the stator was short-circuited will be seen at the end of the film. The starting switch was closed just as the film commenced to revolve.

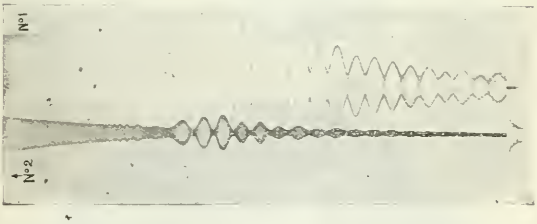

FIG. 13.—OSCILLOGRAM SHOWING STARTING AND SELF-SYNCHRONISING OF B.T.H. 1,000 KW. ROTARY CONVERTER.

Curve No. 1 indicates voltage across induction motor ; curve No. 2 indicates starting current. Time taken after starting to self-synchronise and short-circuit the induction motor windings = 45 seconds.

CONSTRUCTION OF B.T.-H. MACHINES.

The magnet frame is made of cast-iron or steel of high permeability divided horizontally to allow the upper half to be easily removed for inspection and repair.

The pole pieces are bolted to the magnet frame, and this construction permits the removal of a field spool without dismantling the machine.

The field spools are wound on insulated sheet-steel bobbins : this construction efficiently protects the field windings, and is not liable to deterioration. The commutating field coils consist of edgewise wound copper, which construction is superior to all other forms of winding for this purpose. The method of connecting the leads to the field winding is shown in Fig. 11.

Fig. 15 illustrates the damping bridge construction used. A heavy casing of copper surrounds the pole face, and drawn copper rods are passed through holes in the latter. The rods are expanded into holes in the ends of the copper casing, so as to make a thoroughly sound electrical and mechanical joint without the use of bolts and nuts, which are very liable to loosen on bridges of converters. This construction of bridge is practically immune from breakdown, and the damping is very effective.

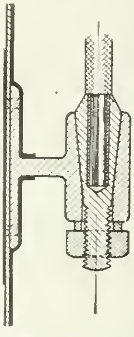
Fig. 14.—Method of Connecting Leads to Main Field Coils.

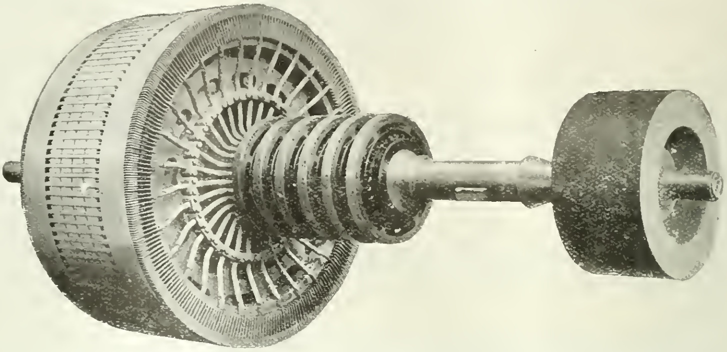
Fig. 17.—Complete Armature for 750 kw. Self-synchronising Rotary Converter, showing Solid Rotor of Alternating-current Starting Motor.

All armatures are slot wound, the windings consisting of separately formed and insulated coils. To ensure that the armature will be as free from breakdown as is possible, the British Thomson-Houston Company has standardised the practice of insulating the armature conductors throughout their length (outside the slot as well as inside) with the same thickness of insulation. The windings are held in the slots by means of specially treated white fibre wedges, no binding bands being used on the core portion. The end windings are bound in such a way as to afford the maximum of protection from injury during the dismantling or erection. The direct current brush yoke, bus rings, &c., are split on the horizontal diameter, so that the whole of the brush gear may be removed without upsetting the brush spacing.

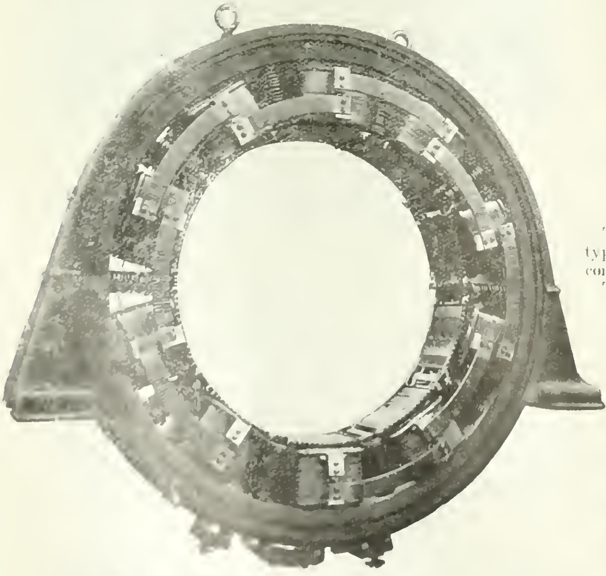
Fig. 15.—Rotary Converter Magnet Frame, showing Main and Commutating Pole Windings, also Damping Bridge Construction on Pole Face.

The slip rings are shrunk on a cast iron supporting sleeve insulated throughout its length with mica, which has been compressed and ground to size. This method of support avoids all bolted connections liable to come loose, and thus prevents the rings becoming eccentric. It also eliminates all joints and insulating washers, which are difficult to clean and under which copper dust can accumulate.

The connecting bolts to the various rings are insulated throughout their length with mica tubes.

The slip-rings are specially shaped so as to propel a good draught of air under the outer surface of the slip-rings, with consequent cool running.

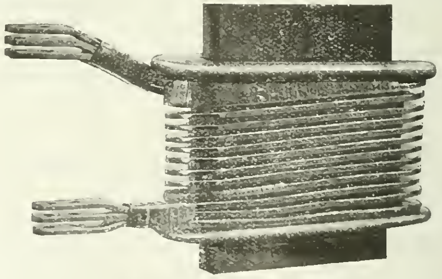
Fig. 16.—Commutating Pole and Spool.

The alternating-current brushes on all rotaries are of the block type. Each brush is fitted with heavy duplicate pigtails, which conduct the current from the brush to the brush holder.

The construction of the brush holder adopted enables the whole of the alternating current brush gear to be mounted on the top of the slip-rings in the most accessible position, and avoids the accumulation of dust on the lower brush holders which occurs when slip-ring gear is mounted under the rings.

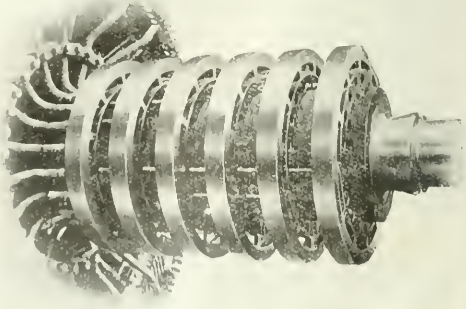
Fig. 18.—Rotary Converter Slip rings.

It will be noticed that the top of the brush holders can be swung back, so that the brushes can be easily removed, cleaned or replaced.

The speed of a rotary converter running in parallel with alternating-current generators is fixed by the frequency of the latter. If, however, a converter becomes disconnected from the alternating-current side, and still remains connected to machines generating on the direct-current 'bus bars, its speed will depend on the field excitation (if the rotary be running alternating to direct-current), or on the field excitation and power factor of the alternating-current load left on the rotary (if it be running inverted).

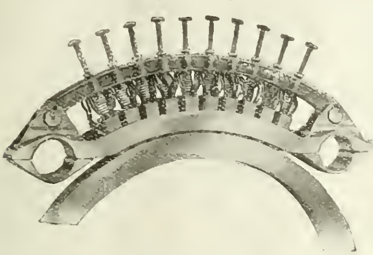

Fig. 19.—Alternating-current Brush Gear.

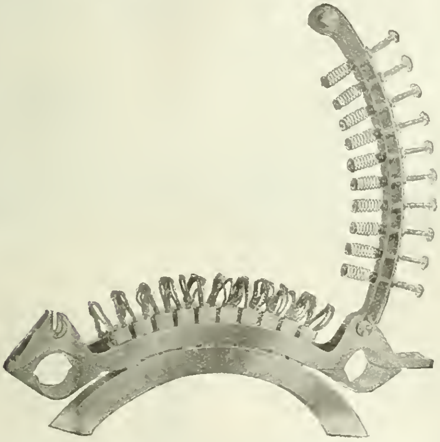

Fig. 20.—Alternating-current Brush Gear showing Springs raised for Cleaning Purposes.

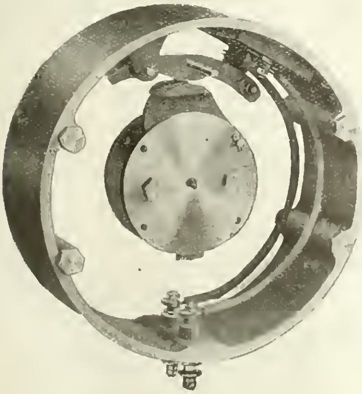

Fig. 21.—Speed-limit Device.

In order to remove the possibility of the speed of a converter increasing unduly, all B.T.-H. machines are equipped with speed-limit devices. These operate by centrifugal force, and close the contacts of the shunt trip coil on the direct-current circuit-breaker in the event of the speed exceeding the normal by 15 per cent.

The British Thomson-Houston Company recommends the provision on all rotary converters of an end-play device, which gives the armature a slight reciprocating motion in a direction parallel with the shaft. This reduces the tendency of the commutator and slip-rings to wear in grooves, with a resulting increase in the life of these parts.

The end-play device is illustrated in Fig. 22, and consists of a steel plate set slightly out of parallel with the end of the shaft, the top being inclined towards the latter. The plate is grooved on the surface next to the shaft, and in the groove travels a steel ball.

When the shaft rotates the ball is carried up between the end of the shaft and the grooved plate, and, due to the inclination of the plate, forces the armature lengthways against the magnetic pull of the field. When the ball has reached its top position in the groove, the armature, owing to its inertia, tends to move still further, with the result that the ball is released and immediately drops to its old position. It is then ready to recommence the cycle of operations as soon as the shaft, drawn by the magnetic pull, returns to its old position. By this means periodic end-play is given to the armature.

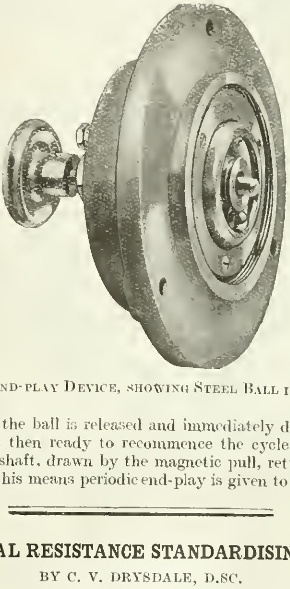

Fig. 22.—End-play Device, showing Steel Ball in Groove.

A UNIVERSAL RESISTANCE STANDARDISING BRIDGE.

By C. V. DRYSDALE, D.Sc.

(Concluded from p. 419.)

Theory of Double Standardising Bridge with Unequal Ratios.

Using the same notation as before and supposing that p, q, p' and q' (Fig. 5) are known

$$i_1\left(R+\frac{p'+l'}{f'}X\right)=i_2(p+l),$$

and

$$i_1\left(S+\frac{q'+m'}{f'}X\right)=i_2(q+m),$$

dividing

$$\frac{R+\dfrac{p'+l'}{f'}X}{S+\dfrac{q'+m'}{f'}X}=\frac{p+l}{q+m}.$$

from which

$$R=\frac{p+l}{q+m}S+\left(\frac{p+l}{q+m}-\frac{p'+l'}{q'+m'}\right)\frac{q'+m'}{f'}X.$$

Writing $\frac{p}{q}=r(1+k)$, and $\frac{p'}{q'}=r(1+k')$, this reduces to

$$\frac{\Delta R}{R}=\frac{\Delta S}{S}+K+\frac{K-K'}{r+1}\frac{X}{S}+\frac{l}{p}-\frac{m}{q}+\left\{\frac{l}{p}-\frac{l'}{p'}-\left(\frac{m}{q}-\frac{m'}{q'}\right)\right\}\frac{X}{(r+1)S}$$

where $\Delta S/S$ is the error in the standard from its nominal value.

The following examples will best show the procedure in building up and stepping down by means of the build-up standard and ratio coils and the double bridge.

Example of Building-up From 1Ω to 1,000Ω.

The following is an example of the process of building up from a 1 Ω to a 1,000 Ω standard, by means of three of the built-up standard and ratio coils. The primary standard was a 1 Ω compensated coil of the author's form made by Mr. Baugh and adjusted by Mr. Jolley at the Northampton Institute in 1908, and recently standardised by the N.P.L., its value being given as 111·5 parts in 1,000,000 high at 20°C., with a temperature coefficient of 4·5 millionths per 1°C. Unfortunately, the 1—3 build-up standard, forming the first of the series, was wound with manganin wire which was afterwards found to have the high temperature coefficient of 70 millionths per 1°C., and since the temperature could not be kept very steady and the thermometer could not be read much closer than 0·1°C., the readings are not as accurate as should be the case. The air temperature during most of the observations was under 15°C., and the coils were kept near their correct temperature by occasional heating.

A. Building-up from 1 Ω *to* 10 Ω.

1 Ω Compensated Standard. *JHB* 5.
Value, +111·5+4·5 (*t*—20).

1/3 Ω Build-up Standard, No. 2,914.

Coil tested.	Temp. coefficient.	T_1.	T_2.	*D.*	*R.*	Δ	Standard resis.	Temp. correction.	Value of coil at 20°C.
L.H. 1 Ω (*a*)	25	20·75	20·49	92·4	103·5	+11·1	114·9	−12·3	+113·7
Centre 3 (*b*)	70	20·65	20·50	164·4	30·4	−134·0	114·4	−35·0	−54·6
R.H. 1 Ω (*c*)	27	20·60	20·52	87·2	108·5	+21·3	114·2	−14·0	+121·5
L.H. 1 Ω (*a*)	25	20·50	20·52	89·2	105·3	+16·1	113·8	−13·0	+116·9
Centre 3 (*b*)	70	20·15	20·70	156·2	39·0	−117·2	112·2	−19·0	−54·0
R.H. 1 Ω (*c*)	27	20·05	20·70	84·3	110·3	+26·0	111·7	−19·0	+118·7

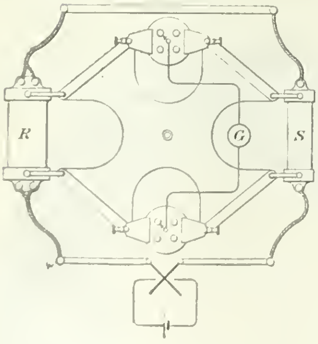

FIG. 10.

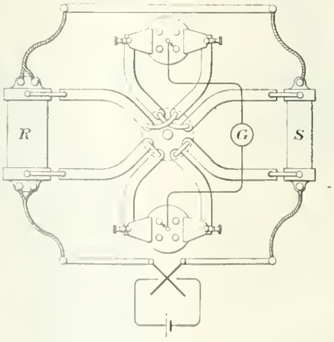

FIG. 11.

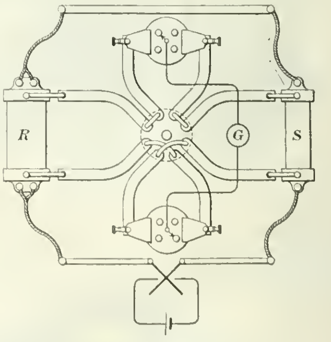

FIG. 12.

Similar observations were made with the coils interchanged, giving the following results :—

Coil.	Standard on left.	Standard on right.	Mean.	Coil value (deducting 6 for block).
L.H. 1 Ω (*a*)	+115·3	+112·8	+114·0	+108+25 (*t*−20)
Centre 3 (*b*)	−54·3	−53·0	−53·7	−59·7+70 (*t*−20)
R.H. 1 Ω (*c*)	+120·0	+121·2	+120·6	+114·6+27 (*t*−20)

This gives us the two following 10 Ω combinations :

$$\text{L.H. 10 (L.H. 1+Centre 3 Series)} = 0{\cdot}1\{108+25(t-20)\} + 0{\cdot}9\{-59{\cdot}7+70(t-20)\} = -42{\cdot}9+65{\cdot}5(t-20).$$

$$\text{R.H. 10 (R.H. 1+Centre 3 Series)} = 0{\cdot}1\{114{\cdot}6+27(t-20)\} + 0{\cdot}9\{-59{\cdot}7+70(t-20)\} = -42{\cdot}3+65{\cdot}7(t-20).$$

B. Building-up from 10 Ω *to* 100 Ω.

1/3 Build-up Standard, No. 2,914.

10/30 Build-up Standard, No. 2,918.

Standard.	Coil tested.	Temp. coefficient.	T_1.	T_2.	*D.*	*R.*	Δ	Standard resis.	Temp. correction.	Value of coil at 20°C.
L.H. 10	L.H. 10...	25	20·13	20·74	82·8	113·4	+30·6	−34·4	−18·5	−22·3
,,	Centre 3//	16	20·07	20·7	87·8	107·9	+20·1	−38·2	−11·2	−29·3
,,	R.H. 10...	25	20·05	20 7	78·5	120·0	+41·5	−39·6	−17·5	−15·6
R.H. 10	L.H. 10...	25	20·06	20·75	80·6	114·2	+33·6	−38·2	−18·8	−23·4
,,	Centre 3//	16	20·07	20·72	89·5	106·2	+16·7	−37·6	−11·5	−32·4
,,	R.H. 10...	25	20·08	20·70	79·3	116·5	+37·2	−37·0	−17·5	−17·3

This gives us the following values :—

$$\text{L.H.}10=-22{\cdot}8+25(t-20),\ \text{Centre } 3//=-30{\cdot}8+16(t-20),\ \text{R.H. }10=-16{\cdot}5+25(t-20).$$

$$\text{L.H. }100=0{\cdot}1\{-22{\cdot}8+25(t-20)\}+0{\cdot}9\{-30{\cdot}8+16(t-20)\}=-30+16{\cdot}9(t-20).$$

$$\text{R.H. }100=-0{\cdot}1\{-16{\cdot}5+25(t-20)\}+0{\cdot}9\{-30{\cdot}8+16(t-20)\}=-29{\cdot}4+16{\cdot}9(t-20).$$

C. Building-up from 100 Ω *to* 1,000 Ω.

100/300 Build-up Standard, No. 2,916.
(Shunted with 500,000 Ω = 200 *m*.)

10/30 Build-up Standard, No. 2,918.

Standard.	Coil tested.	Temp. coefficient.	T_1.	T_2.	*D.*	*R.*	Δ	Standard resis.	Temp. correction.	Value of coil at 20°C.
L.H.100	L.H. 100.	10	20·22	20·16	114·5	81·4	+33·1	−27·3	−2·2	+203·6
,,	Centre 3//	7	20·26	20·16	92·4	103·0	−10·6	−27·3	−1 8	+160·3
,,	R.H. 100.	8	20·22	20·13	110·5	85·3	+25·2	−27·8	−1·8	+195·6
R.H.100	L.H. 100.	10	20·14	20·11	113·5	82·0	+31·5	−27·5	−1·4	+201·6
,,	Centre 3//	7	20·12	20·10	92·4	103·1	−10·7	−27·7	−0·9	+160·7
,,	R.H. 100.	8	20·12	20·10	110·0	85·4	+24·6	−27·7	−1·0	+195·9

Hence, we have finally :—

$$\text{L.H. }100=+202{\cdot}6+10(t-20),\ \text{Centre } 3//=+160{\cdot}5+7(t-20),\ \text{R.H. }100=+195{\cdot}8+8(t-20).$$

$$\text{L.H. }1{,}000=0{\cdot}1\{202{\cdot}6+10(t-20)\}+0{\cdot}9\{160{\cdot}5+7(t-20)\}=164{\cdot}8+7{\cdot}4(t-20).$$

$$\text{R.H. }1{,}000=0{\cdot}1\{195{\cdot}8+10(t-20)\}+0{\cdot}9\{160{\cdot}5+7(t-20)\}=164{\cdot}1+7{\cdot}1(t-20).$$

From these sets of observations we therefore have two 1,000 Ω combinations. A series of tests made two months previously gave the values of the L.H. 1,000-ohm as +159, and of the R.H. as +158, or between 5 and 6 parts in 1,000,000 lower. This small discrepancy may be accounted for by a rise in the resistance of the coils, which is quite probable.

Example of Stepping-down from 1 Ω to 0·0005 Ω.

For this purpose two of the 10/30 Ω build-up standards were used as ratio coils. One of these was the coil No. 2,918 standardised in the last series of tests, and this was used as a front ratio. A similar coil, No. 2,919, was used as a back ratio, and the values of the ratio in each case are given as follows :—

10/30 Ω Standard, No. 2,918 :

Ratio 1/10 $\{1+6{\cdot}6m+8{\cdot}1(t-20)m\}$
R.H. 100
L.H. 10
$-29{\cdot}4+16{\cdot}9(t-20)$
$-22{\cdot}8+25(t-20)$ | $-30{\cdot}8+16(t-20)$ | $-16{\cdot}5+25(t-20)$
$-30+16{\cdot}9(t-20)$
R.H. 10
L.H. 100
Ratio 1/10 $\{1+13{\cdot}5\,m+8{\cdot}1(t-20)m\}$

10/30 Ω Standard, No. 2,919 :

Ratio 1/10 $\{1-19{\cdot}6m+8{\cdot}1(t-20)m\}$
R.H. 100
L.H. 10
$+348{\cdot}6+16{\cdot}9(t-20)$
$+329+25(t-20)$ | $+346+16(t-20)$ | $+372+25(t-20)$
$+344{\cdot}3+16{\cdot}9(t-20)$
R.H. 10
L.H. 100
Ratio 1/10 $\{1+26m+8{\cdot}1(t-20)m\}$

For each coil there are, of course, two positions of the galvanometer contact which give a ratio of about 10 to 1, and this enables us to make two independent measurements in each case of stepping up or down. The most accurate way of using these ratio coils is to put four copper bars across the corner of the bridge, as in Fig. 10, but if rapidity is required with slight sacrifice of accuracy the bridge may be used with its ordinary bars and commutator as in Fig. 11, and a second reading taken by reversing the commutator and galvanometer contacts, as in Fig. 12. In the latter case a resistance of 55 microhms must be allowed for each pair of bars with the commutator and contacts. The contact bar and connections at the back forming the coupling resistance X have a contact resistance of almost exactly 0·001 Ω, so that the corrections

$$\frac{K-K'}{r+1}\frac{X}{S},\ \text{and}\left\{\frac{l}{p}-\frac{l'}{p'}-\left(\frac{m}{q}-\frac{m'}{q'}\right)\right\}\frac{X}{(r+1)S},$$

are negligible when stepping down from 1 Ω to 0·1 Ω, and almost so when stepping from 0·1 Ω to 0·01 Ω.

D. Stepping-down from 1 Ω *to* 0·1 Ω.

Standard 1 Ω Compensated Coil, *JHB* 3.
Value, $+111{\cdot}5+1{\cdot}5\,(t-20)$.
Resistance of potential leads negligible.
Resistance of bridge blocks and commutator, 55 microhms.
0·1 Ω Tarnac Standard, No. 3,224.
Temperature coefficient, $22m$.
Resistance of each potential lead, 35 microhms.
Resistance of bridge blocks,&c., 55 microhms.

Hence, m and m' are each 55 microhms, and l and l' are each 90 microhms. Ratio coils, front, 10/100, No. 2,918 ; back, 10/100, No. 2,919, as above.

$$\text{Corrections}\ \frac{K-K'}{r+1}\frac{X}{s},\ \text{and}\left\{\frac{l}{p}-\frac{l'}{p'}-\left(\frac{m}{q}-\frac{m'}{q'}\right)\right\}\frac{X}{(r+1)S}$$

negligible.

The differences Δ were obtained by taking two deflections, D_1 when the coils were unshunted, and D_2 when the 1 Ω coil was shunted by 10,000 Ω.

Commutator.	Temperatures.			Deflections.		Difference. Δ.	Ratio K.	$\frac{l}{p}-\frac{m}{q}$	Standard resistance.	Temp. correction.	Coil value at 20°C.
	Front ratio, T.	T_1.	T_2.	D_1.	D_2.						
Direct ...	20·7	21·1	20·95	32·0	13·0	−168·5	+18·6	+8·5	116·5	−20·9	−45·8
Reversed	20·8	21·2	21·0	30·8	12·0	−163·8	+13·1	+8·5	116·9	−22·0	−47·3

Hence, the value of 0·1, No. 3,224, is −16·5+22 $(t-20)$.

E. Stepping-down from 0·1 Ω *to* 0·01 Ω.

0·1 Ω Tarnac Standard, No. 3,224.
Value, $-46{\cdot}5+22\,(t-20)$.
Resistance of each potential lead, 35 microhms.
Resistance of bridge blocks and commutator, 55 microhms.
Hence, m and m' are each 90 microhms.

0·01 Ω Tarnac Standard, No. 3,383.
Temperature coefficient, $25m$.
Resistance of each potential lead, 44 microhms.
Resistance of bridge blocks, &c., 55 microhms.
Hence, l and l' are each 99 microhms.

Ratio coil and coupling resistance as before. The deflection D_2 was obtained when the 0·01 Ω coil was shunted by 1,000 Ω.

Commutator.	Temperatures.				Deflections.		Δ	Ratios.		$\frac{l}{p}-\frac{m}{q}$	$\frac{K-K'}{r+1}\frac{X}{S}$	Standard resistance.	Temp. correction.	Coil value at 20 C.
	Ratios.		Coils.											
	T	T'	T_1	T_2	D_1	D_2		K	K'					
Direct ...	21·2	20·8	21·4	21·0	1·7	11·0	−18·3	+22·6	+33·0	+9·0	−0·1	−15·7	−25·0	−27·5
Reversed	21·1	20·8	21·45	21·0	1·0	10·5	−10·5	+15·5	−13·0	+9·0	−0·3	−14·6	−25·0	−25·3

Hence, the value of 0·01 Ω, No. 3,383 is $-26+25\,(t-20)$.

F. Stepping-down from 0·01 Ω *to* 0·001 Ω.

0·01 Ω Tarnac Standard, No. 3,383.
Value, $-26+25\,(t-20)$.
Resistance of each potential lead, 44 microhms.
Resistance of bridge blocks and commutator, 55 microhms.
Hence, m and m' are each 99 microhms.

0·001 Ω Concentric Standard.
Temperature coefficient, $28m$.
Resistance of potential leads,
Front, 51 microhms.
Back, 56 ,,
Resistance of bridge blocks, 55 microhms.
Hence, $l=199$ and $l'=111$ microhms.

Ratio coils and coupling resistance as before.

Balance obtained by shunting 0·001 Ω resistance across potential contacts.

Commutator.	Temperatures.				Shunt S	$\Delta=\frac{1110}{S}$	Ratios.		$\frac{l}{p}-\frac{m}{q}$	$\frac{K-K'}{r+1}\frac{X}{S}$	Standard resistance.	Temp. correction.	Coil value at 20°C.
	Ratios.		Coils.										
	T	T'	T_1	T_2			K	K'					
Direct ...	21·1	20·7	21·8	20·8	2·67	+416	+15·5	−13·9	+10·1	+2·9	+19·0	−22·4	+441·1
Reversed	21·1	20·7	22·1	20·8	2·72	+408	+21·0	+31·7	+10·1	−9·0	+25·2	−22·4	+440·9

The value of $\left\{\frac{l}{p}-\frac{l'}{p'},-\left(\frac{m}{q}-\frac{m}{q'},\right)\right\}\frac{X}{(r+1)S}$ is again negligible.

Hence, value of 0·001 Ω concentric standard $=+441+28\,(t-20)$.

G. Stepping-down from 0·0001 Ω *to* 0·0005 Ω.

0·001 Ω Concentric Standard.
Value, $+441+(t-20)$.
Resistance of potential leads,
Front, 56 microhms.
Back 54 ,,
Resistance of bridge blocks and commutator, 55 microhms.
Hence, $m=111$ and $m'=109$ microhms.

0·0005 Ω Concentric Standard, No. 3,351.
Temperature coefficient $25m$.
Resistance of potential leads,
Front, 50 microhms.
Back, 52 ,,
Resistance of bridge blocks, &c., 55 microhms.
Hence, $l=105$ and $l'=107$ microhms.

Ratio coils and coupling resistances as before, but centre three coils in parallel, giving front ratios direct as $+10{\cdot}3+1{\cdot}5\,(t-20)$, and reversed $+0{\cdot}9+4{\cdot}5\,(t-20)$.

The value of

$$\left\{\frac{l}{p}-\frac{l'}{p'}-\left(\frac{m}{q}-\frac{m'}{q'}\right)\right\}\frac{X}{(r+1)}S\ \text{is}\ -0{\cdot}3.$$

Hence, value of 0·0005 Ω concentric standard No. 3,351 $=+178+22\,(t-20)$.

The above tests show the facility with which the whole range of standardisation from 1,000 Ω down to 0·0005 Ω or less can be effected.

Commutators.	Temperatures.				Shunt S	$\Delta = \frac{1110}{S}$	Ratios.		$\frac{l}{p}-\frac{m}{q}$	$\frac{K-K'}{r+1}\frac{X}{S}$	Standard resistance.	Temp. correction.	Coil value at 20°C.
	Ratios.		Coils.										
—	T	T'	T_1	T_2			K	K'					
Direct ...	19·8	19·9	20·5	20·2	3·57	−311	+9·5	−29·8	+5·0	+26·2	+455	−5·0	179·7
Reversed	19·9	19·9	20·5	20·2	4·32	−257	+0·5	+34·3	+5·0	−22·5	+455	−5·0	+176·0

With a moderate regulation of temperature to within a degree of its standard value, the whole of a series of standards of the above range can be checked in a few hours.

It is proposed in future to wind all the coils of the build-up standards with the same wire, so that the ratio is unaffected by temperature. For example, the 1—3 standard will be made with nine similar 3 Ω coils, each of the 1 Ω coils being made of three 3 Ω coils in parallel. There is some advantage, however, in having a ratio varying with temperature, as it is then possible to find a temperature which will give an exact ratio, including the potential contacts, blocks, &c. If the ratios are then kept at this temperature no corrections are required.

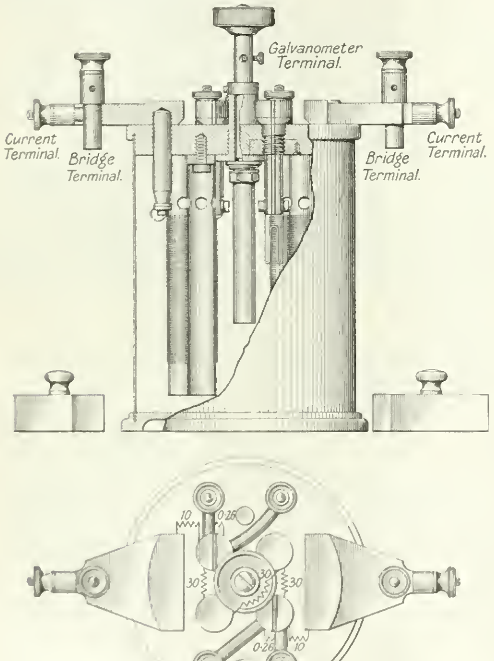

Fig. 13.—Built-up Standard and Ratio Coil with Interpolations.

The two outer 30Ω coils in Fig. 13 are shown for clearness as if they were connected directly to the 10Ω coils, but each is, of course, connected to the other half of the block so that the interpolation resistances are between the 10Ω and 30Ω coils.

For cases where a great deal of stepping down work has to be done the writer has modified the design of the build up ratio to include interpolation resistances which allow of its being used in conjunction with the double slide wire and of reading the value of the coil under test directly in millionths, as when making level comparisons. The construction of the 10—30 Ω build-up ratio bobbin is shown in Fig. 13, from which it will be seen that two of the circular copper blocks are split in halves, with an interpolation resistance of 0·26 Ω between them. As the end of each of the slide wires are fixed additional terminals with resistances of 2 Ω and of 2·5 Ω between them, as in Fig. 14. If the front and back ratio coils are each of them connected to these terminals as shown in Fig. 14 (*a*), (*b*) or (*c*), the bridge will be very nearly direct reading either for even ratios or for ratios of 2 to 1, or of 10 to 1. For the bulk of ordinary work, however, the simple build-up ratios are all that are required.

In conclusion, it should be again pointed out that the tests above given are by no means such as should be obtained under satisfactory laboratory conditions with perfectly adjusted coils and skilled observers. In the case of Government standardising laboratories or other institutions where such conditions obtain, the bridge should be capable of measuring to the highest degree of accuracy, and with great convenience and freedom from error. The ability to check a whole series of standards of different values in terms of a fundamental standard or to evolve a complete set of standards of different values from a single unit with ease and rapidity is of special value.

For an example, a 0·1Ω non-inductive standard coil was tested on October 6th last by slipping down from the 1 Ω standard previously tested by the N.P.L., and found to have the value +173+23 (t−20). It was then tested at the N.P.L., the value being given as 0·100011 international ohm at 17·13°C. on October 26th. After its return it was again checked against the 1 Ω standard and found to have the value +176+23(t−20) on November 10th. Applying the temperature correction the value of the coil on October 6th was 0·1000107Ω, and on November 10th 0·1000110Ω at 17·13°C., agreeing with the N.P.L. well within the accuracy to which its certificates are issued.

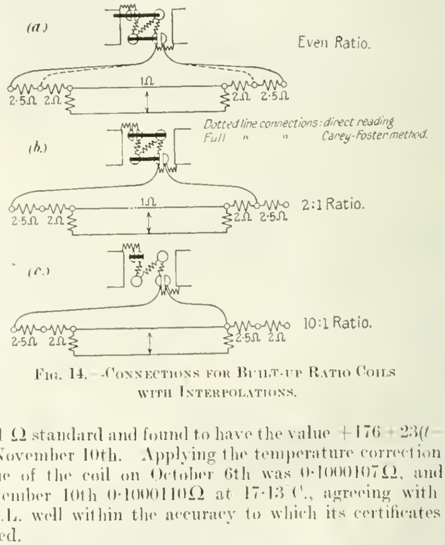

Fig. 14.—Connections for Built-up Ratio Coils with Interpolations.

But, although the bridge has been designed for such accurate work, it has been specially devised for good commercial testing, and it has been in satisfactory daily use for adjusting standards and taking their temperature coefficient by a lady assistant having no previous technical training, and who regularly obtained quite as good temperature curves as those shown in Fig. 7, taking about two to three hours over each set of observations. It has thus been found commercially possible to issue with each separate resistance standard a certificate and temperature curve, which even the Germans have not yet done. Even for adjusting moving coil instrument shunts of high quality this bridge serves better than most ordinary devices.

Mr. A. C. Jolley, who has recently been making a long series of measurements with the original bridge at the Northampton Institute informs me that he finds the rapidity of reading with the slide wire just 10 times as great as with the shunting methods usually employed.

Although the new bridge, &c., is an advance as regards convenience, it is admittedly merely a combination of the methods laid down by the great pioneers of accurate resistance measurement, Prof. Carey Foster, Lord Kelvin, and Lord Rayleigh, and the more that is done in this direction the more does one find to admire in their work.

APPENDIX.

EFFECT OF SHUNTING LOW-RESISTANCE STANDARDS.

A low-resistance standard may be shunted in either of two ways, which we may refer to as the "short shunt" and "long shunt" methods respectively. In the former case the shunt is connected between the potential terminals, as in Fig. 15, while in the latter it is joined to the current terminals as in Fig. 16.

Short Shunt Connection.—The parallel resistance of the combination (leaving out of consideration the ratio resistance of the bridge) is

$$\frac{R(s+l+l')}{R+s+l+l'}.$$

But the P.D. between the bridge blocks is less than that across the resistance R in the proportion of s to $s+l+l'$. Hence, the effective resistance of the combination as regards P.D. across the bridge is

$$R'=\frac{R(s+l+l')}{R+s+l+l'}\,\frac{s}{s+l+l'}=\frac{Rs}{R+s+l+l'}.$$

Hence, change produced by shunting, $\Delta R=R-R'=\frac{R(R+l+l')}{R+s+l+l'}$, and $\frac{\Delta R}{R}=\frac{R+l+l'}{R+s+l+l'}$, or the shunt produces the same change of effective resistance as if it shunted the resistance $R+l+l'$ instead of R. If s is large compared to $R+l+l'$

$$\frac{\Delta R}{R}=\frac{R+l+l'}{s}.$$

Long-shunt Connection.—Here the effect of connecting the shunt S across the current terminals is to reduce the current through the resistance in the ratio of s to $R+c+c'+s$, so that the fractional change in effective resistance

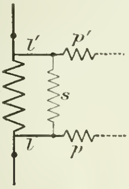

FIG. 15.—SHORT SHUNT.

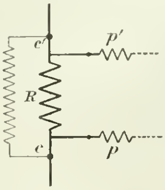

FIG. 16.—LONG SHUNT.

$$\frac{\Delta R}{R}=\frac{s}{R+c+c'+s}=\frac{R+c+c'}{R+c+c'+S},$$

or, if s is large compared with $R+c+c'$, $\frac{\Delta R}{R}=\frac{R+c+c'}{s}$.

It thus appears that in whichever way a low resistance standard is shunted, the change of effective resistance is obtained by applying the ordinary shunting formula to the total resistance between either the potential or the current terminals. As the resistances of the potential or of the current terminals may be 10 per cent. or more of the nominal value care must be taken to measure the total resistance between the terminals shunted, if balance is to be obtained in this way.

LINKING-UP IN THE WEST OF ENGLAND AREA.

A meeting was held at the Merchant Venturers' Technical College, Bristol, on Monday, the 18th ult., when an introductory statement was made by the convener, Mr. H. Faraday Proctor (joint hon. secretary to the National Electric Power Supply Joint Committee).

Mr. PROCTOR surveyed the growth of the movement, and stated that the question of the smaller undertakings was given very early consideration, and it was laid down by the Joint Committee at its meeting on June 23 "that in formulating any linking-up proposals existing areas and rights should be preserved." It was felt that the output of the smaller undertakings is likely to be much improved. Mr. Proctor then compared the West of England area with the area of a proposed Lancashire scheme, which comparison showed how unfavourable was the West of England area as defined for a linking-up scheme of any magnitude. Also that the scheme was introduced as a war measure, with a view to economising the coal output, but as an outcome, the Government would see that the electrical industry in the future was run on more economical lines, especially as regards generation. In the Manchester neighbourhood coal consumption was 3½ lb. per unit per unit sold, and in some American schemes, as low a figure as 2 lb. per unit or less was reached. Mr. Proctor mentioned the probable linking-up of Bristol with Bath and Portishead.

Mr. BACHE thought that the electrification of main lines already begun by several railway companies would be extended after the war, and would facilitate linking-up. Also that adequate defence for small undertakings should be provided.

Dr. PURVES expressed the view that the West of England area was not very hopeful ground, but thought that many cases could be taken to begin with.

Mr. CHRISTY desired to know whether any financial assistance would be afforded by the Government in respect to capital outlay, also whether it was the intention to "swallow up" the smaller undertakings.

Mr. VERDON SMITH desired that the matter should be treated on national grounds, and inquired as to the compensation for displaced officials.

Mr. SWARBRICK stated that farmers would welcome a supply if it could be obtained, and referred to what had been done in this connection in Hereford, as described before the last I.M.E.A. Conference.

Mr. CHARLTON remarked that his undertaking would welcome the prospect of obtaining cheap electricity, which seemed probable under a linking-up scheme.

Dr. PURVES said the question of connecting up farmers, large or small, would follow quite naturally when it had been decided to connect up small towns.

Mr. PROCTOR having replied to some of the points raised, it was decided to form a General Committee which should comprise all those who had been invited to the meeting that day, viz :—

Local Authorities.

Name.	Representing.
Teague F.	Bath Electricity Department.
Proctor, H. Faraday	Bristol Electricity Department.
Bache, W. J.	Cheltenham Electricity Department.
Fippard, A. J.	Frome Electricity Department.
Corson, F. H.	Gloucester Electricity Department
Wilkins, A. C.	Monmouth Electricity Department.
Dimmack, A.	Swindon Electricity Department.
Howard, A. J.	Taunton Electricity Department.
Bolam, J. H.	Weymouth Electricity Department.
Companies.	
Hardy, W. E.	Bath Tramways Co.
Smith, W. G. Verdon	Bristol Tramway Co.
Purves, Dr. J. A.	Blandford, Burnham, Dorchester & Swanage Supply Companies.
Parfitt, G. J. T.	Keynsham Electric Light Co.
Swarbrick, F.	Minehead Electricity Co.
Christy, F.	Portishead & Mid Somerset Supply Co.
Randall, A. B.	Salisbury Electric Supply Co.
Edwards, J. H.	Tewkesbury Electric Supply Co.
Charlton, G.	Weston-super-Mare Electric Supply Co.

Mr. Corson (Gloucester) was elected chairman, and Mr. W. J. Bache (Cheltenham) was elected vice-chairman and secretary.

The following working sub-committee was appointed :—

Mr. H. Faraday Proctor	Representing Local Authorities.
Mr. F. Teague	
Mr. A. Dimmack	
Mr. J. H. Bolam	
Mr. F. Swarbrick	Representing Companies.
Mr. F. Christy	
Mr. G. Charlton	

The following matters were referred to the sub-committee : Consideration of extent of area ; report on plant capacity and requirements ; standardisation ; consideration of provision of capital required for linking-up ; and suggestions as to possibility of immediate linking-up of specific districts.

Use of Earthed Neutrals in Transmission Systems. In a recent discussion on the above subject, at a meeting of the American Institute of Electrical Engineers, Mr. Bernard Price gave some interesting particulars of the methods used on the transmission system of the Victoria Falls and Transvaal Power Co. In this case it has been found unquestionably wise to earth the neutral. When this was done the automatic cut-outs served to isolate instantaneously the initial fault and prevented the lightning arrester gear from a continuous discharge and flash-over on switchgear connections. It is essential that each separate section of the system should be separately grounded, and for arrangements to be made such that when portions of the system become automatically isolated from other portions they still remain grounded. Dealing with the question of inserting resistance in the neutral connection, Mr. Price said that the principle adopted was to make such resistances as low as possible. The earth side of the resistance is connected to the station main earth, the resistance working out to under 0·2 ohm. Good earths are readily secured by sinking large metallic plates into an expanse of water.

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THE DEVELOPMENT OF THE POWER LOAD.

In another 12 months we hope it will be possible to deal with this subject at some length, and to show that recent developments in electricity supply for industrial purposes have kept pace with the remarkable industrial developments that have taken place in little more than a year. Notwithstanding these developments, and regardless of the shortage of coal, waste is still allowed to go almost unchecked in certain of the important manufacturing districts of the country. There are still those who think that because they have the means to purchase a ton of coal they have the right to use it as they wish.

Although at this time one cannot describe what has been done at home during the year, nor refer to what is contemplated in the immediate future, one may at least draw broad conclusions from facts which are common knowledge. Probably the best lesson is afforded by those countries which, although rich in mineral wealth, are, according to our pre-war standards, deficient in man power, and which are less favourably situated geographically than ourselves. In these countries the development of the power load overshadows everything else, and it is recognised that the natural drawbacks are to a very large extent neutralised by the lavish use of electrical energy and by the substitution of machinery for men.

Whereas at the beginning of the century it was customary to think in hundreds, or at most in thousands, of kilowatts, it is now common to think in tens, or in hundreds, of thousands of kilowatts. During the year just closed the development of the turbo-alternator unit and its auxiliaries has kept well up to requirements, and greater developments are foreshadowed in the immediate future. Considerable attention has been given to the securing of efficiency in the boiler house, and a number of informative Papers on this subject have been read. In the boiler house, also, striking developments appear to be imminent.

An excellent example of the progress that has been made in the design of prime movers is furnished by the 74th Street Power Station of the Interborough Rapid Transit Co., of New York. Little more than 15 years ago eight 5,000-7,500 kw. reciprocating engine sets were installed. These operated at 175 lb. steam pressure, there was no superheat, the water rate was 17 lb. per kilowatt hour, and the cost of engines, generators and condensers was £8 per kilowatt. In 1915 four of these sets were broken up and sold as scrap, and, if we remember rightly, three 30,000 kw. turbine units were installed. In a space no greater than that required for one of the old reciprocating sets, a 30,000-kw. turbine unit was erected and was operated from the same boilers, which delivered three times their rated output. The boilers were worked at 205 lb. gauge pressure, and were equipped with underfeed stokers and superheaters to give 200° F. superheat. The water rate under similar load conditions to that of the reciprocating sets was 11·4 lb. per kilowatt hour, and the cost was £1. 16s. per kilowatt. To the non-technical man a better way of expressing these figures is to state that they mean a saving of over £10,000 per annum in fuel alone for each turbine unit. Early in the year just closed it was announced that the same company, after careful consideration, had ordered a 70,000-kw. turbine unit. This unit is to be in three sections, one high pressure and two low pressure, and on light load it will be capable of operation at high economy with the high-pressure and one low-pressure cylinder. The completion of this set and the publication of the test results will create a good deal of interest. Such a progressive policy on the part of the Interborough engineers and financiers is one greatly to be admired and one worthy of being imitated.

Hopeful as we are as to the future development of the power load at home, a strong public opinion will, nevertheless, be necessary before local authorities and companies can be dislodged from the grooves into which they have either wedged themselves or have been wedged by the State, and which make economical working an utter impossibility. Great as is the need for economy in every direction, London is still supplied with electricity upon 49 different systems, from 70 generating stations, by 65 authorities. Dr. H. F. PARSHALL's estimated saving of more than half a million tons of coal per annum by supplying the 400-million kilowatt-hours required in the London area from two generating stations each of 125,000 kw. installed capacity, has not yet materialised.

Rather are our engineers engaged upon the development of schemes for the linking-up of the many existing, and more or less equally inefficient, stations throughout the country. They, at the request of the Board of Trade, are seeking to secure economies in hundreds of thousands of pounds, whereas we would have them secure economies in millions. If in making war the country can afford to spend thousands of millions sterling at the rate of six millions sterling per day, it surely stands to reason that we can well afford to spend a total of some tens of millions sterling in order to secure for our people one of the prime essentials of industrial prosperity. When peace is proclaimed, as we most earnestly hope it will before the end of the year, it would make little difference to us if we were to pretend, for little more than a week, that we were still at war. Such pretence would result in incalculable and immediate gain to the country; but, as we have already said, the attempt is being made merely to tide over the difficulty. The inevitable result will be that the problem, which is now being shirked, will become increasingly difficult in course of time, and will have to be solved by the next generation.

There are those who believe that relatively few generating stations would be a source of weakness to the country in time of war. It is said that the German military authorities vetoed electric traction on an extensive scale for this reason.

Beginning with Marathon, B.C. 490, and counting the present war decisive—as Ministers assure us it will be—history records 16 decisive wars. Of these, five took place before the dawn of the Christian era, and four in the 18th century. This leaves seven decisive wars spread over a period of 1,800 years. For this reason alone we should be tempted to take the risk of what is thought by some to be a source of weakness.

We have thought it necessary to deal with this point at some length because at the present time we are paying dearly for our omissions in not constructing the Channel Tunnel. The so-called " weakness " of the Channel Tunnel in time of war is such that the scheme is now being seriously discussed by those who, only a few years ago, were bitterly opposed to it.

It has yet to be shown that work which in normal times is for the good of mankind is likely to be to the detriment of mankind in time of war. Helpful as has been the development of the power load to us during the past year in the manufacture of munitions, we maintain that even more helpful will it be found in the future, and we would have the people of the country look at the matter from a national rather than from a parochial point of view.

At the outset it was our intention to record the year's progress in heavy electrical engineering, and as yet we have dealt only with the question of power supply. Since the former depends on the latter, it is fitting that the importance of a practically unlimited and inexpensive power supply should be emphasised. The holding over for a week of the record of the progress in heavy electrical engineering is, therefore, excusable.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Treatise on the Theory of Alternating Currents. (Vol. II.) By ALEXANDER RUSSELL, M.A., D.Sc., M.I.E.E. Second edition. (Cambridge: University Press.) Pp. xiv. + 566. 15s. net.

At first sight this book seems to have needed little alteration since the original edition was published ten years ago, but although there are few additions, several of the chapters have been entirely re-written. The chief differences are to be found in the matter dealing with armature reaction and with power transmission. In the former the method now adopted is easier to follow than the old one, and is an improvement in that there is less ground for the criticism that the treatment is too mathematical and too far removed from practical considerations. It is, however, in the chapter on power transmission that real improvements have been made by much fuller use of hyperbolic functions in the manner developed by Kennelly, of Harvard; and to help the student a new chapter dealing with hyperbolic trigonometry has been added. Only those who have used these methods realise what advantages they offer over the semi-graphical or "topographical" method of Steinmetz; whilst, excellent as the Steinmetz "symbolic" method may be for the purpose, it is far surpassed in convenience and brevity by the new method.

A new chapter has also been added which is of interest from the practical point of view: Dr. Russell has worked out a most ingenious system for analysing a distorted E.M.F. or current-wave into its harmonic components by a simple algebraic method depending on Weddle's Rule for finding the area of a curve; this avoids the very heavy labour involved in the ordinary methods of curve analysing based on a direct application of Fourier's theorem. With the continued rise in transmission voltages more attention must be paid to the possibility of resonance effects and wave-form study is accordingly of increasing importance, so that Dr. Russell has conferred a boon on electricians by devising a method of analysis which, for simplicity, ranks with graphical methods, whilst possessing the added advantage of brevity.

The other new matter is to be found in the short descriptions of such modern machines as the La Cour motor converter and the frequency transformer, but these additions are very brief and are only descriptive. Lastly, the theory of the induction motor has been re-written so as to bring it more in line with modern methods, and, in particular, the "circle diagrams" have been simplified.

The book as a whole is essentially one for the mathematical student; there is very little descriptive matter, and although the actual standard of mathematical knowledge required is not high, the point of view in the arguments is generally that which would be taken by a mathematical physicist as compared with that taken by a practical engineer. But for a student who has graduated in mathematics and who then studies engineering the book is admirable in every way, as the descriptions are sufficient to point out the purpose of the theory, without falling into the error that a practical engineer can be made by reading text-books. F. J. DYKES.

Practical Mathematics for Technical Students. Part II. By T. S. USHERWOOD and C. J. A. TRIMBLE. (London: Macmillan & Co.) Pp. x. + 565.

The authors of this book have earned and they deserve the thanks of students of engineering and other branches of applied science. In view of the many books on "Elementary Practical Mathematics" it is refreshing to come across a book that is not elementary.

A feature of the book is the attention given to vectors. In the first chapter the fundamental principles are explained and illustrated. Later in the book, the principles of the calculus are applied alike to vectors and scalars as these principles are stated or illustrated. The determination of laws and empirical formulæ to suit numbers determined by experiment is dealt with at some length, the chapter on Harmonic Analysis including most of the work required by the engineer. The use of symbolic operators, as labour-saving devices, is illustrated fully, the chapters on differential equations containing a number of typical examples.

Students who master the text will be in a position not only to solve the many exercises given in the book, but also to apply their knowledge to the problems of engineering or applied science. The many examples in the text cover a wide range of subjects, and will be invaluable to those who are working without a teacher. In the next edition we should like to see included a chapter on the construction and use of graphical charts and solid models. The use of such charts and models is rapidly extending, and, as yet, the literature on the subject is scanty.

Messrs. Macmillan, Ltd., enjoy the reputation of being the publishers of sound mathematical works, and the book under review will enhance their reputation. It is unreservedly recommended to those who, having mastered the elements of arithmetic, algebra, geometry and trigonometry, are able and willing to devote the time necessary for acquiring a knowledge of the subject.

Electric Lighting. By A. H. AVERY. (London: Cassell & Co.) Pp. viii. + 150. Price, 1s. net.

As the sub-title states, this book is a practical guide to the wiring of houses and the installing of electric light plants; it does not deal with electric lighting in its more general aspects. It is well printed, as also are the diagrams it contains; probably many of our readers are already familiar with it, as the edition before us is a reprint of one published in 1913. It is founded on a series of articles, originally contributed to "Work," and may be recommended to those who are interested in the work of house lighting, either as amateurs or professionals. W. H. S.

Electric Bells and Telephones. Edited by B. E. JONES. (London: Cassell & Co.) Pp. 154. 1s. net.

This is one of the well-known "Work" series of handbooks, a statement which sufficiently describes the nature of its contents. It contains a clear outline of all the practical details of the installation of bells and telephones in a private house; perhaps it makes its appeal more particularly to the amateur, but it might be useful to many a beginner. It contains a couple of chapters describing the general principles on which the action of the telephone is based.

Engineering as a Career. By P. and A. W. MARSHALL. (London: Percival Marshall & Co.) Pp. 51. 6d.

This little pamphlet is likely to be useful to parents and guardians, and to help to a proper understanding of what an engineering career really is. It deals mostly with workshop life, and says very little about the technical college. It gives some notes about the main subdivisions of engineering activity, while avoiding the thorny question as to whether a boy does better to begin with the college or the workshop. It is impossible to avoid a feeling of bewilderment when one considers the many alternative possibilities which are suggested to the would-be engineer, but the authors cover superficially a good deal of ground, laying stress throughout on the practical rather than the theoretical aspect of things.

THE PARALLEL OPERATION OF ELECTRIC POWER STATIONS.

The following discussion on Mr. J. S. Peck's Paper took place before the Manchester Local Section of the Institution of Electrical Engineers. An abstract of the Paper appeared in our issue of November 24th.

DISCUSSION.

Mr. W. B. WOODHOUSE saw no difficulty in the parallel working of stations, as it had been done in this country for many years, particularly on the north-east coast, not merely with two stations, but with a number of stations. Some people considered that linking-up simply meant extending existing mains at existing pressures, but that was far from being the case. Mr. Woodhouse then discussed the subject numerically on the same lines as in the London discussion.

Mr. J. ROBERTSON said the question for discussion was whether existing stations with mains laid out were to be linked-up for mutual assistance, or whether the larger view was to be taken of a big linking up scheme at much higher pressures, which would probably include some of the prospective large super-stations. The Lancashire linking-up scheme was on a somewhat modest scale, and after careful consideration it had been decided that there was much benefit to be derived from linking-up stations of moderate capacity and using as far as possible cables already laid. If a bigger scheme were to come along in the future, and it was decided to link-up with 50,000 or 100,000 volts, these modest little 6,600-volt stations would work quite well for distribution purposes; at any rate, the money spent on them would not be lost. It was of interest to note that the author confirmed the fact that there was no serious technical difficulty in linking-up. During the last two years the speaker had been responsible for the working of a station at Salford; there they had in daily operation two 5,000 kw. turbines running in parallel with the Lancashire electric power station, where they had in operation plant aggregating about 11,000 kw. At Salford the turbines were throttle governed, whilst at Radcliffe they were nozzle governed. At Salford the alternators were compensated by a Miles-Walker compensator, whilst at the other end the alternators were uncompensated. The regulators were of different types; in fact, the conditions were the worst possible for parallel running. Notwithstanding the conditions, the stations had run in parallel for two years without any of the wonderful things happening which were prophesied owing to resistance and reactance not being in correct proportion to secure satisfactory running. The Radcliffe pressure was 10,000 volts and the Salford pressure 6,600 volts, and it had been demonstrated that 2,000 kw. could be interchanged in either direction at 0·6 power factor without voltage regulation. This low power factor meant about 15 per cent. line loss, and it was necessary to regulate the voltage in order to bring the power factor nearer unity. It was found that if the generating end voltage were raised about 3 per cent. and the receiving end voltage lowered about 2½ per cent., practically ideal parallel conditions were obtained. During the two years of parallel operation only two cases of surging had occurred; and, whilst the cause was still in doubt, the speaker was of the opinion that it was due to the voltage regulators. Mr. Robertson agreed that if there was to be any appreciable interchange between stations a boosting regulator was absolutely necessary. It was quite possible to deliver power from one station to another regularly without a device of this kind, but when this transfer was required in either direction the regulator was essential to maintain the power factor and keep down line losses. Double wire wound transformers were desirable in connecting systems, also cables of ample cross section in duplicate. Even if the technical difficulties were greater than demonstrated, the advantages of linking-up were such that the difficulties should be faced and overcome. A 25 to 30 per cent. reserve supply from another station was a condition which only station engineers could appreciate.

Mr. G. B. VICKERS, referring to the connections of the boosting transformer in Fig. 1, thought it better to put a transformer in each phase, as the connection shown would tend to unbalance the load on the phases and cause unstable running of the machines. The author had indicated a method of calculating the load on two stations connected by an induction motor generator set, and in this connection Mr. Vickers gave a formula for the same purpose.

Prof. A. B. FIELD said the Paper emphasised once more the penalty demanded for haphazard lines of electrical development. Not only were great varieties of voltage, frequency and types of plant to be provided for, but all the two phase systems had to be linked up to three phase systems until the former were abolished. Trouble sometimes arose in meeting the exact frequency ratio; for instance, when 60 and 25 cycles were involved, the maximum speed of a set comprising two synchronous machines directly coupled together was 300 revs. per min. When the linking together of a two phase and a three phase system was in question, difficulties due to slight phase distortion easily arose unless greater care was taken than had been in some cases in the past. A rather exaggerated case of such trouble occurred on a power system in the States in which two 2,200 volt two phase plants had to be linked together. The distance separating the plants necessitated a transmission voltage of about 25,000, and in view of the advantages of transmission, three-phase was used on the line, thereby involving a two to three phase transformation at each end of the line, the Scott connection being used for the purpose. In operation it was found that at the receiving end the two phase synchronous motors accepted the bulk of their power on one phase, leaving the other phase lightly loaded, and the unbalancing was enough to cause serious heating of the windings in the overloaded phase. Rotating the connections at the motor gave no improvement, and even slightly raising the voltage by taps on the transformer failed to equalise the distribution of the load. It had been supposed that the conditions would be best if symmetry were maintained as much as possible, and to this end care had been taken to see that the transmission line which was connected to the teazer transformer at one end was also connected to the teazer transformer at the other end. Actually it was better to avoid this arrangement, and further, for one direction of transmission, the improvement by shifting round the three connections between line and transformer at the receiving end in one direction was greater than if the connections were shifted round in the other direction. It was easily understood how the leakage reactance of the transformers induced a phase distortion in the case of the Scott transformer connection, and how this effect might be serious unless suitable precautions were taken in the design of the transformers. Regarding the method of voltage regulation shown in Fig. I (in the original Paper), it would appear that the neutral on either one or other of the systems could be earthed, but not both.

Mr. JUHLIN considered that there was a great need for a clear exposition of the great bogey of wattless load. There was no need for more wattless current on a system than that required by the external load provided the operating conditions of the two stations were correctly adjusted to the load connected.

Dr. WM. CRAMP thought the Paper should be discussed by engineers in charge of large schemes rather than by those dealing with smaller systems, although in the latter case some very interesting questions arose. The author appeared to be overstating the fact in suggesting that at the present time there was no trouble with parallel operation. Turbo-generators gave little trouble, but in Lancashire schemes it would probably be necessary to parallel gas-engine sets with turbine and steam sets. Would this present no difficulty? Again, where more than two stations were operating in parallel it was difficult to see how the division of load was to be accomplished with induction synchronous machines unless there was more than one linking machine between each pair of stations or duplicate connections arranged. Taking the case of three stations, A, B and C, of which A was the largest, and B larger than C; also the distance between stations was A to B, 10 miles; B to C, 10 miles and A to C, 25 miles. Then an induction synchronous set installed between A and B would naturally have its motor fed from A, and similarly the set between B and C would have its motor fed from B. If each linking-up set had a slip of 4 per cent. at full load, the frequency of the systems A, B and C might under the worst conditions be 50, 48 and 46 respectively. In many cases, for example the cotton industry, the difference between 50 and 48 would be serious; but in nearly every case the change from 50 to 46 would be prohibitive. The use of induction synchronous machines was, therefore, strictly limited. Further, in even the smallest case, what was the position regarding reversibility? If A was connected to the induction motor of the linking set it could obviously divert power to B; but if A broke down B was powerless to help. This might be provided for by arranging the connections between A and B and the linking set so that either station might feed the motor and be fed by the generator. This did not appear to be an expensive addition, and it would be of interest to know whether it had previously been tried or even proposed. When at the beginning of the Paper the author referred to Appendix I. as "treating the subject in a general way" he was a little optimistic; the solution did not consider the effect of load upon the machines nor take into account the different effects of the iron losses in the generating and motoring machines respectively. These points were thoroughly covered by C. P. Steinmetz in "Alternate-current Phenomena," 3rd edition, page 315.

Mr. H. A. RATCLIFF said the Paper provided a strong argument for the standardisation of frequencies, since the main difficulties incidental to the parallel working of power stations appeared to rise in connection with the operation of frequency changers. The author had stated that frequency changers should be designed for abnormal conditions; but if they were large enough to deal with such conditions, it was possible that one result would be a poor overall efficiency. Presumably, the load under abnormal conditions would be very much greater than the normal running load, and it meant either running a large machine at a comparatively low load or paralleling smaller machines, which apparently introduced other difficulties. These difficulties were not specifically mentioned, but reading between the lines in the Paper it was evident that they had a real existence. One statement—"occasional shut downs may be expected"—gave an idea of what was likely to happen. Regarding static conversion from two phase to three phase and vice versa, this was quite sound with the exception of the small point raised by Prof. Field. In the case of conversion from single phase to polyphase, the author said this could only be done at the expense of unbalancing the load on the separate phases. It was possible to convert from three-phase to single phase with an equal current on all three phases; but the power factor would probably be different on each of the three phases, and consequently the load would not be balanced. Obviously, a polyphase supply could never be converted to a single-phase one through the medium of static transformers. An interesting fact in connection with the use of induction frequency changers was the comparatively large slip necessary to transfer an appreciable load from one system to the other. Assuming there were two stations, A and B, one of which (A) was celebrated for maintaining a constant frequency, linked through a converter requiring a 2 per cent. slip, then between the conditions when A was supplying power to B, and the conditions when B was supplying power to A there would be a total variation of 4 per cent.

in the frequency of station B. This would not suit the Lancashire textile industry.

The Author, in reply to Mr. Vickers, did not think the arrangement shown in Fig. 1 would give unbalanced voltages except to a very small degree, due to a slight difference in the value of the impedance introduced by the regulating transformers into the different phases; but, as pointed out by another speaker, this method of boosting on two phases only shifted the position of the neutral point of the system, so that two stations connected through a feeder, having a booster of this type, could not both be earthed. The only advantage of this regulator was that it was cheaper than the three-phase regulator. Replying to Prof. Field's comments on the "Scott" method of transforming from two phase to three phase, the unbalancing of voltage which might occur was one of the difficulties foreseen by Mr. Scott originally, and great care was always taken to interconnect the windings on the three-phase side of the main transformer, so that there would be a minimum reactance between the two halves of the winding. Hundreds of transformers were built in this manner, and nothing was ever heard of unbalanced voltages. If the two halves of the winding were not properly interconnected, the unbalancing might be very serious. Regarding Dr. Cramp's remarks on parallel running, it was generally safe to assume that if the different generators in a station ran well in parallel with each other they would run in parallel with those in another station. As to the difficulty of connecting several stations by means of induction synchronous sets, it was a fact that a difference in speed ratio was required in order to make the set take its full load; but the value of 4 per cent. taken for the slip was altogether too high. In general the slip would not exceed 1 to 1½ per cent. on a machine of, say, 500 kw. capacity; but even with this small slip the difference in speed ratio might be very objectionable under certain conditions. Another objection to the induction synchronous set pointed out by Dr. Cramp was that the induction machine could not re-generate if the synchronous plant to which it was usually connected was shut down. The suggestion that this might be overcome by arranging the set so that the connections of the two machines might be interchanged with reference to the generating stations was hardly feasible for the following reason: A motor-generator set was only utilised for interconnecting when the stations had different frequencies, therefore the induction machine would be wound for a different frequency from that of the synchronous machine, and it was obvious that under these conditions it would not be possible to interchange their position. Mr. Ratcliff had suggested that a frequency changer would have to work at low load most of the time, and would, therefore, be an inefficient as well as expensive piece of apparatus. The extent to which it could be loaded would depend upon the rate at which the loads fluctuated on the generating stations. If load changes were gradual, the set could be worked at approximately full load most of the time; but even at full load there was approximately 100 per cent. margin before it would pull out of step. If, however, the loads fluctuated too rapidly to permit adjustment of governors, then the frequency changer would have to be of larger size or more lightly loaded. When considering the question of the effect of resistance in the feeder upon parallel operation it was to be remembered that the reactance of the generators themselves should be taken into account. On the other hand, if the interconnecting feeder was of very small capacity as compared with that of the generating station, its ohmic value might have a very appreciable effect on synchronising power. Mr. Robertson's remarks on the parallel operation between Salford and the Lancashire Electric Power Co. were of considerable interest, and it was to be hoped that further particulars of tests actually made would be given.

NEW TOTALLY-ENCLOSED MOTORS OF ELECTRO-MOTORS (LTD.)

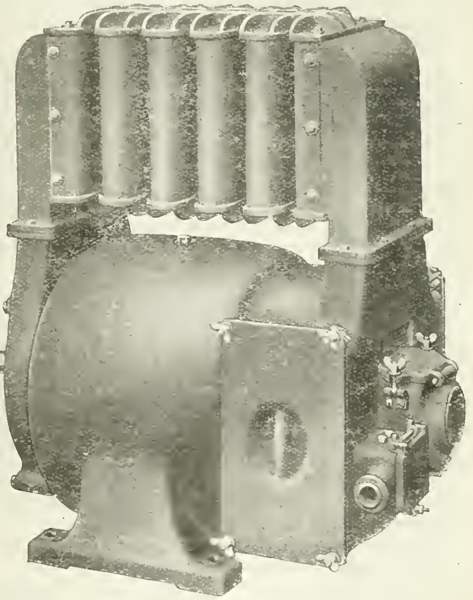
It is well known that the demand for totally enclosed motors has in the past been restricted partly by the difficulty in constructing them of any size and partly by their high cost compared with ventilated motors. The reason for this is that all the heat generated in an enclosed motor must of necessity be radiated through the outside carcase of the machine, and as the rate of dissipation is limited it follows that the heat generated must also be limited, and from a practical point of view this necessitates that the output for a given carcase is restricted, with the result that these machines are relatively costly. Furthermore, high speeds have been impracticable, for the very reason that a large proportion of this heat is generated by the armature iron losses alone, and as these increase with the speed a point is soon reached when these losses alone balance the radiating capacity.

Many expedients have been employed to overcome this, such as pipe ventilated motors, forced ventilation, &c., but the necessary trunking is always an objection and frequently impossible. Other devices such as pipes through the machines itself have been employed, fins and ribs upon the carcase, but still without much success.

A more successful means has been the employment of a hollow bedplate upon which the motor is mounted, and through which air is circulated from the motor. The hollow bedplate is embedded in concrete to absorb the heat, or can be cooled by a system of water-pipes. This introduces an element which has to be taken into account in any scheme of erection, and any arrangement which eliminates this fixture is of obvious advantage.

The idea of the present invention lies in a practical means of providing large air cooling surfaces constructed in such a manner that the system can be applied to standard machines of the well-known chimney or pipe ventilated type, the construction being such that the surface can easily be adjusted by the manufacturer to suit any requirement.

It is constructed by Electromotors, Ltd., in various forms. In one of these the radiator consists of a box with end pieces to fit on vertical trunk openings in the motor end covers, and through this box pass in a vertical direction a number of thin metal tubes. Inside the back bearing of the motor a fan is fitted on the armature shaft which causes a circulation of air through the machine and through the radiating box and the arrangement of the tubes, &c., is such that the air impinges on the thin vertical tubes giving maximum cooling. The advantage of the system is that not only is increased radiating surface provided, but as the tubes are thin compared with the motor carcase the radiation is much greater, and it is possible to approach within quite reasonable limits of the capacity of a ventilated motor of given frame size without the use of anything excessive in the size of the radiator.



Totally-enclosed Motor by Electromotors, Ltd.

Another form of the invention is shown in the illustration. Here the tube radiator is replaced by one having thin sinuous metal sides with top and bottom covers and also having mounted inside the radiator baffle plates which cause the air to impinge in a thin stream against the outside surfaces so that this type performs the same functions as the tube radiator.

The design lends itself very well to an entirely water or dust-tight construction, yet at the same time the bulk is of quite moderate dimensions; in fact, we understand that it is less than for an ordinary totally enclosed motor when dealing with larger powers. Such a motor is applicable to all situations where the atmosphere must be excluded and it will be advantageous to centrifugal pump makers owing to the higher speeds that are thus available. Application has been made for patents, and the makers state that a considerable number of these motors have already been built and put into practical service in collieries, chemical works, &c., with the most satisfactory results.

CORRESPONDENCE.

CITY AND GUILDS EXAMINATIONS.

TO THE EDITORS OF THE ELECTRICIAN.

Considering the general apathy which appears to exist regarding these valuable examinations, it was pleasing to find that the publication of the annual report was noticed by you in your issue of December 15th, even though—as you said—"it makes very gloomy reading." It should be the duty of every principal, head of department, and teacher at our technical institutions to "read, mark, learn, &c.," this report; but we wonder how many will do so.

On more than one occasion you have allowed us to comment on the bad treatment which "Electric Wiremen's Work" (now re-named "Electrical Installation Work") receives at the hands of those in authority at technical institutes. Now this is the fundamental electrical engineering subject, it appeals to all sorts of people besides wiremen, and should, therefore, be taught at more centres than the other electrical subjects, and have a preponderance of students.

From the report we gather the following facts :—

(*a*) That in session 1915-16, "Electric Wiremen's Work" was taught at only 48 centres as against 108 centres for "Electrical Engineering," a ratio of 44½ per cent. In 1914-15, the ratio was 48½ per cent. These figures clearly show that the fundamental subject—"Electrical Installation Work," to give it its new name—is grossly neglected. In a word, our technical institutes give twice as much attention to the training of officers as to the training of men for the electrical army; even though the cost of equipment in the latter case is far less. We might also infer that when there is any cutting-down to be done, it is the fundamental subject which suffers.

(*b*) The percentages of those "in attendance" at the classes who got as far as sitting for examination were as follows :

	1916.	1915.
Electric wiremen's work ...	15 per cent.	23 per cent.
Electrical engineering	28 ,, ...	31½ ,,

Thus, on the average, we have 70 per cent. of the electrical engineering students failing to come up to the examination scratch; and no less than 80 per cent. of the "wiring" students failing likewise. The construction we put on the 70 per cent. is that in spite of the attraction of well-equipped laboratories the subject is too far over the heads of the majority. In the case of the 80 per cent., we should say the result was due to inadequate equipment and tuition simply.

(*c*) The percentages of those who passed to those who sat at the two sets of examinations are as follows :

	1916.	1915.
Electric wiremen's work ...	51 per cent.	50 per cent.
Electrical engineering ...	37 ,, ...	46½ ,,

These figures show that in spite of the miserable equipment and poorly-paid teaching vouchsafed to the so-called "*Wiring Classes*," the examinational results therein are decidedly better than those of the other classes. It is then surely worth while giving more attention to these classes. May we not infer also from the above figures that many students who are at present pitchforked direct into the electrical engineering course, would do better if they had a preliminary grounding in "*Electrical Installation Work*"?

Very few people, we suppose, are aware that students in a Grade II or Final Class, who find the examination paper beyond them, can take the Grade I. paper and obtain the same certificate that they got when in the lower class.

This sort of thing reflects strongly on the quality of the tuition, and depreciates the value of the tabulated results in the official report.

We do not know enough of the situation to comment on your statement that "*the technical colleges and their staffs are being utilised for the purpose of making second class air mechanics out of third class gardeners.*" But we do know that the excellent work being done by Mr. G. Bowron in the electrical workshops at Queen Mary's Convalescent Auxiliary Hospital at Roehampton, London, has attracted much favourable attention and has been regarded as a novelty; yet it is exactly the sort of work that should have been the regular thing in "Wiring Classes" for years past. The above two matters seem a clear case of "doing those things which ought not to have been done and leaving undone . . . . . &c."

London, Dec. 27. A. P. LUNDBERG & SONS.

[We regret that pressure on our space compels us to hold over some correspondence.—EDS. *E.*]

ELECTRIC SUPPLY COMPANIES AND EXCESS PROFITS TAX.

On Friday, Dec. 15, the appeal of the electricity supply companies of Great Britain was heard by the Board of Referees. The provincial companies and certain of the London companies (127 undertakings in all) were represented by Mr. H. B. Renwick (managing director of the County of London Electric Supply Co.), and certain other of the London companies (10 in number) by Mr. W. F. Fladgate (chairman of the Charing Cross, West End & City Electricity Supply Co.). The appeal thus represented no less than 137 companies' undertakings, involving a capital expenditure of about £25,000,000. The application of the companies was for an increase of the statutory percentage.

The Referees decided that in the case of the London-suburban and provincial companies the statutory percentage should be increased from 6 per cent. to 7½ per cent., and in the case of the London companies (other than the above) the percentage should be raised from 6 to 7 per cent. The following companies are classed as London-suburban companies: The County of London Electric Supply Co., the South London Electric Supply Corpn., the South Metropolitan Electric Light & Power and the Metropolitan & Electric Supply Companies.

The chief considerations which weighed with the referees in arriving at their decision were the following :—

The electricity companies are working under a concession—viz., a terminable lease. Not only is the lease terminable, however, but the terms of the compulsory purchase provided therein are extremely uncertain and provide nothing for goodwill. The companies are also working in competition and subject to statutory limitations, obligations and restrictions, which due to these and other causes prevented in the past the forming of adequate reserves for depreciation. Further, the supply of electricity is an industry newly developed, and the present companies were the pioneers. Also the industry necessitated a capital expenditure not only heavier in the first place than in the ordinary commercial business; but there is also involved a capital expenditure continuously throughout the whole of its lease in advance of the profitable demand. The pioneer work in developing the industry also involved the successive scrapping of plant which rapidly becomes obsolete owing to new inventions, thus hitherto preventing the providing of adequate reserves. The proper working profits were, therefore, deferred. Moreover, the companies were all originally established as lighting companies, in conformity with the Electric Lighting Acts, in which no mention of power for driving machinery is mentioned, and were framed to deal with lighting only. The supply of electric power was a later development, depending on the invention and perfecting of the electric motor, which has, in fact, become thoroughly efficient only during the last decade or so. The companies, therefore, had to adapt their systems to cope with this now growing and big demand, and in many cases this meant the partial or complete reconstruction of their distributing systems, and the scrapping of a large proportion of their generating plant, and in any case much larger expenditure of capital in advance of demand. It was shown what a very large proportion of the output of many of the electric lighting companies is for power purposes, and although working under a terminable concession they are, in effect, practically power companies without enjoying the advantage of perpetual tenure, as in the case of companies working under a power Act.

Evidence on the above lines was given by Mr. H. B. Renwick, Mr. C. H. Merz and Sir Harmood Banner. The thanks of the industry are due to Mr. H. B. Renwick for initiating and organising the appeal, and in establishing, apart from the financial side, the principle that electric supply companies working under statutory obligations and subject to compulsory purchase are entitled to special consideration as compared with ordinary traders.

Utilisation of Water-power in the French Alps. One result of the war has been the extensive exploitation of the waterfalls in the Alps of Dauphiné and Savoy for power production used in munition work. The pressure available is often considerable. In addition to the generation of electric power for steel furnaces, &c., the direct water pressure is often employed hydraulically, and, according to a correspondent of the "Daily Telegraph," is capable of cutting bars of steel into lengths for "75" shells.

PATENTS EXPIRING IN 1917.

The following is a list of patents of interest to electrical engineers which, unless extended by the Privy Council, will expire during 1917. The list does not include any patents granted in 1903 which have since for any reason become void :

No.	Date (1903).	Name of patentee.	Subject of patent.
322	Jan. 6	T. A. Edison	Storage batteries.
702	Jan. 10	B.T.-H. Co. & F. Holden	Electric measuring instruments.
1,088	Jan. 15	C. Roderbourg	Manufacture of positive electrodes.
3,438	Feb. 13	S. G. Brown	Relay translations for submarine cables.
3,704	Feb. 17	O. S. Bragstad and J. L La Cour	Germany. A.C. machine applicable as converter, motor and generator.
3,876	Feb. 18	L de Forest	Methods and apparatus for wireless signalling.
4,077	Feb. 20	H. A. Mavor, W. F. Graftan and Mavor & Coulson	Armatures for a.c. motors.
4,246	Feb. 24	E. O. Carolan	Insulated conductors and manufacturing same.
4,7[illegible]	Feb. 28	W. G. Heys	Telephone receivers.
5 292	Mar. 6	E. O. Carolan	Elec. train control systems.
5,314	Mar. 6	R. Lundell	Field magnets for dynamos or motors.
5,448	Mar. 9	J. Szirmay and L. von Kollerich	Electrolytic zincing process.
5,492	Mar. 9	S. Evershed and Evershed & Vignoles (Ltd.)	Apparatus for measuring electric resistances.
5,561	Mar. 10	F. Porsche	Dynamo electric machines.
6,060	Mar. 16	A. Blondel	Electrodes for arc lamps.
6,061	Mar. 16	A Blondel	Electrodes for arc lamps.
6,113	Mar. 17	R. W. Paul	Moving coil galvanometers
6,510	Mar. 20	C. O. Bastian	Electrolytic electricity meter.
6,735	Mar. 23	M. W. O'Connell	Candle fittings of incandescent lamps.
6,742	Mar. 23	Siemens Bros. & Co.	Telegraphically recording typewritten characters.
6,950	Mar. 25	Société Electrometallurgique Française	Deoxidising and carbonising molten iron and steel.
7,027	Mar. 26	A. G. Bloxam	Production of iron and steel
7,293	Mar. 28	G. Winter & F. Eichberg	Regulating a c. machines.
7,462	Mar. 31	E. O. Carolan	Electric motor control systems.
7,713	Apr. 2	W. E. Evans	Elec. switching arrangements.
7,966	Apr. 6	A Graham	Telephonic apparatus.
8,279	Apr. 9	T. von Zweigberg	Switches.
9,498	May 25	A. Artom	Apparatus for transmission of electrical energy.
9,531	Apr. 28	B. J. and A. Round	Electro depositing.
9,604	Apr. 28	J. H. S. H. Mawdsley	Dynamo elec. machinery.
9,806 9,807 9,808	Ap. 30	F. O. Carolan	Emergency brakes.
9,932	May 1	F. W. Howarth	Treating materials by radiated or reflected heat in electric furnaces.
11,378	May 19	Evershed & Vignoles and S Evershed	Dynamos for testing.
11,921	May 23	S. Z. de Ferranti	Electric welding.
11,997	May 26	F. C. Guy	Joints for tubular metallic poles.
12,083	May 27	E A. Ashcroft	Agitating contents of electrolytic cells or transfer of portions of contents of one cell to another.
12,[illegible]09	May 30	H. H. Lake	Brushes for dynamo electric machines.
12,462	June 2	J. Gell	Perforating tape for telegraphy.
12,526	June 2	W. Dieselhorst and A. W. Martin	Cables.
13,746	June 19	S. M. Young	Operating signals on electric railways
14,[illegible]01	June 25	G. M. T. Piltz	C.B. telephone systems.
14,5[illegible]2	June 30	D. L Lindquist	Controlling devices for electric motors.
14,551	June 30	A. Sundh	Electric controllers.
14,558	June 30	D. L. Lindquist	Electromagnets.
15,186	July 9	S. Z. de Ferranti	Automatic electric welding machine.
15,500	July 13	A. G. Brown, Boveri & Co	A C. contact apparatus.
15,599	July 14	V. Poulsen	Production of alternating currents.
17,587	Aug. 13	G. W. Johnson	Electrodes for electrolytic purposes.
17,640	Aug. 14	E. A. Ashcroft	Production of alkali metals
19,092	Sept. 4	W. R. Sykes, jun.	Electric locking apparatus for signals.
19,454	Sept. 9	E. Weintraub	Operating vapour lamps from an a.c. source.
19,520	Sept. 10	C. F. Scott	Alternating-current apparatus.
20,101	Sept. 18	J. Maclean	Armatures for dynamos and motors.
20,528	Sept. 24	A. Eckstein and A. J. D. Krause	Switches.
20,606	Sept. 25	J. H. Holmes	Multipolar dynamo-electric machines.
20,633 20,634	Sp. 25	E. J. Chambers	Attaching insulators to brackets.
20,655	Sept. 25	W. E. Evans	Electrolytic production of metals of the earthy alkalies, esp. metallic calcium.
21,005	Sept. 30	B T.-H. Co. & S. S. Meyer	A.C. motors.
21,027	Sept. 30	W. Hamilton	Electricity meters.
21,305	Oct. 3	Siemens Bros. & Co.	Maintaining uniform speed in electric motors.
21,596	Oct. 7	M. Short	Rheostat.
21,972	Oct. 10	J. H. St. H. Mawdsley	Dynamo-elec. machinery.
22,190	Oct. 14	L. G. Hunt and Sandycroft Foundry Co.	A.C. induction motors.
22,216	Oct. 15	A. E. Tanner and E. A. Claremont	Laying conductors.
22,432	Oct. 17	C. M. Darman and R. A. Smith	Ceiling fittings.
22,440	Oct. 17	W. C. Fairweather (Kellogg Switchboard, &c., Co.)	Telephone systems and apparatus.
22,465	Oct. 17	B T.-H. Co., R. C. Clinker, E. B. Wedmore and J. Whitcher.	Safety devices for a c. distribution systems.
23,478 23,488	Oct. 29 Oct. 29	A. Artom	Electric transmission of energy through space.
23,540	Oct. 30	A H. Adams & A.H. Curtis	Resistance boxes.
24,305	Nov. 9	O. J. Lodge	Elec. deposition of smoke, fume, fog and the like
25,381	Nov. 20	Marconi's Wireless Telegh Co. and A. Gray	Circuit-breakers & closers for wireless telegraphy.
25,383	Nov. 20	J. A. Fleming and Marconi's Wireless Telegh Co.	Transmitting instruments for wireless telegraphy.
25,527	Nov. 23	B.T.-H. Co.	Train control systems.
26 273	Dec. 1	G. A. E. Kohler	Controlling device for electric motors.
26,465	Dec. 3	B.T.-H. Co.	Electric motor control.
26,595	Dec. 4	K. Schaffler and E. Jilcke	Elec. igniting apparatus.
26,775	Dec. 7	C. D. Abel (Siemens & Halske)	Manufacture of homogeneous masses, tantalum and like difficultly fusible metals.
27,196	Dec. 11	C. E. Hunter	Switches.
27,276	Dec. 12	Warwick Machinery Co.	Relief mechanism for electric fluid turbines.
27,712	Dec. 17	C. D. Abel (Siemens & Halske)	Glow lamps with metallic filaments.
28,003	Dec. 21	W. Fairweather (Kellogg Switchboard, &c., Co.)	Telephone transmitters.
28,290	Dec. 23	R. A. Fessenden	Wave telegraphy.
28,291	Dec. 23	R. A. Fessenden	Receivers for electro-magnetic waves.
28,601	Dec. 29	G. B. Bowell and Pearson Fire Alarm	Automatic fire alarm systems.

PARLIAMENTARY RECORD FOR 1916.

Notwithstanding the length of the 1916 session of Parliament, there was not much legislation except for the purposes of the war. Of the public Acts only one related to the electrical industry—viz., the Telegraph Construction Act, which amends the Telegraph Acts, 1863 to 1915, and confers additional powers upon the Postmaster-General as to wayleaves and for the construction and maintenance of telegraph lines, &c. The Registration of Business Names Act is of considerable importance to all business firms, as it introduces stringent regulations for the registration of firms and of partners of firms. The Gas (Standard of Calorific Power) Act is only of indirect interest to electrical engineers, and the remainder of the public measures relate to the war, and are not intended to be permanent. Private legislation reached its lowest point so far as the electric supply industry is concerned, for there was only one private Act—

viz., that confirming the Church Stretton Electric Lighting Provisional Order. We give below a list of the Acts which are likely to affect or interest our readers.

Public Acts.

Expiring Laws Continuance.
Gas (Standard of Calorific Power).
Imperial Institute (Management).
Ministry of Pensions.
National Insurance (Part II.) (Munition Workers).
New Ministries and Secretaries.
Prevention of Corruption.
Public Authorities and Bodies (Loans).
Registration of Business Names.
Summer Time.
Telegraph Construction.
Trading with the Enemy (Copyright) (No. 2).
Trading with the Enemy and Export of Prohibited Goods.

Provisional Order Confirmation Act.

Electric Lighting Provisional Order (Church Stretton).

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a list of the applications for provisional orders deposited with the Board of Trade on or before December 21, 1916, under the provisions of the Electric Lighting Acts, 1882 to 1909: –

Title of order and description of area.	Promoters.
Clayton and Queensbury (urban districts of Clayton and Queensbury)	Electrical Distribution of Yorkshire (Ltd.).
Epsom Rural District (Extension) (parishes of Cuddington and Ewell)	South Metropolitan Electric Tramways & Lighting Co.
Featherstone (urban district)	Electrical Distribution of Yorkshire (Ltd.).
Garforth (urban district)..................	Electrical Distribution of Yorkshire (Ltd.).
Horbury (urban district)..................	Electrical Distribution of Yorkshire (Ltd.).
Luddenden Foot (urban district)	Electrical Distribution of Yorkshire (Ltd.).
Otley (urban district)	Electrical Distribution of Yorkshire (Ltd.).
Penistone (urban district)	Electrical Distribution of Yorkshire (Ltd.).
Rawdon and Yeadon (urban districts of Rawdon and Yeadon)	Electrical Distribution of Yorkshire (Ltd.).
Wimbledon (Extension) (parish of Cuddington	Wimbledon Corporation.
Wortley (parishes or townships of Bradfield, Ecclesfield and Tankersley in the rural district of Wortley)	Electrical Distribution of Yorkshire (Ltd.).

NEW ELECTRICAL COMPANIES OF 1916.

We give below a list of the more important electrical engineering companies registered during the past year with their capital:

Ac[illegible] (Magneto) ...	£5,000
Allen (Mar[illegible]) & Sons ...	10,000
Anchor Electric Co. ...	1,100
Atkey (London), Ltd. ...	25,000
Automatic Loading Co....	20,000
Baxendale Bros. ...	5,000
Birmingham Elec. Accessories Mfg. Co. ...	1,000
Bladon (T. [illegible]) & Son ...	5,000
British Elec. Trading Co. ...	2,000
British Electro Chem. [illegible] ...	10,000
British Electrolytic Zinc Co. (Underwood Process)	62,[illegible]
British Graphite & Tr[illegible]ing Co. ...	12,000
British Italian Corpn. ...	1,000,000
British M[illegible] Electric Vehicles ...	5,000
Brown's Motor [illegible]	[illegible]
Burr[illegible] (W. [illegible])	[illegible]
Butler [illegible] (Nickel plated)	[illegible]
Canadian Car & Foundry Co. (England)	[illegible]
Carter [illegible]	[illegible]
Caton Electric Supply	2,000
Coleman & Appleby	[illegible]
Cramer & Magneto [illegible]ation	[illegible]
Electric Stores (Nott hm)	£5,000
Elliott Bros. (London) ...	[illegible]
Entente Engineering Co. ...	5,000
Faraday & Son	5,000
Fellows Magneto Co.	75,000
Filbar Electric Heater ...	20,000
Fuller's Carbon & Elec. Co.	25,000
Galloway Engineering Co.	10,000
General Engineering & Export Co.	5,000
General Instrument & Engineering Co.	5,000
Grinyer & Co.	5,000
Harlesden Lamp Co. ...	10,000
Hanson, A & B ...	5,000
Harrison (T. S.) & Son ...	10,000
Hemel Hempstead Eng. Co.	[illegible]
Henri [illegible] & Co. ...	10,000
Higgins & Griffiths, Ltd.	10,000
Hall Bros. Magneto ...	[illegible]
Holt (Wm.) & Son and Norman & P[illegible] .	10,000
Hubbard Bros. ...	5,000
Insulated Cap & Rivet Co.	5,000
International M.P. Superheater Co. ...	100,000
James Smith Heating Machinery Co. ...	10,000
Kilmallock Elec. Light & Power Co. ...	2,700
Leabank Mfg. Co.	£9,500
Lester (J. E.) & Tolwell .	3,000
Levick (John), Ltd.	50,000
Lidgett Engineering Co. .	5,000
Light Railways	50,000
Ling (Oliver) & Co.........	20,000
Lock (Thos. J.), Ltd.	5,000
London Lorries	5,000
Lowcoyle Engine Co. ...	15,000
Mander & Co.	2,000
Midland Dynamo & Motor Repairs	2,000
Milton Mfg. Co.	60,000
Mitcham Rubber Co. ...	50,000
Mould (A. H.) & Sons......	10,000
Mountford (John) & Co. .	5,000
N.E.C.I.A. (Ltd.)	4,000
New London Electron Works	15,000
New Peto & Radford Accumulator Co............	30,000
New Shipston Lighting Co.	5,000
New Union Electric Co....	2,950
Owen King & Co.	1,000
Parsons & Hedges	3,000
Pearson (J. W.), Ltd. ...	3,000
Phillips' Magneto	1,250
Phonopore Constrctn Co.	4,175
Powell (E.), Ltd.)	4,000
Precision Screw Co.	3,000
Quead Limited	7,000
Regulus Metal & Plumbing Co.	10,000
Reliance Lubricating Oil.	£6,000
Renter's Limited	200,000
Robb (Walter), Ltd.	10,000
Robin Hood Engineering Works	10,000
Rogers (Wilfrid) & Co. ...	20,000
Sanders & Forster	5,000
Scott Electrical Co.	100,000
Selective Signal Co.	5,000
Selson Engineering Co. ...	3,000
S. Coast Kearney High-speed Railway	21,000
S. Wales & W. of England Wireless Training Col.	5,000
Stevens Petrol-Electric Vehicles	3,000
Storey Machine Tool Co.	10,000
Swindon Eng. Works ...	10,000
Taylor (James) & Bates...	10,000
Telephone Motor Works .	1,000
Thornton (W. R.) & Son .	5,000
Townmead Eng. Works .	50,000
Troup, Curtis & Co.	7,000
Tyne Electric Steel Foundries	39,750
Universal Elec. Supply Co.	3,000
Vandervell (C. A.) & Co..........................	350,000
Volta Magneto Co.	5,000
Weekes (L.), Ltd.	10,000
Wolf Safety Lamp Co. (Wm. Maurice)	6,000
Woods-Gilbert (Brit.) Rail Grinding & Milling Co.	10,000

PUBLIC COMPANIES WOUND UP OR DISSOLVED IN 1916.

The following are the principal electrical and engineering limited liability companies which have been wound up during the past year. A dagger (†) denotes that the company has been stuck off the register of joint stock companies, and a star (*) indicates that the company was wound up by an order of the Court:

Ardwick Electric Regulator Co.
†Aladdin Lamp Synd.
†Anglo-German Wireless Synd.
†Australasian Vacuum Cleaner Synd.
†Autobloc Synd.
†Auto-Electric.
†Auto-Flash Sign Co.
Bachelet Levitated Railway Synd.
†Blanchard Lamp Foreign Patents
†Bridlington Elec. Engineering Co.
†British Metallurgical Co.
†British Motobloc Synd.
†British Tungsten Lamp Co.
†Budleigh Salterton Electric Light & Power Co.
†Bullough's Adjustable Rail-Joint Support Co.
†Cable Construction Synd.
*Cedes Electric Traction.
†Cie. Générale Electrique de la Champagne.
Collings-Bishop.
*Colston Electrical Works.
†Commercial & Eng. Development.
Derby Electrical Co.
†Doncaster Electrical Co.
Eades Hoist Co.
Easton Lift Co.
Electrical Oil Refining Co.
†Electrical Advertising Co
†Electric Mirror Publicity Co.
Electric Ozone Synd
†Electric Safety Boiler Cleaner.
Electro-Flex Steel Co.
†Ellwood Motor Co.
†Ernest Scott & Mountain.
Excelsior Aluminium Solder Co.
†Flash Controller Co.
†Glamorgan Tram & Contractional Works. [Synd
†Grindell Matthews Radiophone
†Helix Cell & Accumulator Co.
High Tension Insulator.
†Houchen Electroplating Co
Ilkeston Motor & Elec. [illegible] Co.
†Improved Railway Signals.
†Improved Vacuum Cleaner Co.
Institute of Industry (of Great Britain & Ireland).
†International Filaments.
†International Inventions & Finance Co.
†International Power & Lt. Trust.
†Kevan Electric Co.
Letters Patent Insurance Co.
Light Electric Motor Co.
†Liverpool Traction, Light & Power Investment Trust
†Llanidloes Electric Lighting Co.
†Marples, Leach & Co.
†Maximum Magneto Co.
†Mica Mfg. Co.
Naylor Battery Co.
†New Century Arc Light Co.
†New Ignition Synd.
†Oil & Gas Turbine Synd.
Omega Electric Lamp Co.
†Paris Accumulator Co.
†Power Synd. of S. America.
†Power Transmission Synd.
Resisto Electrical Mfg. Co.
Riddle Automatic Signal Co.
†Rochdale Electroplating Co.
†Russian Wireless Telegraph Co.
†Scientific Researches Co.
South Wales Wireless Training College (for reconstruction)
†Teleca Co.
†Telerews.
†Transvaal Mica Co.
Turbinia Engineering Co.
†Turbaro Engine & Pump Co.
†United Elec. Lt. & Power Supply.
†United Salt & Power Co.
†Vacuum Elec. & Gas Heating Appliances.
†Walker Reversible Turbine Co.
†Warner Engineering Co
†Wireless Electric Light Co.
†Wireless Telephones.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Excess Profits Duty Decision. On the application of the Society of Motor Manufacturers & Traders (Ltd.), the Board of Referees has increased the statutory percentage as regards the business of manufacturing motor road vehicles to 7½ per cent. in the case of a company or other body corporate and 8 per cent. in the case of any other business. The decision of the Board on the application of the Electric Supply Companies is given in another column.

* * * *

Controlled Works. The Minister of Munitions has made a further Order, under which 39 additional establishments have been declared controlled establishments. The total number of controlled establishments is now 4,623.

* * * *

Copper for Casting. The Ministry of Munitions has announced that no copper will be supplied for the purpose of casting brass or other copper alloy, and no brass or other copper alloy may be cast except for the purposes of Class "A" or Class "B" orders, under the Ministry of Munitions Circular L 33.

* * * *

Control of Metals. It is announced that the Minister of Munitions has taken possession, as from Jan. 1, until further notice, of all unwrought copper, including copper scrap and swarf, in any form whatsoever, subject to the following exceptions:—

(*a*) Rough copper, copper ore and copper scrap and swarf, in possession of or due under an existing contract in writing for future delivery to a smelter or refiner for conversion into refined metal. (*b*) All copper, including copper scrap and swarf, in the possession of or due under an existing contract in writing for future delivery to a manufacturer, for use in such manufacturer's own works. (*c*) Copper scrap and swarf specially excepted under the written authority of the Minister of Munitions.

All existing licences for dealing in any scrap or swarf to which the notice applies are cancelled. Every smelter or refiner is required to make a return to the Director of Materials at the end of each month, including December, 1916, of the total quantities of refined copper in stock, and every maker and holder of copper scrap or swarf is required to make a similar return.

Applications with regard to the Order should be addressed to the Director of Materials, A.M. 2 B., Armament-buildings, Whitehall-place, S.W., and marked "Copper Permit."

A schedule to the Order gives prices and terms of payment, &c., for copper taken over.

An Order has also been made as to the supply of steel, &c.

* * * *

Trade After the War. The third report of the Special Committee of the London Chamber of Commerce on trade during and after the war has been issued.

In the report the members affirm their conviction that the practical application of measures for the extension of trade and industry after the war will be mainly a matter for private enterprise. Their inquiries indicate that neither merchants nor manufacturers are indifferent to the need for preparation on business lines. The committee strongly hold that Government intervention is only desirable within defined limits. With this object in view a closer connection between the business community through their appointed representatives and the various Government departments (co-ordinated as far as possible through a Ministry of Commerce) affords the most likely prospect that co-operation between trade interests and the Government will be really effective. Among the State-aided efforts recommended are:—

A Ministry of Commerce and Industry for the promotion of business interests; the improvement of the commercial side of the Consular service; restriction of the operations of enemy traders within the Empire; State-aid in improving the means of transport on land and water and penalising enemy shipping; and the co-operation of the State in promotion of trade banks to furnish financial accommodation to traders doing business abroad. The committee say they have had impressed upon them the necessity in many trades for the larger employment of competent commercial representatives in order to bring goods directly to the notice of the retailer or consumer, and to supplement this by the appointment of travelling representatives to visit agents where principals themselves are not available. The need for the study of languages and of acquiring technical knowledge is also emphasised.

In the matter of industrial organisation, the committee state that the principal question is the future relationship between employers and employed, and they submit the following recommendations as a basis for negotiation between capital and labour:—

(*a*) As to remuneration of employees, the principle of payment by results should as far as possible be adopted by employers and employed.

(*b*) The basis of rates of payment for labour should involve such a scale as will ensure for all willing and efficient workers a fair and reasonable standard of living.

(*c*) The Government should afford opportunities for considering the amendment of the Trade Disputes Acts and of any provisions of the Factory and Workshop Acts other than those relating to health of workers.

(*d*) Encouragement should be given as far as possible to profit-sharing and co-partnership agreements, or premium and bonus systems on lines which have been proved beneficial to employers and employed in the past, subject to the special conditions of particular trades, and to the maintenance of the standard rates of wages.

Among the subsidiary questions which must be taken into account are;

(*a*) The utilisation, for the purposes of private enterprise after the war, of factories now engaged in the production of munitions in connection with industries for which they may be suitable.

(*b*) The encouragement of the technical education of younger employees by giving them greater facilities for attending the necessary classes beyond the statutory school age.

(*c*) The amendment of the Patents, Designs and Trade Marks Acts so far as they may be restrictive of the adoption of new processes, labour saving appliances and new inventions.

(*d*) The improvement and cheapening of means of transport by rail, road and waterways, including canals.

(*e*) Increased facilities for obtaining information through Government departments regarding competition in the markets of the world, and new openings for the sale of British goods.

(*f*) Such further direct representation of manufacturers individually and collectively in the Dominions, allied and neutral countries as may be in harmony with the legitimate interests of the merchant.

(*g*) A more sympathetic attitude on the part of the Government in regard to the promotion and amendment of legislative measures affecting British industry.

(*h*) A preference on the part of Government departments and local authorities for goods produced within the British Empire.

* * * *

Municipal Industrial Development Committees. Some of our municipal authorities have commenced to discuss the industrial future and we are glad to notice that Sheffield Corporation, which we look upon as one of the leading municipal Councils in the country, have formed a strong and representative committee, in order to consider and report upon the steps to be taken to form and control such a department of the Council.

As Col. Hughes stated, "The biggest city of Yorkshire, with all the world for its market, had woke up to find what the position really is and what are its drawbacks." During the last two years, he said, they had been developing to an extent that they could not have expected to attain in 10 or 15 years; they must look round them and take very broad views of the situation. One of the principal ways in which the Corporation can help is to provide a cheap supply of electric current for power purposes, and in view of the fact that it is proposed to obtain powers to put down another large generating station it would appear that the Corporation realise their responsibilities in this direction. The Corporation can also do much by economical administration and by keeping down rates, by assisting to improve and cheapen transport facilities, &c. These and other questions which affect industrial development will, no doubt, be fully considered by the new department.

* * * *

America and World Trade. In a recent message President W. Wilson made reference to the measure which was passed last session giving greater freedom of combination to those engaged in promoting foreign commerce than is now allowed by the law against monopoly. Referring to the fact that America's foreign trade had reached unprecedented proportions, he said: "Congress should clear away all legal obstacles and create a basis of undoubted law which will give freedom without permitting unregulated licence. It must be done now, because the opportunity may pass if we hesitate or delay in taking it."

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Electric Cooking in the U.S.A. During the year ended October 31st last the Edison Electric Illuminating Co. (of Boston, Mass.) sold 1,019 electric ranges, and a combined "experience" and "booster" meeting was held on November 1st in order to celebrate the event.

It was estimated at the beginning of the year that the 1,000 ranges which it was expected would be connected would represent a total load of 1,000 kw., but the 1,019 ranges actually represented a load of 5,225 kw. Although the use of electric ranges is extending rapidly in the western cities, it is claimed that the past year's connections in Boston create a record for any city in a single year. The average cost of operating an electric range is put at 80 cents to $1 per person per month in Boston.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 23, 1916, *to* Dec. 30, 1916.

IMPORTS.

LONDON.—*U.S.A.:* Wire and cable, £474; elec. machinery, £85; unenumerated, £2,493. *Japan:* Unenumerated, £297. *France:* Elec. carbons, £613; unenumerated £223. *Switzerland:* Unenumerated, £299. *Denmark:* Unenumerated, £511. *Canada:* Telephone material, £24; unenumerated, £211. *Sweden:* Unenumerated, £85.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £102; elec. lamps, 1,500 n.o.; elec. machinery, £45. *Melbourne:* Elec. machinery, £579; wire and cable, £626; elec. lamps, £225; unenumerated, £803. *Sydney:* Elec. machinery, £262; unenumerated, £301. *Wellington:* Elec. machinery, £28; wire and cable, £729; unenumerated, £80. *Lyttelton:* Unenumerated, £84. *Adelaide:* Telephone material, £157; wire and cable, £196; elec. lamps, 800 n.o. *Brisbane:* Elec. lamps, 1,700 n.o. *Perth:* Unenumerated, £26. *Hobart:* Unenumerated, £26. *Dunedin:* Unenumerated, £138. *New Plymouth:* Unenumerated, £151.

AFRICA.—*Durban:* Unenumerated, £701. *Cape Town:* Elec. machinery, £30; elec. lamps, 300 n.o.; unenumerated, £38. *Port Elizabeth:* unenumerated, £191. *Ascension:* Telephone material, £102. *Mauritius:* Unenumerated, £65. *Mombasa:* Unenumerated, £11. *St. Helena:* Telephone material, £497.

EGYPT.—*Alexandria:* Unenumerated, £58. *Port Sudan:* Elec. machinery, £12; unenumerated, £39.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £40; unenumerated, £113. *Calcutta:* Unenumerated, £195. *Madras:* Unenumerated, £59; elec. machinery, £14. *Ceylon:* Unenumerated, £12. *Singapore:* Unenumerated, £252. *Sourabaya:* Elec. cable, £152. *Penang:* Unenumerated, £10. *Rangoon:* Elec. machinery, £47. *Bankok:* Elec. lamps, 1,750 n.o.

CHINA.—*Hongkong:* Unenumerated, £115.

SOUTH AND CENTRAL AMERICA.—*Monte Video:* Elec. machinery, £150. *Valparaiso:* Unenumerated, £179.

HOLLAND.—*Amsterdam:* Wire and cable, £847.

FRANCE.—*Paris:* Wire and cable, £51; unenumerated, £2,502. *Dieppe:* Unenumerated, £471. *Bordeaux:* Unenumerated, £93. *Marseilles:* Telephone material, £225.

CANADA.—*St. John's, N.B.:* Unenumerated, £97.

MALTA.—Telephone material, £310.

FOREIGN GOODS (duty paid and free).

New York: Unenumerated, £8. *Hongkong:* Unenumerated, £10. *Madras:* Unenumerated, £18. *Montreal:* Elec. cable, £568. *Perth:* Unenumerated, £77.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Tramways Assessment.

As briefly reported in our last issue, judgment was delivered by the Deputy Chairman of the London Quarter Sessions (Mr. Lawrie) in the appeal of the London County Council against the quinquennial assessment of their lines in Finsbury and Holborn.

Mr. W. Ryde, K.C., and Mr. Konstan appeared for the L.C.C.; and Mr. Clavell Salter, K.C., and Mr. Jeeves represented the Holborn Assessment Committee.

The hearing of the appeal occupied several sittings, and much technical evidence was given on both sides. At the outset an objection to the hearing of the appeal on the ground that the notice of objection to the assessment did not state the correction which the objector desired to be made was overruled, but the Deputy Chairman agreed to state a case.

Mr. RYDE explained that the rateable value fixed by the overseers was £16,923, which was reduced by the Assessment Committee on appeal to £13,818, and the London County Council now claimed that it should be further reduced to £6,960. This sum included £810, which had been agreed by the parties as the value of the Holborn electrical sub-station. The gross value had been fixed at £32,055, and the County Council claimed that it should be reduced to £25,197. The tramways were no doubt a going concern, but they had been seriously affected by the competition of motor omnibuses and tube railways, and as a consequence in one year there was a fall of something like a quarter of a million in the net proceeds. In the year following there was a minus figure of £88,000, so it was quite obvious that at that stage the motor 'buses had made themselves felt as a most powerful rival to the tramway undertaking. The year following, however, there was a slight recovery or a less adverse balance. The respondents' case simply stated that in view of the earning capacity of the tramways the tenant of such hereditaments might be reasonably expected to give a rental which would justify the gross value appealed against. It had been decided in the High Court that in arriving at the value the separate earnings of each route should be divided between the parishes in proportion to lineal mileage of each route in each parish.

Mr. FRANK HURST, chief of the Estates and Valuation Department of the L.C.C., said it was not true that the city termini ends of a tramway were more remunerative than the others. On a tramway route there were two thin ends, and what was called "a fat middle," and the two ends were always less valuable, if they had to discriminate from a traffic-earning point of view, than the average of the route as a whole. In the day time they got their "fat middle" in the shopping centres. The value of the generating station had been agreed at £207,000, which was equal to 8·91 of the gross receipts. The aggregate capital expenditure to March 31, 1915, was as follows: Permanent way tracks, £1,681,718; overhead equipment, £12,179; cables, £510,568; ducts, £351,838; total, £5,616,303. He submitted figures in support of the assessment. In the parishes in question the total car mileage was 3,444,331, and the passenger receipts were £131,712. He deducted £93,284 for expenses assignable in proportion to car mileage (at 6½d. per car mile) and £32,928 assignable in proportion to passenger receipts at 25 per cent. There remained a rateable value plus rates of £5,500, from which he deducted £1,528 for rates, leaving a rateable value of £3,972. To that sum he added £810 for the Holborn sub-station, not in dispute, making a total rateable value of £4,782, against £13,818 fixed by the Assessment Committee. His gross value was £23,019, against £32,055 appealed from.

Mr. JOHN WELLING, permanent way engineer of the tramways, said his summarisation of the annual cost of repairs for the ensuing quinquennial period on 279·42 miles of tramways was as follows: Permanent way, at £385 per mile, £107,577; electrical equipment, at £42 per mile, £11,736; cables and ducts, at £13 per mile, £3,632; total, £122,945. He added £11,833 for increase in mileage of repairable lines, and £26,955 for increased cost of labour and materials, making £161,733. Dealing with renewals, he said that a 25 years' life in place of a 60 years' life would increase the annual provision for renewals of concrete yokes, &c., from £7,666 to £34,285, or by £26,619. He estimated the total annual provision required for renewals at £186,357, or if the £26,619 were added, the amount would be £212,976. Increased acceleration of the running of the cars and the rapid retardation now rendered possible by magnetic brakes not only caused a great increase in repairs and the shortening of the life of the rails, but must cause a greatly increased strain on the cars themselves. The amount that should be put aside annually by the Council, spread over the capital loan period, by way of repayment of the cost of reconstruction, was £224,652, apart from any provision for the renewals of short-lived works. The provision for renewals should exceed the original cost, since, in the first place, it was cheaper to construct works simultaneously than to renew any parts; secondly, it was more costly to do work under running conditions and subject to continual interruptions; and, thirdly, the cost of labour and materials had greatly increased. The stores of materials for repairs and renewals were valued on March 31, 1915, at about £100,000, and he estimated there should be an allowance of £5,000 a year in respect of the stores in stock. Junctions, cross-overs and all parts required had to be designed and ordered in ample time before they were wanted, and the cost was reduced by ordering in fairly large quantities. He estimated the average life of the whole of the Council's tramway system as 11½ years, while the lines in the parishes comprising the Holborn Union had only a life of 10·6 years, owing to the greater frequency of tram and general vehicular traffic above the average of the whole system. The estimates for repairs and renewals that he had given were averaged over the whole system.

Mr. WIGNER, electrical assistant of the County Council, and Mr. H. S. MAY, assistant superintendent of rolling stock, also gave evidence.

Mr. H. VORLEY, accountant for the tramways, also gave evidence, and he admitted (in cross-examination) that in the first six months of the current year the receipts showed an increase over the six months ended Michaelmas, 1915, of £134,937. The 1915 figures, however, included the strike period, during which the Council lost £100,000 in receipts.

Mr. JOSHUA K. BRUCE, deputy chief officer of L.C.C. tramways, said the receipts per car-mile were lower in the Holborn Union than over London generally. The costs outside would probably be lower. Slow speed increased the cost of operating cars, and in consequence of the speed being much lower in Holborn than on the remainder of the system 17 more cars were required. It was the almost universal experience that as a company or public authority improved a tram route the more money was taken. The longer the route the better value per car-mile.

Mr. DONALD DINWIDDY said that in his valuation of the lines in Holborn he took the total car-mileage for 1914-15 at 3,444,331, and the total receipts at £131,712. He added to the receipts a prospective increase of 5 per cent. (equal to £6,586), making a total of £138,298. He calculated working expenses—power, traffic, general war bonus, &c., repairs and renewals—at 7·453d. per car-mile, and deducted 0·049d. for advertisement receipts, leaving 7·404d. per car-mile, which gave a deduction of £106,258. He made other deductions usual in such a case, and arrived at a rateable value of lines of £4,562.

On behalf of the Assessment Committee, Mr. CLAVELL SALTER submitted that the receipts in the parishes in question must be assumed to be considerably in excess of the average of the system, which was 9·5d. per car-mile. He would call evidence to show that those routes were more lucrative at their London end than at their northern and north-eastern ends.

Mr. W. H. EVE said he arrived at a rateable value considerably in excess of that fixed by the Assessment Committee. He had added 1½d. per car-mile to the average receipts of each route, on the ground that the earnings of the lines in Holborn were greater than on the routes outside. There were many ½d. fares in the district.

Mr. E. M. LACEY, consulting engineer, also gave evidence, and in cross-examination he said he thought £70 or £80 would be a fair figure to allow for the repair of a car on the conduit system. The Manchester and Salford systems were the nearest parallel in this country to the London cars, and he submitted figures concerning them. He had fixed his renewal fund on the basis of steel rails being £7 per ton, which was much above the average of the previous seven or eight years, and much above the average the County Council had paid for their rails. He put the average life of the rails in Holborn at about 14 years. If one-fifth of the rails had been renewed in 11 years it supported his average. He had taken the life of the cables at 35 years, though he had not had a cable lasting that length of time in his experience, and probably few people had. He did not know the age of the oldest electrical cable now in existence, but some he laid in 1891 were still in existence. Tramway cable laid as that was in ducts was laid under the best possible conditions; they were in the habit of taking 25 and 30 years for ordinary electric light cables. If it was fair to do that it was certainly fair to take 35 years for a tramway cable laid under the conditions mentioned. He would give a cable laid in ducts a longer life than one laid solid.

After counsel had addressed the Court, the Deputy Chairman said he would take time to consider his decision, which he would give on Dec. 21.

In delivering judgment, he said that throughout the hearing of the case the fact had more and more impressed itself upon him that the case need never have come into Court. It was a most deplorable thing to see two public bodies spending large sums of money in fighting over matters which should have been easily capable of adjudication without litigation. The Court could but feel that if each party had approached the other with the earnest desire to settle, a solution would have been reached very similar to the result which they had arrived at, and much of the ratepayers' money would have been saved. But while a settlement would have been easy if that course had been adopted, a decision in the case was by no means so simple. When the parties found that the question was to be fought they both appeared to have shut their eyes to the points telling against them, and opened them very wide to every point that even appeared to tell in their favour, with the obvious result that differences necessarily increased, the valuations of the rival sides were hopelessly at variance, and both included many obviously untenable claims, either of additions or deductions. The Court had asked themselves what a reasonable man would have anticipated at the time in question, and in the main they had based their finding on the accounts of 1914-15, but there were many variations in those accounts available to anybody in 1915, both figures of increased receipts and expenditure already incurred. There were also tendencies which seemed clearly defined which they had had to consider, and they had had to decide which of those would affect a prospective tenant. The result they had arrived at was that the total rateable value in Finsbury should be £6,527, which was in the neighbourhood of two-thirds of the amount of rateable value (£9,770) appealed against. The judgment of the Court, therefore, was that the appeal be allowed, with costs, and the figures be inserted in the valuation lists. His Lordship merely desired to add that the decision might be of some assistance to the parties in the effort he was sure they would make, without any further litigation, in the outstanding cases in the Borough of Holborn. If Mr. Ryde and Mr. Salter could come to some arrangement it would be best, but if they could not he was prepared to work out the figures for the other parishes on the same lines,

Counsel on both sides acquiesced in the proposal.

Mr. CLAVELL SALTER said that at the outset he submitted that the appellants had no *locus standi*, on the ground that they had not taken the necessary steps as provided by the statute. He would like that matter to be left open, so that it might again be mentioned.

The DEPUTY CHAIRMAN: Certainly.

Mr. CLAVELL SALTER: May I take it that the Court would be prepared to consider whether each party should pay their own costs?

The DEPUTY CHAIRMAN: It is a very large reduction, and it was necessary for the appellants to come here before they did get that reduction.

The matter was then adjourned until a day in the new year, when the result of the conference between counsel will be made known.

BUSINESS NOTICES.

The partnership between D. H. Morton, Andrew Home-Morton, W. Arthur Ker and G. H. Leckie Gibson (carrying on business as Home-Morton, Ker & Gibson), consulting engineers, &c., 153, St. Vincent-st., Glasgow, and 2, Eldon-st., London, E.C., has been dissolved. Messrs. D. H. Morton, A. Home-Morton and G. H. L. Gibson will carry on business as Home-Morton & Gibson at the above-mentioned addresses, and Mr. W. A. Ker will carry on business as W. Arthur Ker & Co., at 115, St. Vincent-st., Glasgow. Debts by late firm will be met by Messrs. Home-Morton & Gibson.

The E.S. Company, Ltd., 233, Tottenham Court-rd., W., announces an increase of capital to £10,000.

Mr. Vernon H. Wells, electrical engineer, who has been with Messrs. Clarke, Chapman & Co. and the Westminster Engineering Co., has joined the board as from Jan. 1, and Mr. E. Cecil Beman, the founder of the company, remains managing director. The company invites inspection of their premises.

The Council of the British Manufacturers' Association has decided to link up with the Federation of British Indusrtries.

Messrs. David Colville & Sons (Ltd.), steel manufacturers, and Archibald Russell (Ltd.), coal masters, have amalgamated.

Signori Stauble & Salvini, dealers in electrical supplies, 76, Foro Bonaparte, Milan, are anxious to increase their foreign connection and would be glad to receive manufacturers' catalogues with trade prices and conditions.

Patent Development.—The proprietor of Letters Patent Nos. 38,106, 10,062, 123 and 72 of 1904, relating to "Improvements in electrical accumulators," desires to dispose of the Patents or to grant licences thereunder. Inquiries to the Svenska Ackumulator Aktiebolaget Jungner, Stockholm, Sweden.

The owner of patent No. 28,630 of 1913, relating to "Electrolytic converter for the transformation of a.c. into c.c., desires to make arrangements for developing same in this country. Particulars from Messrs. Allison Bros., 84/6, Chancery-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting to receive an account of the winding-up of the Baldur Engineering & Supply Co. (Ltd.) will be held at 27, Mincing-lane, London, E.C., on Jan. 22.

A receiving order has been made against Chas. B. Ogilvie, electrical engineer, 43, Dudley-rd, Whalley Range.

ELECTRICITY SUPPLY.

EXTENSIONS.

Arklow (Co. Wicklow).—The Town Commissioners are introducing electric lighting on the northern quays, and a petition has been presented to extend the lighting to the southern quays.

Derby.—On Wednesday the Corporation were informed by the Electricity Committee that extensions of the electric supply undertaking were necessary.

The committee stated that in consequence of the great increase in the demand for electrical energy for power they find it essential, if there is to be no shortage next winter, to put in additional generating plant. An expenditure of £34,000 would be necessary for a 2,000 kw. turbine, rotary converter, a boiler, economiser, &c., and the requisite enlargement of the building.

The Finance Committee recommended that if the expenditure is sanctioned the sum should be paid out of the sinking fund.

Glasgow.—The Secretary for Scotland has sanctioned the borrowing by the Corporation of a further sum of £500,000 for the completion of the new electricity generating station. The total sum authorised to be borrowed for the department is now £3,000,000.

Keighley.—The Electricity Committee recommends the expenditure of a sum not exceeding £300 for the electric lighting of the streets in which tramways are laid.

Kirkcaldy.—Sir John Snell has now presented his report on the proposal of the borough electrical engineer (Mr. O. F. Francis) to put down additional generating plant, &c.

Sir John thinks that it would not be sound policy to abandon the present works now and launch into the greater expenditure which a new station would entail. The only proper alternative to a bulk supply is the removal of the existing station, and he submits a programme of extensions spread over ten years, which he thinks would meet local requirements for at least that period. He states that Mr. Balfour, the managing director of the Fife Power Co., would be prepared to recommend his company to acquire the existing power station at the amount of the present capital indebtedness (approximately £38,000); that sum to be paid two years after the declaration of peace, his company to supply all current in bulk for the present and future requirements of the Corporation, the Corporation paying a certain sum per annum towards the expenditure and to retain control of the distribution of electricity within the burgh. Failing the adoption of that suggestion, he thinks the next best alternative would be to extend the present works, at an expenditure of £61,300, spread over ten years.

Willesden.—The Council has recently received sanction from the L.G. Board to raise £5,000 to cover the cost of laying a new direct-current feeder, in order to meet the growing demand for current by factories. This sum, together with recent sanctions for other extensions, exceeds £10,000 spent on developments for power supply.

Worcester.—The question of the supply of additional electrical energy to the works of Messrs. Heenan & Froude and McKenzie & Holland came before the Council again on Tuesday.

The Electricity Committee's recommendation at the Council meeting in December was withdrawn, as Messrs. Heenan & Froude had applied for an increased supply, necessitating an entirely fresh scheme. In addition to the five motors of 162 H.P., another 40 H.P. had been applied for, and there was a probability of further current being wanted. The laying of a ring main and the installation of additional plant at the electricity works were advised, involving an outlay of £2,890. Messrs. Heenan & Froude asked, however, that in consideration of their contribution of £1,800 they should have the current required for lighting at a reduced charge. The Council were therefore recommended to give an increased supply of current to Messrs. Heenan & Froude, and to apply to the L.G. Board for sanction to borrow £440 for payment of the balance payable by the Council of carrying out the work.

GENERAL.

Accrington.—As the acting manager of the electricity department (Mr. A. W. Clegg) was one of the four selected candidates for the post of electrical engineer to a Cheshire chemical firm, the Electricity Committee has made arrangements for retaining Mr. Clegg's services.

Aldershot.—In consequence of the action against the Council for an injunction against nuisance, property adjoining the electricity works is to be acquired for £1,500.

It was reported to the Council last week that the contract for small coal had expired, and that the present contractors would renew the contract for 1,200 tons at 23s. 6d. per ton. The Board of Trade had intimated that, having regard to the present position in regard to coal supplies, the Council would be well advised to renew, and, after discussion, the Council decided to do so.

Aylesbury.—The L.G. Board recently refused to sanction a loan of £6,000 for electric supply extensions, and the Town Council has had to refuse a demand for an additional supply of 40 H.P.

Birmingham.—At the meeting of the Corporation on Tuesday Mr. Cambridge moved that a special committee (with power to employ expert assistance) be appointed to inquire into and report on the failure of the electricity department to supply sufficient current for the needs of the city.

Mr. COMBRIDGE explained that his motion was in no sense an unfriendly attack on the Electric Supply Committee. He sympathised with its chairman and members in the worry and anxiety which they had had, but there had been so much inconvenience and loss to the citizens that the Council ought to take some action in the matter. The result of the stoppages of the tramcars was common knowledge; there had been inconvenience to the public, a loss to the retail traders, and there had also been a national loss, as he understood some of the factories had been deprived of current at various times. They not only owed it to themselves but to the public to show they were really in earnest, and that they wanted to do everything possible to prevent a recurrence of the inconvenience.

The motion was seconded, but Ald. Sir GEO. KENRICK urged that the proposal was open to the gravest objection. To appoint another Committee at this juncture would be subversive of the good feeling and discipline of the Committees of the Council.

The chairman of the Committee (Ald. JEPHCOTT) stated that the Committee were opposed to the motion, although they had no desire to shirk an inquiry. The Council had recently strengthened the Committee, which subsequently met and decided to ask two of the new members who had no past and who had not taken sides in regard to the work of the Committee—to undertake a full inquiry. They were to have a free hand and to have access to anything in relation to the Committee's work. The members (Mr. Beale and Mr. Appleby) had not undertaken a very pleasant duty, but he thought it would be foolish now to appoint another Committee to do the same work. He wanted to warn the Council that in the future they might again have tramcar stoppages. They had been enabled by strenuous work to get the trams running regularly, but that had created on the part of a higher authority trouble and annoyance, and it would be wise for the friends of the tramways to say as little as possible about the question of current because of the demands for further current for power purposes. If they wanted to secure the running of the trams they should not flaunt this matter before the Ministry, or things might be as bad again as they were in November.

Ultimately, Mr. Combridge agreed to withdraw the motion on the understanding that the report of Mr. Beale and Mr. Appleby should be presented in its original form, and if it did not cover the whole of the ground he should be at liberty again to move the resolution.

Edinburgh.—The Electric Lighting Committee has decided to restrict for the present the connection of new consumers except engineering works and factories.

Hebden Bridge.—The Council has decided to open negotiations with the Yorkshire Electric Power Co. and Halifax Corporation as to a supply of electricity in bulk, and Messrs. Willians & Robinson have been asked to quote terms for another Diesel oil engine.

Leeds.—For the appointment of chief engineering assistant at the Leeds electricity department, rendered vacant by the appointment of Mr. Robert Owen as borough electrical engineer of Wigan, 78 applications were received by the Electricity Committee, and the following were selected as a short list:—

Messrs. J. F. Dawson, B.Sc., A.M.I.E.E. (Manchester), R. W. Grubb, M.A., A.M.I.E.E. (Dewsbury), Ernest A. Mills, A.M.I.C.E. (Birmingham), Ernest Porter (Leeds), and W. Yorke, A.M.I.E.E. (Sunderland).

The Committee, after visiting Sunderland and Birmingham, recommended Mr. Ernest A. Mills to the Council for appointment. The salary attaching to the position is £350 per annum.

Manchester Electricians' Wages.—As from Jan. 1 the wages of the electricians employed by members of the Manchester, Salford and District Building Trades Employers' Association have been advanced 1d. per hour and county work expenses 6d. per night.

Sending Steel to Sheffield.—At the annual meeting of the National Steam Car Co. on Friday last, Mr. T. Clarkson stated that some time ago when the directors saw there were difficulties ahead in obtaining supplies of steel they erected an electric steel furnace and foundry.

He said that the enterprise was developing satisfactorily and was providing wheels and castings for lorries and transport vehicles, and was enabling us to send steel to Sheffield—rather like sending coals to Newcastle. It was thus helping to supply the great demand for tool steel.

Sheffield.—The most progressive branch of Municipal activity in 1916 was that of electricity supply.

Considerable expansions have been made or are in progress. In 1914 the output of the department was 36 million units, in 1916 it had risen to 120 millions, and a figure of 200 million units is in prospect. The employment of electricity for power and for melting steel is responsible for a great proportion of the increase. Hence the Council have found themselves faced with the necessity of extending their already overburdened resources for the generation of electricity, and Parliamentary powers are being sought for the erection of a great new generating station, the initial outlay on which will be £500,000, but the figure will ultimately approach £2,000,000.

Like all other electric supply undertakings, the greatly increased price of coal and other materials has necessitated an advance in the charges for current for power and lighting.

South Shields.—Ald. J. W. Henderson has been elected chairman, and Mr. T. R. Dowson vice-chairman of the Electricity Committee.

Wimbledon.—At a special meeting of the Council a formal resolution was passed authorising the Corporation to apply for a provisional order to supply electricity throughout the parish of Cuddington.

Ald. Stuart, chairman of the Electric Lighting Committee, stated that he hoped the extension would mean doubling the plant at the electricity works.

Yorkshire Provisional Orders.—The Urban Councils of Featherstone, Otley and Queensbury have assented to the applications of the Electrical Distribution of Yorkshire (Ltd.) for provisional electric lighting orders.

TRACTION NOTES.

Darlington.—The Corporation has applied to the Light Railway Commissioners for authority to increase the limit of the fares on the local tramways from 1d. to 1½d.

Edinburgh.—The Council is recommended by the Tramway Committee to accept the offer by the lessees of the Edinburgh Tramways to sell the rolling stock, cables and other plant to the Corporation as on the expiry of the lease in 1919.

The sum proposed was £50,000 for the cable cars (not less than 200), four electric cars and 14 single spare cable trucks.

A sub-committee of three has been formed to get into communication with the Admiralty and others concerned in order to ascertain whether there is present or prospective need for further transport facilities between Edinburgh and Queensferry and Rosyth, and, if so, what these facilities should be, and what assistance may be available to the Corporation in the event of their resolving to provide them.

Glasgow.—The Superintendent of Cleansing reports that the first of the two Edison electric vehicles for refuse collection was delivered on Dec. 4, and is giving entire satisfaction.

The general manager of the Corporation tramways (Mr. J. Dalrymple) has issued a memorandum to the staff making a number of suggestions for the avoidance of accidents. He states that for some months he has been much concerned at the number of accidents. Many of them are new to the service, and all are working under very trying conditions, but he is satisfied that in several respects they could carry out their work with greater efficiency and with more satisfaction both to themselves and to the department. Drivers and conductors are urged to take greater care, and submits to them the following instructions:—Do not, under any circumstances, run your car ahead of time; do not run your car past stopping-places when people are standing there; do not start your car until you are absolutely certain that no one is entering or leaving; do not ring the bell until everyone is on or everyone is off; do not quarrel with passengers; and do not lose your temper with passengers, even under provocation.

There were many circumstances conspiring against them at present. There was, of course, the inexperience of many of the staff, the overcrowding of cars, the darkening Order, drunks, the boy in charge of the horse and cart, the general carelessness in the street, both on the part of pedestrians and of those in charge of vehicles. They had got to face all these difficulties and do their best to overcome them. To the conductresses he would say, "Do not imagine that you know all your duties after being a week on the cars. Do not carry out your work as if you meant to leave the job to morrow." To the motresses he would simply say, "Gang warily. Take plenty of time. Do not put on a notch of power until you know that the road is clear." He would like every woman to put down her name for the motor school.

Hull.—A special meeting of the Council was held last week to consider recommendations of the Tramways Committee to suspend half-penny fares during the war, &c., but after discussion the report was referred back.

Ilkeston.—In the Bill introduced by the Nottinghamshire and Derbyshire Tramways Co. power is sought to take over the tramway undertaking of the Corporation.

The purchase price has already been agreed at £28,150, and this is to be paid by instalments on March 1 in each year, but the transfer is to take effect as from Sept. 30, 1916.

Leicester.—Owing to the additional expenditure required during the ensuing year the Tramways and Electricity Committee has fixed a 1½d. fare for the full journey on all tramway routes, with a 1d. stage on each route, the fare for children being increased to 1d.

Luton.—A tramcar which left the rails at a curve in Midland road on the 28th ult. caused injuries to the driver and five or six passengers.

Newcastle-on-Tyne.—Owing to complaints of inadequate and irregular tramcar services, the general manager (Mr. E. Hatton) has prepared a full report on the subject.

Since the war the number of cars running had been considerably increased, the number of passengers weekly had increased by over 300,000 and the receipts had increased £1,400 a week. A large number of men had been called up for service, and 696 new motormen, 201 youths and 528 women had had to be trained; but the department had not been able to keep the cars regularly overhauled or keep steady motormen of experience. The street lighting was inadequate for a regular service, and the ordinary service was interfered with by the excessive demands in providing for workmen's cars. Nothing was being left undone which it was possible to do, but even if hostilities ceased at once it would be some time before the ordinary condition of affairs could be restored. It would take a very long time to get the rolling stock and other plant back to the condition it was in before the war.

Reduced Train Services.—On the 1st inst. the new train regulations and increased fares came into force.

In many suburban districts the tramway traffic was heavier, especially in districts where railway stations had been closed. The number of tram passengers was also considerably augmented by those who decided to travel cheaply rather than pay the increased railway fares.

The Underground Electric Railways Co. of London has notified that the increase of 50 per cent. on existing railway fares does not apply on the District Railway within the limits of Acton Town in the west, Putney Bridge in the south, and Bow-road in the east; on the Bakerloo, Piccadilly and Hampstead lines of the London Electric Railway; on the Central and the City & South London Railways, and on the Inner Circle and stations on the Hammersmith and City line; and also on the Great Northern & City Railway.

Local and through fares between these groups and within these limits remain unaltered. In the case of bookings to and from stations outside the limits 50 per cent. will be added to the fare. Bookings to stations on certain main line railways will be suspended and in other cases the fares will be adjusted. Season tickets will not be affected.

Many complaints have been made as to the operation of the 50 per cent. increase of fares, and it is probable that this regulation will be modified in the case of bookings before 10 a.m.

EMPIRE NOTES.

Australasia.—The Government has granted licences to Martinborough Town Board, Kaitangata Borough Council and Wairnairi County Council to establish and maintain electricity undertakings.

Wollongong (N.S.W.) Council has rejected the proposal of Mr. S. Cornforth to establish electricity works. Mr. Corin, electrical engineer of the Public Works Department, is preparing a new scheme for electricity supply in the town on the basis of the current supply being derived from the Government's power-house at Port Kembla. Mittagong Municipality, to which the department made a proposal for a supply from this power-house, is to take a vote of the ratepayers on the question.

Licences have been granted to the Martinborough Town Board, the Kaitangata Borough Council and the Waimairi County Council (N. Z.), to install and maintain electric supply works.

Canada.—The architects of the new Canadian Parliament Buildings have been asked to report on the estimated cost of the electric heating of the whole of the new buildings.

Port Arthur City Council is to take a poll of the ratepayers on the question whether they desire the Hydro Electric Commission to develop some 30,000 H.P. for the city.

FOREIGN NOTES.

Brazil. A consular report states that goods in demand in the Pernambuco district include gas engines and other machinery, motor-cars, electric fittings, hardware and chemicals.

Chili.—Permission has been granted to Senores F. Undurraga and I. J. Diáz Valdes to utilise waters in the Department of La Victoria for the production of electric power. Don Eduardo Heyraud has been given permission to construct and work, for 10 years, an electric street railway between Santiago and Renca, a distance of about 5 miles.

Mexico.—The "Electrical World," states that recent advices from Mexico point to an increasing demand there for electrical goods.

When the revolution broke out the Republic had a very satisfactory electrical trade. The country was well covered by salesmen representing the various U.S.A. supply houses. These men are for the most part returning to the country, and the latest despatches state that the agents of the larger supply houses are actively engaged in all of the principal cities of the interior of the country.

MISCELLANEOUS NOTES.

Contraband of War Changes.—The following articles have now been declared absolute contraband:

Metallic sulphites and thiosulphates, soda lime and bleaching powder, platinum, osmium, ruthenium, rhodium, palladium, iridium and the alloys and compounds of these metals, strontium salts and compounds thereof, sulphate of barium (barytes) and bone black.

The following amendments are made to the schedule of Oct. 11, 1915:—

For "ethyl alcohol, methyl alcohol," there shall be substituted "Alcohols including fusel oil and wood spirit and their derivatives and preparations." For "aluminium alumina and salts of aluminium," there shall be substituted "aluminium and its alloys, alumina, and salts of aluminium." For "wolframite, scheelite," there shall be substituted "tungsten ores." For "fuel, other than mineral oils," there be shall substituted "fuel, including charcoal, other than mineral oils."

Dinners.—At the Grand Hotel, Bristol, on Friday, a few friends from the West of England and South Wales gave a presentation dinner to Mr. Percival F. Crinks, in order to give him a hearty send off, prior to his removal to take up an important position on the London staff of the British Westinghouse Co.

After the courses had been duly honoured, Mr. H. Faraday Proctor (engineer and general manager, Bristol, Corporation Electricity Department) presented Mr. Crinks with a handsome gold English lever watch and a gold wristlet watch for Mrs. Crinks. In the course of his remarks Mr. Proctor spoke of the connection of Mr. Crinks with Bristol Corporation prior to his joining the Westinghouse Co., and said a man's worth was only appreciated by a department after he had left them.

Mr. Crinks, in responding to the toast, stated that whatever success he had achieved was due in no small measure to the kindness and sympathy he had always received from the gentlemen interested in the electrical industry in the West of England and South Wales. He regretted that at the moment he could not name his successor, but he hoped that whoever succeeded him would command the sympathy and support which it had been his good fortune to experience.

Mr. G. H. Hedley (managing director, St. Annes Board Mill), in proposing the health of the chairman (Mr. W. H. H. Porter), incidentally remarked that he had a grievance, inasmuch as the Westinghouse Co. had allowed the Minister of Munitions to commandeer a turbine on the eve of its delivery to his works.

Mr. Porter spoke in eulogistic terms of Mr. Crinks' connection with the South Wales office, and whilst regretting his departure, felt sure that his future was assured.

Eulogistic speeches were also delivered by Mr. H. I. Rogers (Messrs. Brecknell, Munro & Rogers), Mr. A. J. Newman (deputy engineer, Bristol) and Mr. A. H. Dowson (Veritys, Ltd.). The singing of the National Anthem and "Auld Lang Syne" terminated a very enjoyable evening.

The first annual dinner of the E.S. Company, Ltd., was held at the Horse Shoe Hotel on Dec. 22, when the whole of the staff and a few interested friends sat down to an excellent repast.

The managing director (Mr. E. C. Beman) was in the Chair and the guest of the evening was Mr. V. H. Wells, a director, who has just joined the board. After dinner there was a capital musical programme, and speeches were delivered by Mr. Beman and Mr. Wells.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding up of 396 businesses controlled by alien enemies.

In the latest lists are included: H. Uhlhorn & Co. (Ltd.), 11, Christopher-street, Finsbury-square, London, E.C., manufacturers' agents (Controller, E. J. Webber, 61, Gresham-street, Bank, E.C.). Armorduct Mfg. Co. (Ltd.), 6, Farringdon-avenue, London, E.C., electric cable and conduit manufacturers. (Controller: John Paterson, 1, Walbrook, E.C.)

Claims against Isaria (Ltd.) are to be sent to Mr. G. S. Pitt, 140, Leadenhall-street, London, E.C., by Jan. 28.

Claims against H. Traun & Sons, 25, Goswell-road, London, E.C., are to be sent by Feb. 10 to Mr. J. D. Pattullo, 65, London-wall, E.C.

The controllers of the Berndorf Metal Works and the Hanover Rubber Co. have asked for their release. Objections to the Board of Trade by Jan. 6.

Inquest.—On Friday an inquest was held on the two victims of the tramcar smash on Boxing Day on the Nottingham tramways.

The inquiry was adjourned for the attendance of the driver of the car and another witness who were unable to be present.

The town clerk said the accident was the most serious since the electrification of the system 16 years ago. Everything had been done to keep it well equipped.

Ministry of Munitions and Railway Plant.—By an order of the Minister of Munitions under Regulation 30A of the Defence of the Realm (Consolidation) Regulations (which prohibits dealings without a permit in any war material), the war material to which the regulation applies includes the following:—

Second-hand railway material, including locomotives of all types; waggons of all types, rails of all sections and types, chairs, fish-plates, fastenings, signal apparatus, sleepers, and the like. Applications for permits should be addressed to the Deputy Director General, Railway Materials Licences, Ministry of Munitions, Whitehall place, S.W.

TENDERS INVITED.

Turbo-Alternators, Dynamos, Switchboards, Motors, &c.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of MELBOURNE electricity works. Tender form, with specification, from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Agents for Melbourne City Council, Billiter-square-buildings, London, E.C., and tenders, addressed to the Chairman, Electric Supply Committee, Town Hall, Melbourne, must be received by noon of March 5, 1917. *See also an advertisement.*

WEST HAM Council invite tenders by 10 a.m. Jan. 11 for a Water-tube Boiler and a 3,000 kw. Turbo-alternator. Specification from the engineer and manager, Mr. J. W. Beauchamp, 84, Romford-road, Stratford, E.

The AUSTRALIAN COMMOMWEALTH NAVY DEPARTMENT, Melbourne (Victoria), require tenders by noon Jan. 31 for supply of Dynamos, Switchboards, Motors, Balancers and Control Gear for Flinders Naval Base. Specifications from Director of Navy Contracts, Melbourne, and the Naval Staff Offices, Brisbane, Sydney, Birkenhead (S. Australia), Fremantle and Hobart.

DUNEDIN (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

Telephone Material.

Tenders are invited by Jan. 10, 1917, for the supply and delivery to the POSTMASTER-GENERAL'S DEPARTMENT, STATE OF WESTERN AUSTRALIA, of telephone instruments and parts (W. A. Schedule No. 497). Tender forms, &c., can be obtained at the Commonwealth Offices, 72, Victoria-street, S.W.

Electrical Stores, &c.

HAMPSTEAD (London) Council require tenders by 4 p.m., Jan. 10, for one year's supply of Electrical Engineers' Stores, Oils, Ironmongery, &c. Forms of tender from the Town Clerk.

TENDERS RECEIVED AND ACCEPTED

ABERDEEN.—The Electricity Committee has accepted the following tenders for annual stores:—

A. C. Macdonald, paints, oil, glass, &c ; Stewart & Lloyds, wrought iron tubes and fittings.

SALFORD.—The Gas Committee has accepted the tender of Mather & Platt for a 12 H.P. electric motor, for £123.

LAUNCESTON (TASMANIA).—The Council has accepted the tender of the British General Electric Co. for 25 transformers at £1,087. 10s.

Government Contracts.—The following tenders were accepted by the War Office during November :—

Phœnix Dynamo Mfg. Co., motor alternator; Dorman & Smith and W. White & Co., electric light fuse bases and carriers; Evershed & Vignoles, bridge meggers; General Electric Co., W. T. Henley's Telegraph Works Co. and Hooper's Telegraph & India Rubber Works, electric cable; J. C. Fuller & Son and Siemens Bros. & Co., electric cells; Bruce, Peebles & Co., motor converters; Bristol Ebonite Co., India Rubber, Gutta Percha & Telegraph Works Co. and Siemens Bros. & Co., rod and sheet ebonite; Sturtevant Engineering Co., extracting fans; General Electric Co., S. Heath & Sons, C. H. Parsons (Ltd.), G. Rco & Sons, Sun Electrical Co. and Verity's (Ltd.), electric light fittings; Austin Motor Co., Coventry Engineering Co. and Keighley Gas & Oil Engine Co., generating sets; British Thomson-Houston Co., Cryselco (Ltd.), Dick, Kerr & Co., Edison Swan Electric Co., General Electric Co. and Imperial United Lamp Co., electric lamps; Cook, White & Co., telegraph poles; Berry & Hayward, Park Royal Engineering Works (Ltd.), Sperryn & Co. and W. White & Co., switches; Automatic Standard Screw Co., Davis & Timmins, D. Gilson & Co., Ingram & Kemp, W. McGeoch & Co. and Sperryn & Co., electrical instrument terminals; British Ever-Ready Co., Edison Swan Electric Co., Efandem Co., Siemens Bros. Dynamo Works, C. Twigg & Co., Vulco Battery Co. and Westwood Electrical Co., electric torches and parts.

FINANCIAL MATTERS.

NEW COMPANIES, &c.

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ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS (145,644).—By licence of the Board of Trade the word "limited" is omitted from the title of this company, which was registered Dec. 28, as a company limited by guarantee and not having a capital divided into shares, with an unlimited number of members, each liable for not more than £25 in the event of winding up, to promote co-operation between British subjects engaged as manufacturers in the chemical or closely allied industries; to place before Government and Government officials and others, either in the British Dominions or elsewhere, the views of members of the association and others upon matters affecting the chemical industries; to develop technical organisations; to promote industrial research, industrial efficiency, and the advancement of applied industry, &c. The management is vested in a council consisting of not less than 16 or more than 20, the first members of which are: E. F. Armstrong, D.Sc., E. H. Carr, F.I.C., C. Carpenter, D.Sc., M.Inst.C.E., M. O. Forster, F.I.C., D.Sc., F.R.S., J. Gray, F.I.C., C. A. Hill, B.Sc., F.I.C., N. N. Holden, D. L. Howard, C. P. [illegible], Rt. Hon. Sir A. M. Mond, Bart., P.C., M.P., Max Muspratt, F. G. Perry, Sir W. Pearce, M.P., E. D. Pullar, A. T. Smith, the Rt. Hon. J. W. Wilson, and Dr. A. Ree. There are to be "group" committees, each consisting of not less than three members, representing: Group 1, acids; group 2, alkalis; group 3, fats, waxes, resins, &c.; group 4, [illegible], glue, varnishes, &c.; group 5, distillation of coal, shale, oils and wood, alcohol, &c.; group 6, fine chemicals; group 7, phosphates, [illegible], potassium, sodium, barium, calcium, &c., lead, arsenic, antimony, tungsten, molybdenum, &c.; group 8, cellulose products; group 9, explosives and dyes and their intermediaries; group 10, glass, porcelain, pottery, refractory materials, &c.; group 11, allied industries, such as bleachers, dyers and textile printers.

CORONA LAMPWORKS NORTHERN (LTD.) (145,612).—Reg. Dec. 22, capital £10,000 in £1 shares, to take over business of electric lamp supply stores or depot, carried on by the Corona Lamp Works (Ltd.) and by J. Brown, their agent, at 150a, Briggate, Leeds, together with the agency rights, interest in connection with the "Corona" filament lamps. Private company. Reg. Office: 150a, Briggate, Leeds.

FACTORY EQUIPMENT (LTD.) (145,551).—Reg. Dec. 29, capital £1,000 in £1 shares, to carry on the business of wholesale and retail ironmongers, contractors, electrical engineers, &c. Private company. H. G. Martindale is sole director.

CITY NOTES.

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MEMORANDA (Jan. 3). Bank rate 6 per cent. (since July 13, 1916). Consols, 55¼. Stocks and Shares Ticket Day, Jan. 11. Pay Day, Jan. 12. Price of Silver, 36½d.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The interest on the 4 per cent. mortgage debenture stock for the half year ending Jan. 31, due on the 1st prox, will be paid by warrant on Feb. 1 next. The stock register will be closed from the 27th to the 31s inst., inclusive.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—An interim dividend of 5 per cent. (1s. per share) less tax, has been declare on account of the current year.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—In a circular th directors express regret that they have not yet been able to obtain fro Government Departments a basis of settlement in respect of either re muneration or compensation for services rendered, for the use of the stations since the commencement of the War, nor in respect of othe matters in which the Government is indebted to the Company. I these circumstances the declaration of a bonus must still remain i abeyance. However, the directors feel justified in declaring the 7 p cent. preferential dividend upon the cumulative participating prefe ence shares and an interim dividend of 5 per cent. on the ordinar shares.

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NOTES.

Tractive Resistance on Roads.

MANY years ago experiments were made on the tractive resistance on roads by Mr. WORBY BEAUMONT, and other investigators have worked at the same question; but we doubt if such a complete analysis has ever been made as that by Prof. A. E. KENNELLY and Mr. O. R. SCHURIG, the account of which is completed in our present issue. Very naturally the electric vehicle lends itself particularly well to an investigation of this kind, and it has been used on this occasion as on others. It will perhaps come as a surprise to some of our readers that the overall efficiency, including all mechanical and electrical losses beyond the battery terminals, reached the high figure of 78 per cent. on the vehicle used for the test, the controller being then on the notch for the highest speed. As a result of their tests, the authors split up the tractive resistance into three parts. The first of these is a constant quantity, depending upon the lack of resilience of the road surface and wheel tyre material, and is called by the authors "displacement resistance," being due to energy loss from displacement of tyre material and road surface material. The second component is a quantity which increases with the speed, and is due to impact losses from lack of smoothness of road surface, and is therefore called "impact resistance." The third component also increases with the speed, and is due to air resistance. By far the largest of these components appears to be the displacement resistance, amounting to about 75 per cent. of the whole in the case of asphalt roads in poor condition, the car running at a speed of 12·4 miles per hour. This is merely another way of emphasising the fact that the character of the road surface is all important, as may be seen by referring to the curves given on another page. From those it is seen that the best surface is that given by asphalt, for which the total tractive resistance varies from about 19 lb. per ton upwards, according to the speed, whereas wood block paving varies from about 22 lb. upwards. The latter is not so good as macadam at low speeds, but is better at higher speeds. Of course, much depends upon the condition of the particular paving. For example, soft tar macadam gives a very high result, although when in proper condition it is comparatively good. Also granite blocks, as might be expected, give a very high value for the tractive resistance, and this rises rapidly with the speed. Results of this kind should be of great practical interest to all who are concerned with the electric vehicle.

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Youngsters and Their Training.

ALMOST without exception the many schemes that have been proposed for continuing the education of our boys and girls after they leave school are far too ambitious. As an example may be mentioned the recommendations contained in the "Journal" of the British Science Guild. Of these, that dealing with continuation schools is typical. It is urged that employers should be compelled to give reasonable facilities within the hours of employment for young persons between the ages of 14 and 17 to attend suitably-equipped continuation schools for six hours per week. Provided they were sure that the time would not be wasted we think that many employers would willingly grant the concession without any compulsion. But employers are not certain that the time would be spent profitably, nor are we. The many influential members of the British Science Guild weaken a strong case when they state that during the six hours which ought to be allowed, provision should be made for physical training and for continuing the general education of the children, in addition to the "vocational" instruction. We question whether even a properly trained schoolmaster could do any real good with such an extensive range of subjects in the short time at his disposal. We go further, and question whether anybody on earth, even the British Science Guild, could do any real good. Were we large employers of juvenile labour we should teach the youngsters how and what to read, and how to write. We would give them the arithmetic they require in daily life, and, above all, we would instruct them in their duty to their fellow men. We believe that five years spent in this way would do more good to the youngster than does the half-baked science and technology served out in our schools under the name of technical education. Furthermore, we would teach them their several trades in our own works, and not leave this very important work to a so-called manual instructor, who, as a rule, knows nothing whatever about any of the trades he is supposed to teach, and who, in addition, is completely out of touch with practice. We need not remind our readers that we believe employers ought to give facilities to those whom they employ, nor need we insist that the time granted should be wisely spent. In the past public money has been wasted by the bushel in the continuation school.

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Tramway Accidents.

We notice that Mr. J. Dalrymple, general manager of the Glasgow Corporation Tramways, has issued a memorandum to his staff, making a number of suggestions for the avoidance of accidents. We think that other tramway managers might do well to follow the example of Mr. Dalrymple. At the present time there are so many inexperienced employés, more particularly women conductors and even women drivers, working our tramways that it is not altogether surprising to hear of accidents. Safety in manipulation is largely a question of being thoroughly accustomed to the work under all conditions, and this takes time. Recent accidents at Dudley and at Bradford have shown that there is sometimes a lack of common sense. For example, when a woman conductor releases the brakes of a car standing on a gradient without noticing that the driver is not at his post, an accident naturally occurs of a kind which is preventable, and which is merely due to lack of experience or possibly of common sense. We think, therefore, that tramway managers would do well to take into account the fact that more than usual care is necessary in the imparting of instructions under the present difficult conditions.

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Balancers.

At various times a good deal has been written on the theory of the several balancers that are used for three-wire continuous-current systems. But, as far as we are aware, no attempt has been made to collect the information and to present it in an easily accessible form. Notwithstanding the importance of these machines, many users have but little conception of their action, and young designers are often at a loss to know where and how to begin with the design of such a machine. We think that Mr. T. Carter's series of articles on the subject, which commences in this issue, will appeal strongly to many of our readers. The author shows that a single general theory, with modifications to suit individual cases, may be applied to the various types of these interesting machines. For the purpose of serial publication in The Electrician it has been necessary to divide the article into three sections. The first of these deals with preliminary matter, and gives a general treatment of the theory of balancers. The general theory of rotary balancers is set out in the second; descriptions are also given of the various ways in which the fields of these machines may be wound and connected up, and, in addition, the use of feeder boosters in conjunction with these machines is explained. The third section is devoted to the general theory of static balancers, and the author shows how to find the points on armature windings to which the balancers should be connected. We believe that Mr. Carter's article owes its origin to the inquisitiveness of one of his assistants, and in these days it is seldom that one finds a man who is willing to attempt to satisfy the curiosity of those lower down the ladder. It would be very much better for our young engineers if their seniors would take the trouble properly to train them. As a collection of information on the subject of balancers the article is at least as complete as anything hitherto published, and in regard to rotary balancers the treatment is in some respects novel. Such being the case, we hope to publish the article separately as a monograph.

Vacancies in the O.T.C.—Men whose exemptions are about to expire and who are suitable to train as officers, and young men about to reach military age, are advised that there are now vacancies in the Inns of Court Officers' Training Corps. They should call without delay for a personal interview with the Selection Board at No. 10, Stone-buildings, Lincoln's Inn, London, W.C., any day (except Saturdays) between the hours of 10 a.m. and 4 p.m. No appointment is necessary.

Researches on the Electric Arc.—In the "Transactions" of the Illuminating Engineering Society (U.S.A.) for November, 1916, W. A. Darrah describes some experiments on arc lamps using electrodes of various kinds surrounded with a gaseous envelope. The luminosity, colour and stability of an arc struck between tungsten electrodes and burning in gases of various kinds was investigated, the compounds selected being (1) materials which give a high luminous efficiency but which usually produce unstable arcs if used alone, (2) stabilisers, *i.e.*, those materials which have a low luminous efficiency, but which when introduced into the arc give a very stable arc at a relatively low voltage and (3) catalysers or compounds which assist recombination in the flame zone, thus minimising deposits. Chlorine was the halogen most generally used. An investigation on these lines opens up interesting possibilities, but arc lamps of this type must be regarded as still in the experimental stage.

Linking Up on the North-East Coast.—A meeting of the north-east coast interests was held in the Town Hall, Sunderland, on the 20th ult., Mr A. S. Blackman, borough electrical engineer and general manager, Sunderland, presiding. The chairman referred to the Board of Trade circular letter of May 25, 1916, and to the memorandum of the National Electric Power Supply Joint Committee. It was decided to form a committee to go fully into the matter, and the secretary was instructed to obtain information with regard to linking-up already accomplished in other parts of the country. The Committee was appointed as follows:—

A. S. Blackman, Sunderland (chairman).
H. A. Couves, County of Durham Electric Supply Co.
H. Ellis, South Shields.
A. B. Gridley, Cleveland & Durham Electric Power Co.
J. R. P. Lunn, Darlington.
C. Turnbull, Tynemouth.
R. A. Scotson, Middlesbrough.
R. P. Sloan, Newcastle on Tyne Electric Supply Co.
J. J. Smith, Stockton.
J. W. Spark, West Hartlepool.
Together with Mr. S. R. Windle (Sunderland), who was elected honorary secretary.

Condenser-Tube Repairs.—A method of mending condenser tubes is described in a recent issue of the "Electrical World," which is said to have effected considerable saving. The method consists in cutting out the section containing the break and inserting a new one, which is joined with the other sections by an inner sleeve or ferrule about 2½ in. long. The latter consists of a piece of tubing about half as thick as the condenser tube, and has a diameter that will make it fit tightly in the sections to be joined. Both the ferrule and the ends of the sections to be joined are thoroughly tinned, and after being assembled are sweated together. In making these joints special care is taken to cut the ends square so they will meet and make a practically continuous tube. Any solder that may adhere to the outside of the joint is wiped off or removed with emery cloth, so that the tube can be inserted in the tube plates in the regular manner. Usually several ferrules are prepared and tinned in advance so there will not be much delay in making repairs.

Magnesite.—The Minister of Munitions has prohibited as from Jan. 10th the use of magnesite and magnesite products for or in connection with—

(1) The construction or repair of any building (other than a furnace) or any flooring or deck, or (2) the manufacture of any insulating or non-conducting material, except under and in accordance with the terms of a permit granted by the Minister.

Applications in reference to the Order should be addressed to the Director of Steel Production (W.J.J. 342), Armament buildings, Whitehall place, S.W.

OBITUARY.

Hon. A. G. Brand.—The death is announced of the Hon. A. G. Brand, chairman of the Norwich Electric Tramways Co., and a director of the New General Traction Co.

Killed in Action.—The following deaths in action or of wounds are reported :—

Second-Lieut. Wm. McDonald Noble (East Kent Regt.), 26 years of age, who has died of wounds, was formerly in the service of the General Electric Co.

Lieut. L. W. Empson (Canadian Light Infantry), 28 years of age, who has been killed in action, was in the service of the Montreal Engineering Co. prior to the war.

Lieut. C. T. Bowring (Canadian M.G. Co.), 35 years of age, who was killed on Dec. 29, took a degree in electrical Engineering at Lausanne, afterwards served an apprenticeship with the Westinghouse Co. at Pittsburg, and when the war commenced was in the service of the State Elevator Co., Winnipeg.

Second-Lieut. C. W. H. Foord (M.G. Co.), aged 31, who has died of wounds, was apprenticed to Messrs. Gwynnes, of Hammersmith, and was afterwards in charge of Messrs. Marks & Clerk's branch office at Southampton-buildings, London, W.C.

Lieut. F. J. Stone (Gloucester Regt.), who has died of wounds, was a B.Sc. in Engineering of Bristol University.

C. Linford, formerly employed in the St. Pancras electricity department, has died of wounds.

PERSONAL.

Baron Kenjiro Den has been appointed Minister of Communications of Japan in succession to M. Katsnto Minoura, who has retired.

Mr. Edmund L. Hill, for many years past Manchester branch manager of Siemens Bros. & Co. and Siemens Bros. Dynamo Works, and hon. secretary Manchester Engineers' Club, has been appointed secretary to the Federation of British Industries, and, we understand, will take up his duties in London at an early date. The President of this organisation is Mr. F. Dudley Docker, and we have already published particulars of his interesting scheme for the co-ordination of British industrial effort. We wish Mr. Hill every success in a sphere of labour which we feel sure will provide ample scope for his undoubted commercial capabilities and organising powers.

Military Honour.—Pte. F. T. Woods (London Regt.), formerly in the employ of the India Rubber Co., at Silvertown, has been awarded the Military Medal for Gallantry in the field and for carrying messages under heavy fire.

War Casualties.—Mr. Alfred W. Empson (R.F.C.), A.M.I.E.E., A.M.I.Mech.E., is now in a London hospital. Prior to joining the Army he was chief engineer to the Merida Electric Light Corpn., Yuchatan, Mexico. Mr. Empson is a brother of Lieut. Empson whose death is recorded in our obituary column.

L.-Corp. E. Latham (L.N. Lancs. Regt.), 25 years of age, who is in hospital suffering from wounds, was formerly employed at Messrs. Dick, Kerr & Co.'s works. He has been recommended for the Military Medal.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is wanted, with experience in installation work, &c. *See advertisement.*

A working electrician and mechanic is wanted for the duration of the war at the University of Bristol. Applications to the Registrar.

An assistant engineer is required by Birmingham Corporation Electric Supply Department to assist in the preparation of specifications and plans for new buildings and the lay-out of new steam and electrical plant, &c. Forms of application from the Secretary of the Department, and applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Jan. 14.

A chief instructor is required for the Rutherford College school of wireless telegraphy, Newcastle-on-Tyne. Salary £200 to £250 per annum. Applications to the Director of Education, Northumberland-street, Newcastle-on-Tyne.

Mr. Joseph Yates, M.Sc., has been appointed head of the chemical department at Derby Technical College at £300 per annum.

INSTITUTIONS AND SOCIETIES.

Faraday Society.—At the annual general meeting of the Faraday Society, which took place on the 18th ult., the following officers and council were elected :—

President : Sir Robert Hadfield, F.R.S.

Vice Presidents : Prof. K. Birkeland, W. R. Bousfield, K.C., Prof. F. G. Donnan, F.R.S., Dr. Eugene Haanel, Prof. A. K. Huntington, Dr. T. Martin Lowry, F.R.S.

Treasurer : F. Mollwo Perkin, Ph.D

Council : W. R. Cooper, C. H. Desch, Dr. J. A. Harker, F.R.S., Emil Hatschek, Cosmo Johns, Prof. Alfred W. Porter, F.R.S., E. H. Rayner, A. Gordon Salamon, Dr. George Senter, Cav. Magg. E. Stassano.

The report of the Council states that in spite of difficulties consequent on the war, it was found possible to hold two general discussions in the year under review, one on "The Transformation of Pure Iron," and the other on "The Corrosion of Metals: Ferrous and Non-ferrous." The published reports of these discussions will be of particular value in focussing attention on some of the outstanding gaps in our existing knowledge of these important subjects. Indeed, the symposium on corrosion has been characterised in an American journal as the most valuable collection of Papers that has yet appeared on this subject in England. The report indicates that the society has been able to be of some service to the Government in connection with the war, and it states that besides those of its members who are on active service, a very considerable number of the officers and members are serving on the various Government boards and panels that have been constituted since the beginning of the war by the Admiralty, Ministry of Munitions and Board of Education.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, Jan. 13th.

Birmingham and District Electric Club.

7 p.m. At the Swan Hotel, New-street, Birmingham. Annual General Meeting.

TUESDAY, Jan. 16th.

Illuminating Engineering Society.

5 p.m. At the Royal Society of Arts, John-street, Adelphi, W.C. Paper on "The Lumen as a Measure of Illuminating Power," by Prof. J. T. Morris.

Association of Supervising Electricians.

7.15 p.m. At St. Bride Institute, Bride-lane, Ludgate-circus, E.C. Half-yearly Meeting and informal discussions.

Manchester Local Section, Institution of Electrical Engineers.

7.30 p.m. At the Engineers' Club, Manchester. Paper on "The Principles Involved in Computing the Depreciation of Plant," by Messrs. F. Gill and W. W. Cook.

WEDNESDAY, Jan. 17th.

Birmingham Local Section, Institution of Electrical Engineers.

7 p.m. At Birmingham University, Edmund-street, Birmingham. Paper on "Principles Involved in Computing the Depreciation of Plant," by Messrs. F. Gill and W. W. Cook.

THURSDAY, Jan. 18th.

London School of Economics and Political Science.

5 p m Lecture on "The Organisation of Trades," by Mr. Ernest J. P. Benn.

FRIDAY, Jan. 19th.

Royal Institution.

5.30 p.m. At Albemarle-street, W. Discourse on "Soap Bubbles of Long Duration," by Prof. Sir James Dewar, M.A., F.R.S.

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. General Meeting.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding : Lieut.-Col. C. B. Clay, V.D.

Orders of the Week :—

Officer for the Week.—Platoon Commander W. J. A. Watkins.

Next for Duty.—Platoon Commander H. de P. Birkett.

Appointments.—Sergts. Ullman and Jantzen to be platoon sergeants, Sergt. P. F. Allan and Corpl. Fyfe to be section commanders, Sappers G. J. D. Scott and Gillespey to be corporals (all in No. 3 Company). Dated January 6, 1917.

Monday, January 15th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.25 to 8.

Tuesday, January 16th.—School of Arms, 6 to 7. Lecture, 7.15, "Company Drill," by Company Commander Fleming.

Wednesday, January 17th.—Instructional Class, 6.15. Platoon Drill, Platoon No. 1.

Thursday, January 18th.—Platoon Drill, Platoon No. 7. Ambulance Class by M.O., 6.30.

Friday, January 19th.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill, 6.25 to 8.25.

Saturday, January 20th.—Commanding Officer's Parade, 2.15 (Uniforms), for drill in Battersea Park.

Sunday, January 21st.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office) 8.45 a.m. Uniform, Haversacks, Water-bottles. Mid-day rations to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

TRACTIVE RESISTANCES TO A MOTOR DELIVERY WAGON ON DIFFERENT ROADS AND AT DIFFERENT SPEEDS.*

BY A. E. KENNELLY AND O. R. SCHURIG.

(*Concluded from page 438.*)

SYNOPSIS.—In this Paper is given a complete report on an investigation of tractive resistances of urban roads to a motor delivery wagon equipped with solid rubber tyres. The test truck is fully described with its driving mechanism and the storage battery which supplied the motive power. The results included in the Paper are (1) overall efficiency of truck mechanism and (2) tractive resistances of a number of typical urban roads. The components of tractive resistance for a typical road are also given.

Tractive Resistance.—In Fig. 6 are plotted the results for a typical test. The ordinates represent the horizontal force per metric ton and per short ton, which is required to overcome the road resistance and still-air resistance at constant speed on level road with no wind blowing. Curves similar to those of Fig. 6 were plotted for each road test. A summary of the tests is represented by Figs. 10 to 14 inclusive.

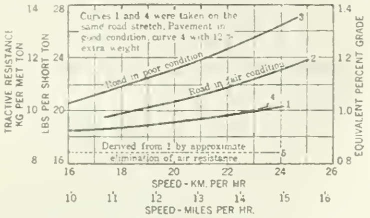

FIG. 6.—TRACTIVE RESISTANCE FOR ASPHALT ROADS.
Sheet asphalt and asphalt macadam and bitulithic.

Asphalt Roads (Fig. 6).—The curves plotted in Fig. 6 apply to both sheet asphalt (*a*) and to bitulithic pavements (*b*), both defined as follows: (*a*) Asphalt, consisting of (1) a foundation of hydraulic cement or concrete, (2) a binder course of broken stone and asphaltic cement (dissolved asphalt), (3) a surface layer of asphaltic cement mixed with sand; (*b*) bitulithic pavement, which may be classified as a type of asphalt-macadam pavement, built on a concrete, stone-block or macadam foundation, consisting of a mixture of broken stone, sand and asphaltic cement, proportioned and mixed before being laid. This mixture, after having been laid hot and rolled is covered with a coat of hot asphaltic cement and fine stone chips.

The tests showed that there was no appreciable difference between the tractive resistances of sheet asphalt and bitulithic pavements as above defined when in good condition; so that both of these pavements are represented on one and the same diagram, Fig. 8. The asphalt pavement, when in good condition, offers a low resistance to vehicular traffic on account of its smoothness and hardness. Curve 1 is almost horizontal, and if the still air resistance is eliminated by an approximate formula†, a straight horizontal line (see curve 5), results for the road resistance alone. Curves 2 and 3 are steepened by the addition of impact and vibration losses. These extra losses are due to the impacts which the truck receives as it encounters local lumps and hollows in the worn pavement. The dash-line curve was obtained when the total moving mass was increased 12 per cent., and is seen to be almost identical with curve 1.

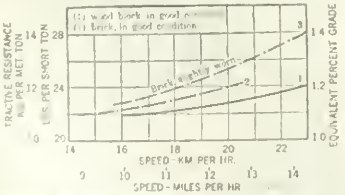

FIG. 7.—TRACTIVE RESISTANCE FOR WOOD BLOCK AND BRICK BLOCK ROADS.

Wood-Block Roads (Fig. 7).—The full-line curve of Fig. 7 applies to wood-block paving, which consists of rectangular creosoted hard-pine blocks, approximately 4 in. (10 cm.) deep, 3·5 in. (9 cm.) wide and 8 in. (20 cm.) long, placed, with the fibre vertical, and the long dimension crosswise to the street, upon a foundation of concrete with a thin layer of sand interposed between concrete and wood blocks. The curve is nearly horizontal because of the smoothness of the pavement.

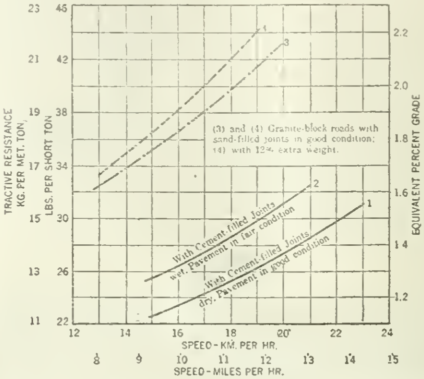

FIG. 8.—TRACTIVE RESISTANCE FOR GRANITE-BLOCK ROADS.

Brick-Block Roads (Fig. 7).—The brick-block roads upon which tests were made consisted of rectangular vitrified paving brick, approximately 4 in. (10 cm.) deep, 3·5 in. (9 cm.) wide, and 8·5 in. (21·5 cm.) long, laid with the length perpendicular to the curb, upon a foundation of concrete and a cushion layer of sand. The results for brick roads show nearly as low a resistance as those for the wood block, but the curve for the former is steeper, particularly for the case of a worn surface, again probably because of the impact and vibration losses on the rougher pavement.

Granite-Block Roads (Fig. 8).—The foundation for these roads is either a bed of sand or a layer of concrete, with a sand cushion to separate the blocks from the concrete. Average dimensions for the rectangular blocks are about 4 in. (10 cm.) wide, 11 in. (28 cm.) long and 8 in. (20 cm.) deep. The joints are filled either with small pebbles and sand or with hydraulic-cement grout. The former filler is subject to being partially washed out by precipitation, and removed by the street sweeper, and thus allows the edges of the blocks to be exposed to wear, which renders the pavement far less smooth than one with cement filled joints. The full-line curves 1 and 2 in Fig. 8, which apply to granite block roads with cement-filled joints, show a greater upward slope than those for the smoother brick-block, wood-block, and asphalt roads, already mentioned; while the granite block pavements constructed with the less durable filler

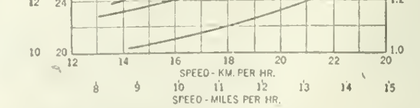

FIG. 9.—TRACTIVE RESISTANCE FOR MACADAM ROADS.

(1) In fair condition, dry and hard.
(2) ,, ,, ,, dusty.
(3) Poor, damp, some holes.
(4) Oiled, in fair condition.
(5) Heavily oiled, in fair condition.
(6) Oiled, rather poor, damp, some holes.
(7) Heavily oiled, wet, 12 per cent. extra weight.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

† $P = 0.0025\frac{AV^2}{W}$ lb. per short ton air resistance, in which formula A is the cross-section of the car in square feet, V the speed of the car in miles per hour, and W the total mass in motion in short tons.

are seen to offer a still more rapidly increasing resistance at increasing velocities, because of the greater losses of kinetic energy due to road impact.

Macadam Roads (Fig. 9).—This type of road has a pavement consisting of several layers of broken stone (trap rock, granite, lime stone, slate, &c.), ranging in size from about 3 in. (7·6 cm.) to about 0·5 in. (1·3 cm.) in largest dimension. The fragments of stone are held together by a binding material of which there are two general types: (1) clay, loam, sand or finest screenings (stone dust from stone crusher), distributed over each layer of broken stone, water being sprinkled over the surface; and (2) tar, either mixed with the broken stone before it is laid or distributed over the broken stone after the latter has been spread and rolled; type (1) is known as a water-bound macadam, and type (2) as tar-macadam.

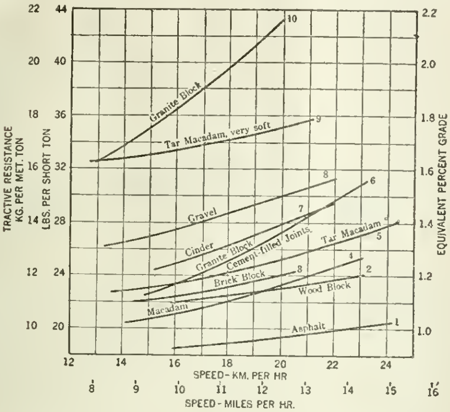

FIG. 10.—SUMMARY OF TRACTIVE RESISTANCE TESTS.

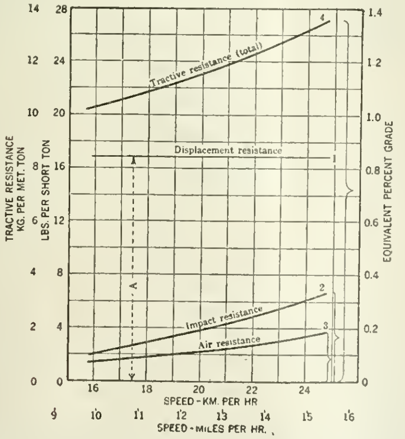

FIG. 11.—APPROXIMATE ANALYSIS OF TYPICAL TRACTIVE RESISTANCE INTO ITS ELEMENTS, FOR ASPHALT ROAD IN POOR CONDITION. (Curve 3, Fig. 6.)

Fig. 11 shows the results obtained for water-bound macadam roads the dot-dash curves apply to the oiled pavement, full-line curves ar, for unoiled roads. A dusty road (curve 2) is seen to have a greatee resistance than a similar one with a hard surface without dust (curve 1); while a badly worn road with holes (curve 3) shows a far highe resistance than 1 and 2, and a much more rapid rise with increasing speed, due to impact losses. Curve 4, for an oiled macadam road, though in fair condition, shows a higher resistance than a similar road unoiled. Heavy oiling increases the resistance without increasing the slope of the curve, as indicated by curve 5; this effect is probably caused by the softening of the surface and the resultant loss of power due to the depression of the surface material by the wheel tyres. The combined effects of wear and oil are seen in curve 6. Curve 7, if compared with curve 5 (the two curves applying to the same road, but to different days and different total weights of moving vehicle), shows a slight increase of resistance due probably to both decreased road resilience and increased weight

Summary for All Classes of Urban Roads Tested.—Typical results for all classes of urban roads tested are summarised graphically in Fig. 10. It appears from these summaries, and from the foregoing discussions, that there are three principal elements which determine the tractive-resistance-speed curve for unit weight of a given vehicle, within the range of conditions covered by this test:

(1) A constant resistance (*see* curve 1, Fig. 11) the magnitude A of which depends on the lack of resilience of the road surface and wheel tyre material, *i.e.*, on the energy losses due to displacement of tyre material and road-surface material. This constant element A would be encountered upon a smooth level road of the particular type considered, in the absence of impact, air and wind-resistances.

(2) An increasing resistance with increasing speed, due to impact losses (curve 2), which results from lack of smoothness of road surface; losses of this nature are usually known to vary approximately as the second power of the velocity at impact; and

(3) An increasing resistance with increased speed, due to air pressure against the front of the vehicle, curve 3, which resistance is known to depend, roughly, on the second power of the speed (*see* above under "Asphalt Roads"). The constant resistance (1) may be briefly called the *displacement resistance*, item 2 the *impact resistance*, and item 3 the *air resistance*. The displacement resistance is low for hard pavements and high for soft pavements (of low resilience). The impact resistance is very marked in granite-block roads. The air resistance, at any definite velocity, is the same for all curves. For the particular type of road represented by Fig. 11 (asphalt road in poor condition), at a speed of 20 km. (12·4 miles) per hour the displacement resistance is 0·84 per cent., the air resistance is 0·11 per cent. the impact resistance 0·20 per cent. and the total 1·15 per cent., equivalent grade.

The displacement resistance of a road manifestly varies, not only with the type and surface quality of the road, but also with the type, dimensions and quality of the tyres on the wheels of the vehicle. In the tests here reported, the same tyres were used throughout, and they remained in substantially the same condition.

The impact resistance of a road manifestly depends not only on the type and surface quality of the road, and the sizes of its irregularities, but also on the type, dimensions and quality of the wheel tyres, the weight of the truck, and the quality of its springs.

The air resistance per unit weight of truck manifestly depends upon the weight, dimensions and shape of the vehicle, as well as on the speed of the vehicle relatively to the surrounding air.

The wind resistance per unit weight of truck manifestly depends upon the weight, dimensions and shape of the vehicle, as well as on the direction and velocity of the wind and the velocity of the vehicle. It is assumed that at low wind and vehicle-speeds, like those here considered, only that component of the wind which is in the direction of the vehicle's path needs to be taken into account, and that the mean of the wind resistances in opposite directions, along the road, is zero.

PHASE LAG IN CURRENT TRANSFORMERS.*

BY P. DE LA GORCE.

The readings of instruments connected in the secondary circuits of current transformers depend on the ratio of transformation and the phase lag between the primary and secondary currents. The former quantity is the only one affecting the readings of voltmeters and ammeters, but the latter must also be reckoned with in the case of wattmeters.

The tests to be described are of a nature to determine the ratio of transformation and the phase lag in commercial current transformers for various frequencies and for various adjustments of the constants of the secondary circuit.

Fig. 1 shows the arrangement adopted in the tests. I_1 and I_2 are the primary and secondary currents of the transformer T under test. The primary circuit contains a non-inductive resistance R_1, an ammeter A_1 and the current coil of a wattmeter W_1, the potential coil of which is supplied from a voltage E_2. The voltages E_1 and E_2 are supplied by two machines coupled together in such a manner that the phase-angle between E_1 and E_2 can be adjusted to any desired value. The secondary of the transformer is closed through an inductance L and a non-inductive resistance R_2 to represent the inductance and resistance of the measuring instruments supplied by the transformer; r and ρ are non-inductive resistances, and G a vibration galvanometer. If the primary and secondary currents were in exact opposition the determination of the ratio of transformation would be given by the relation $R_1I_1 = R_2I_2$ if R_1 and R_2 were regulated until the galvanometer G gave no deflection. In reality the vector R_1I_1 makes an angle a with the vector R_2I_2 (supposed to be reversed) and a difference of potential equal to the vectorial difference between the two vectors is applied to the galvanometer. In order to bring the galvanometer to zero and measure a, the phase difference between E_1 and E_2 is adjusted until the wattmeter W_1 reads zero, thus showing that the current i in the resistance r is in quadrature with the current I_1, and then the resistances r and ρ are suitably regulated. Under these conditions we have (*see* Fig. 2)

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* Abstract of a Paper published in the "Bulletin" de la Société Internationale des Electriciens 6, pp. 299–307, July, 1916.

$$R_1I_1 = R_2I_2 \cos a,$$

$$\tan a = \frac{ri}{R_1I_1},$$

$$i = \frac{E_2}{r+\rho},$$

from which equations the ratio of transformation I_1/I_2 and the angle of phase displacement a can be easily deduced.

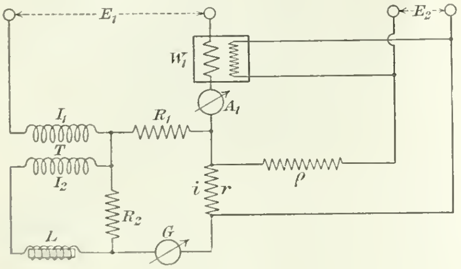

FIG. 1.

R_1 and R_2 are low resistances capable of carrying fairly high currents and are not easily constructed so as to be able to be regulated so as to satisfy the above equations. On this account one was given a fixed value and the other was shunted by a plug-box as shown in Fig. 3. In order that the resistances R_1 and R_2 should have no self-induction they were made of insulated manganin wires connected in parallel so as to form a kind of cable when they were bent over and twisted together.

The potential leads were soldered to the cable near the main terminals and the resistances were immersed in baths of petrol. It is important to attend to these details, as it is not easy to construct resistances that are perfectly non-inductive, and in this connection it should be noted that a resistance of 0·001 ohm with a coefficient of self induction of 10 cm. would be very unsatisfactory, as an error of 20 minutes might be introduced in the value determined for the phase lag. It is also necessary to avoid the flow of parasitic currents due either to defects of insulation or to capacity effects between different parts of the circuit. The vibration galvanometer employed had a resistance of 30 ohms and a high sensitiveness, giving an amplitude of 1 cm. for the micro-ampere. The ratio of transformation could be determined correct to about 0·1 per cent. and the phase angle correct to several minutes. The results are not so accurate at light loads ($\frac{1}{10}$ or $\frac{1}{20}$ of full load) as at full load, as the P.D. becomes very small, but even for such loads the accuracy is fairly good. The following results were obtained in the Laboratoire Central d'Electricité, using good commercial current transformers:

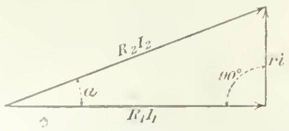

FIG. 2.

Tests 1 and 2 show that doubling the secondary resistance changes the ratio of transformation by only 5/1,000, but that the angle of lag is considerably increased, especially at light loads.

Transformer A. 20/5 amperes.

Test No.	External secondary circuit.	I_1	I_1/I_2	a Deg.	a Min.	Frequency Cycles a sec.
1	Non-inductive Res. = 0·59 ohm.	19·8	4·000	0	28	42
		9·1	4·005	0	37	
		4·9	4·010	1	0	
		2·0	4·015	1	30	
2	Non-inductive Res. = 1·19 ohm.	19·9	4·020	0	31	42
		13·0	4·025	0	45	
		8·0	4·030	1	20	
		3·8	4·035	1	40	
		1·95	4·040	2	10	
3	Inductive. Res. = 0·4 ohm.	20·7	4·020	0	5	42
		10·9	4·025	0	15	
		4·3	4·045	0	36	
		2·0	4·060	0	55	

Transformer B. 75/10 amperes.

Test No.	External secondary circuit.	I_1	I_1/I_2	a Deg.	a Min.	Frequency Cycles a sec.
4	Non-inductive Res. = 0·1 ohm.	74·8	7·47	0	6	50
		37·5	7·50	0	15	
		18·0	7·53	0	22	
		7·6	7·58	0	42	
5	Non-inductive Res. = 0·38 ohm.	74·4	7·49	0	20	50
		37·5	7·52	0	40	
		18·7	7·54	1	10	
		7·6	7·59	1	50	
6	Non-inductive Res. = 0·1 ohm.	74·0	7·48	0	19	25
		36·8	7·50	0	25	
		18·0	7·54	0	50	
		7·0	7·60	1	45	

The presence of inductance in the secondary circuit tends to diminish the angle of lag, but disturbs the ratio of transformation. These results would be anticipated by the usual transformer diagram. It is even possible that with a large secondary inductance the angle a may change its sign. Tests 4 and 6 show that the frequency has an important effect. It is also to be expected that the wave-shape of the current will have an influence on the action of the transformers.*

It appears that even with well-designed transformers phase-lags of the order of 2 deg. may be introduced if the secondary circuit has too high a resistance. This would involve an inappreciable error in the reading of a wattmeter with a non-inductive load, but with a load of power-factor 0·7 the error would reach 3·5 per cent. This error would be partly compensated by the change in the ratio of transformation.

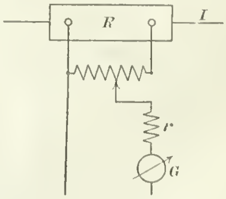

FIG. 3.

The method described above can be applied to potential transformers with suitable alteration of the order of magnitude of the quantities involved and the measurements are simplified. The resistances R_1 and R_2 would be high resistances of fine wire. In a test on a transformer for 6,000/150 volts made at 5,200 volts the following results were obtained for the ratio of transformation E_1/E_2 and the phase-lag a:

Secondary resistance.	E_1/E_2		a
105,000 ohms	39·65	......	+ 18′
2,500 ohms	39·70	......	+ 10′
250 ohms	40·35	......	− 12′

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* *See* Agnew, "Bulletin" of the Bureau of Standards, VII., 1911, p. 123-171.

The first point approximates to the no-load conditions; the second point refers to the case of the transformer loaded with an electro-dynamic voltmeter and the third point to the case of the transformer loaded with several thermic instruments in parallel.

The tests described show the importance with current-transformers of making the secondary connections to the measuring instrument of sufficient sectional area and the necessity of avoiding the insertion of other measuring instruments, ammeters, wattmeters or relays that introduce a supplementary voltage drop.

References to previous work :—

E. Orlich, "Electrotechnische Zeitschrift," XXX., 1909, p. 435 and 466.

C. H. Sharp and W. W. Crawford, "Proceedings" of the A.I.E.E., XXIX., 1910, p. 1207.

E. B. Rosa (VI., 1909, p. 1), M. G. Lloyd (VI., 1909, p. 281), T. T. Fitch (VII., 1911, p. 423), F. B. Silsbee and P. G. Agnew (X., 1914, p. 279), "Bulletin" of the Bureau of Standards.

A. Campbell, XXII., 1910, p. 207, "Proc." of the Physical Society of London.

QUANTITATIVE MEASUREMENTS AT WASHINGTON ON THE SIGNALS FROM THE GERMAN RADIO STATIONS AT NAUEN AND EILVESE.*

BY L. W. AUSTIN, PH.D.

Since September, 1914, the strength of the signals received from Nauen and Eilvese has been measured almost daily at the U.S. Naval Radio Laboratory at the Bureau of Standards. The antenna at the laboratory has an effective height of 30 metres. It is a flat top, 450 ft. long, having two wires about 2 metres apart, 59 metres high at one end and 17 metres at the other. Its resistance at the longer wave-lengths is considerably lower than the one formerly used.

The circuits used for reception are shown in Fig. 1. The detector is the de Forest audion, with an extra coupling, L_3L_4, for producing local oscillations. The current-flow in the audion is naturally unstable, as in the Poulsen arc. This instability tends to produce oscillations, the period of which is determined by the circuit $L_2L_3C_2$. These oscillations are strengthened in the circuit PC_4F, and this increased energy is returned to the circuit $L_2L_3C_2$ through the coupling L_3L_4, thus sustaining the original oscillations, which otherwise tend to break.

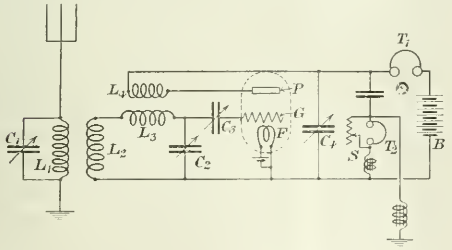

Fig. 1.—Circuits used for Reception.

In the reception of signals from high-frequency machine or arc stations, the receiving audion circuit is so adjusted that the local audion oscillations are slightly out of tune with the incoming oscillations. The combination of the two sets of oscillations produces beats of a frequency which can be heard in the receiving telephones. The pitch of the beats can be adjusted at will by regulating the amount of detuning.

The strength of signal is measured by the shunted telephone method, in which a non-inductive shunt s is placed across the telephones T_2 of the audion and reduced until the signals just remain audible. If I is the value of the current-pulses in the unshunted telephones, and I_0 the current which is just audible, $I/I_0=(t+s)/s$, where t is the effective telephone resistance for the given beat frequency and s the resistance of the shunt which just permits signals to be heard. The ratio I/I_0 is called the audibility of the signal. It has been shown † that the audibility in the oscillating audion is proportional to the current in the receiving antenna, instead of to the square of the current, as in the electrolytic, the crystal-contact detector, and the non-oscillating audion.

The oscillating audion is calibrated by comparing the audibility of a given signal with the deflection produced on a galvanometer attached to a silicon detector by the same signal.* Just before each experiment the silicon detector is calibrated by comparison with a thermo-element in the artificial antenna. It has been found that when the circuits are properly adjusted the sensitiveness of the de Forest bulbs varies very greatly for slight changes of adjustment, so for measurement purposes it is important that the adjustment be made in exactly the same way. One of the most reliable methods is to tune the antenna and closed circuits with loose coupling and then, leaving the antenna unchanged, bring up the secondary and retune it at the best coupling. Using Baldwin telephones of 2,000 ohms direct-current resistance and a sensitiveness of 5×10^{-10} amperes at 1,000 cycles for normal ears, the least audible signal represents about $1{\cdot}5\times10^{-15}$ watts in the receiving system. The audibility increases as the square-root of the received energy. The proper adjustment of the main coupling appears to make the sensibility within wide limits practically independent of the resistance of the secondary and of the wave-length.

The results of the observations on Nauen and Eilvese from Jan. 1 to July 1, 1916, are shown in the curves of Fig. 2. The most striking thing about these curves is their remarkable variability, the received current varying from 1×10^{-7} amperes to 80×10^{-7} amperes; that is, from about 25 audibility to more than 2,000 audibility, with the method of adjustment used. The cause of these variations is not entirely clear. In some earlier experiments † it was thought that probably the variations were, to a considerable extent at least, due to observational errors, but it seems now fairly certain that under normal conditions of atmospheric disturbances the limits of observational error are 20 to 30 per cent., while in extreme cases the limit may be two to one, which will not go far toward explaining these large changes in observed current.

It is now believed that the variation in intensity is due, for the most part, to an irregular reflection or possibly refraction in the upper atmosphere, which brings to the receiving station energy in addition to that which travels along close to the surface of the earth. It is also probable that there is a certain amount of absorption due to the ionisation of the atmosphere. Marconi has stated that between Glace Bay and Clifden, Ireland the signals are weaker during the presence of marked low barometer areas between the stations, and the present work seems to support his statements to some extent. There seems to be some reason to believe that regions where atmospheric disturbances are pronounced may be also regions of absorption.

Prof. Sommerfeld and his students have developed a theory of the transmission of waves over a good conducting surface like salt water, which may be approximately expressed by the following formula : ‡

$$I_R=377\frac{h_1h_2I_s}{\lambda dR}\,.\,e-\frac{0{\cdot}0019.d}{\sqrt{\lambda}}\quad.\;.\;.\;.\;.\;.\quad(1)$$

where I_r is the current in the receiving antenna, I_s the current in the sending antenna, h_1 and h_2 the respective heights of the centres of capacity of the sending and receiving antennas, λ the wave-length, d the distance, and R the resistance of the receiving system. The currents are expressed in amperes and the lengths in kilometres. The equation takes no account of the possible return of some of this lost energy from the upper atmosphere, and it seems probable that this equation is fairly correct for the signals on the worst days. The formula for received current used by the Navy Department makes use of the same Hertzian term as equation (1), but employs an exponential term which was derived empirically from the observations made during the long-distance tests made in 1909 and 1910.§

$$\text{Navy formula}\qquad I_R=377\frac{h_1h_2I}{\lambda dR}\,.\,e-\frac{0{\cdot}0015.d}{\sqrt{\lambda}}\quad.\;.\;.\;.\;.\;.\quad(2)$$

This formula was intended to represent the average value of received current over salt water in the day-time, and appears, so far as can be certainly determined, to give results which are correct within the limits of observational error, at least up to 3,600 nautical miles.

The observations shown in the curves of Fig. 2 were taken in general between the hours of 9 and 11 a.m., Washington time, and therefore represent the signals transmitted from Germany to America when daylight covers the whole path of transmission. After sunset in Germany—that is, when the path of the signals lies partly in darkness and partly in daylight—the intensity of reception is often very much weakened as though there were a backward reflection from the shadow wall.

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* From the "Journal" of the Franklin Institute. Slightly abbreviated.

† "Journal" Washn. Acad., 6, p. 81, 1916.

* On account of atmospheric disturbances this calibration is made on an artificial antenna having the same constants as the real antenna, the signals being produced by a second oscillating audion in the laboratory.

† "Bulletin" Bureau of Standards, 7, p. 315, 1911.

‡ A. Sommerfeld, "Ann. der Phys.," 28, p. 665, 1900; also H. March, *Ibid.*, 37, p. 29, 1912; W. von Rybczynski, *Ibid.*, 41, p. 191, 193; and J. Zenneck, "Lehrbuch der drahtlosen Telegraphie," p. 294.

§ "Bulletin" Bureau of Standards, 7, p. 35, 1911, Reprint 159, and "Bulletin" Bureau of Standards, 11, p. 69, 1914, Reprint 226.

Very few observations have been taken during the hours when the whole path of the signals lies in darkness, but these indicate that the variation between day and night at these wave-lengths is not greater than that noted on different days.*

The average observed received current for each month is given in the table, as well as the values calculated from the Sommerfeld theoretical formula and from the Navy formula.

The currents as calculated from the theoretical formula are seen to be less than one-tenth of the average observed values, but if the square-roots of the theoretical values of current be compared with the observed curves it is found that some of the minimum points are in fairly good agreement. The formula developed by H. M. Macdonald† would apparently give even smaller values than equation (1).

The table shows that the signals during April and May were stronger even than during the winter, and that this period of strong signals was followed by a very decided drop in June. These seasonal variations, as well as the daily variations shown in Fig. 2, are almost certainly connected with atmospheric changes, but these may to a considerable extent take place at heights above the ordinary range of meteorological observations. It is possible that the decrease in intensity in early summer may be connected with the southward movement of the low pressure area of the North Atlantic. It is known that the seasonal changes at great heights lag behind the corresponding surface changes.‡ The study of these relationships, while it is of great interest, must wait until more observations are available.

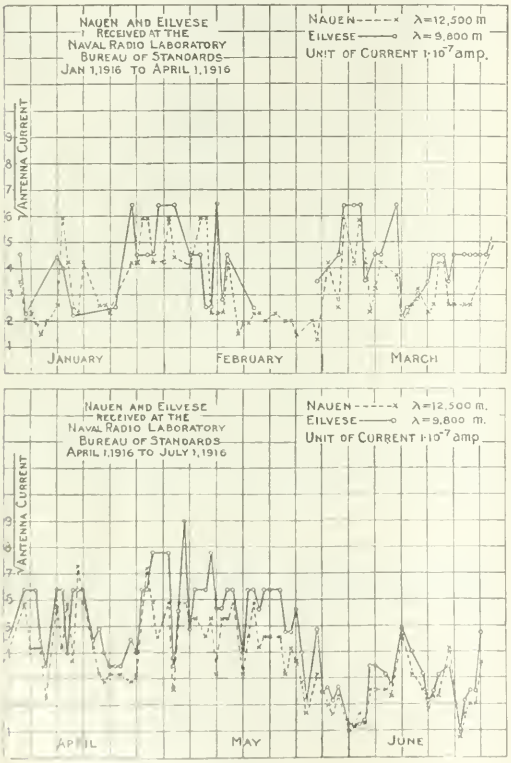

FIG. 2.

Monthly Averages of Observed Received Current.

1916.	From Nauen, amperes.	From Eilvese, amperes.
January	$13.2 \cdot 10^{-7}$	$19.5 \cdot 10^{-7}$
February	10·4	18·2
March	12·6	20·8
April	22·4	29·0
May	21·6	33·8
June	6·2	8·5
General Average	14·4	21·6
Calculated.		
From equation (1)	0·95	1·91
From equation (2)	14·3	22·2

Data for Calculation.

	I^s Amp.	h_1 Met.	h_2 Met.	d Km.	λ Met.	R Ohms.	$e^{-\frac{0.0019d}{\sqrt[3]{\lambda}}}$	$e^{-\frac{0.0015d}{\sqrt{\lambda}}}$
Nauen	...150*	150	30	6,650	12,500	124	0·0039	0·058
Eilvese	...140*	150	30	6,100	9,800	93	0·0045	0·052

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

I. INTRODUCTORY NOTE.

In the process of training various assistants in the work of designing continuous-current electrical machinery, it happens naturally that from time to time the problem of balancers has to be dealt with. Some assistants, of a not too inquiring temperament, accept the known facts and results of past experience on the part of others without much question, and, taking everything for granted, are content to design such sets more or less on trust that what has been will be repeated; others, again, obviously more valuable in the design office, prefer to discover a little more of the reasons behind the various processes in a three-wire system, but are faced with the difficulty that when they wish to read for themslves something more about balancers, and especially rotary balancers, from the point of view of design, than there is time to tell them in the course of the work of an ordinary commercial design office, there is very little collected information to be found anywhere. Most text books, written by men experienced enough to take so much for granted that they forget that they once had to get down to the understanding of the details themselves, merely make statements about what happens; and the average student does not appear to absorb any very clear ideas during his theoretical training about the nature of the process, probably because he is not called upon at that stage to put his knowledge to practical use. This article is an attempt to put down some notes on the general subject of balancers for three-wire continuous-current systems, with more particular reference to the changes which take place in the various parts of a rotary balancer, as it is apparently on that part of the subject that least information of the kind indicated is available. As the method of treatment has been developed in consequence of actual discussion, with an assistant, of difficulties as they arose, it is hoped that it may prove useful to others of an equally inquiring turn of mind.

II. EARLY THREE-WIRE SYSTEMS.

The general arrangement and properties of a three-wire continuous-current system are too well known to need any detailed explanation. Briefly, it may be said that it consists of two ordinary two-wire systems side by side, as shown in Fig. 1, arranged with the negative main of System I. at the same potential as the positive main of System II. by having these two mains actually embodied in one. Each system by itself sends current in the direction indicated by the arrows, but, owing to the common middle wire, the two currents are superposed in this part of the combined arrangement, and the middle wire carries only the difference of the currents of the two systems. The direction of current in the middle wire will be in to, or out from, the common terminal of the two dynamos according as the load on System I. is greater than, or less than, that on System II., and when the two sides are equally loaded the middle wire carries no current at all, and the two dynamos are simply in series with each other. The result thus is that, when the sides are unequally loaded, a current equal to that of the less-loaded side may be considered as flowing through the two sides in series, and superposed on this there is a current on one side only, flowing in one dynamo only, and adding itself, as an out of balance current with respect to the two sides, to that flowing equally on both sides, and, therefore, balanced. The middle wire carries this out of balance current only, and as it cannot therefore ever have in it more than the full load of one dynamo, it need not be larger than the outer mains. Hence the full power of the two dynamos can be distributed with three mains instead of four, the two outers being of the same size as would be needed for each main of the original pair of two-wire systems, and the middle wire being no larger than each of the outers. Thus the copper in the mains is, at most, three-quarters of what it was before with two separate two-wire systems, and it may be as little as one-half as an absolute minimum, in the ideal case where the two sides are always equally balanced. Practically, as is well known, neither extreme occurs, and the middle wire has a section less than each of the outer wires, because systems are arranged for as nearly perfect balancing as possible, with the definite knowledge that this can never be absolutely obtained. Were it possible to work all the apparatus on a system at the same voltage, there would be no need for a three-wire system at all, as everything could be connected across two mains, but with the increase in size of distribution systems, higher and higher voltages have been successively necessary, until the present, though not, therefore, final, stage has been reached of continuous current transmission at 500 volts. Motors of all but the smallest sizes are easily arranged for connection right across the outer wires, and, therefore, need no balancing as between the two sides; but lighting has not yet reached the stage of working generally at voltages higher than 250. Hence a middle wire becomes necessary, as it is not usually suitable to couple up lights two in series; this would make it impossible to have sufficient subdivision of lighting. The lighting load is, therefore, likely to be unbalanced, and means must be provided for dealing with the difference in current between the two sides. A three-wire system, therefore, besides distributing energy economically as regards the size of its mains, also allows the connection to the system, in an extremely simple manner, of apparatus requiring half the total pressure only. In the early days of enthusiasm about three-wire systems, it was proposed to extend the principle to five-wire systems, equivalent to four two-wire systems side by side, but although there have been instances of this vastly more complicated arrangement being carried out, it is never now used for new installations because all usual requirements can be met by the two voltages 250 and 500 (or down to 200 and 400 as a usual lower limit), and any special apparatus requiring a lower pressure, such as, say, a cinematograph arc lantern, can be specially dealt with by using a motor-generator to transform down from 500 volts to the lower value of 70, or by other suitable means in other cases. All this is well known, and is put down here briefly merely for the sake of completeness.

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* The well known increase in strength of night signals is a function both of the wave-length and of the distance. Wave lengths of 10,000 and 12,000 metres will probably begin to show distinct strengthening at night at a distance of about [illegible] miles.

† See Eccles' Wireless Telegraphy, p. 161, 1916.

‡ See W. R. Blair, Bulletin of the Mt. Weather Observatory, U.S. Weather Bureau, Vol. 6, part 4, p. 179, 1914.

* As given in 1914.

III. Early Types of Dynamos for Three-wire Systems.

It will be noted in Fig. 1 that the generating part of the system consists of two independent dynamos. As is shown later, it is absolutely necessary to connect the middle wire to a point of definite potential as nearly as possible midway between that of the two outer wires, and the arrangement shown in Fig. 1 is merely the earliest and most obvious way of doing this. It has the advantage that the voltage on the two sides is capable of independent adjustment, but it is clear that such a set has many drawbacks. Composed as it is of two machines instead of only one of the same total power, it is likely to be less efficient, to occupy more floor space, and, if arranged to be driven from one source of power, to require more exact lining up of bearings, because of their greater number, which tends also to make greater care in running necessary.

Various alternative means of getting a tapping point for the middle wire have, therefore, been devised, all with the object of avoiding the disadvantages of the original scheme. One of the earliest was to have two windings on one armature, with two commutators, that is, practically to combine the two dynamos into one as regards their field, but to leave the rest in principle more or less unaltered. This still has disadvantages, such as great length between bearings, two sets of brush gear to attend to, and consequently more parts to go wrong than in a single ordinary machine, and is actually less good than two dynamos, because the two windings, being in one field, cannot have their volts independently regulated.

Later attempts, therefore, were directed towards using one machine only, with some accessory part, not a commutator, to enable the middle wire to be attached to a point half way between the potentials of the outers. One scheme used a machine with each pole divided into two parts, so that, say, a two-pole machine looked like a four-pole machine, but actually had two north poles adjacent and two south poles adjacent, instead of opposite. It is possible to put on the commutator a brush opposite one of these gaps without getting excessive sparking, and such a brush will obviously be intermediate between the others in potential. It can be kept exactly half way between by suitably winding the various poles of the machine with compound winding, and the middle wire of the system may therefore be attached to this brush. This machine, due to Dettmar & Rothert, is described in some detail in a Paper read before the National Electric Light Association in 1907 by B. Frankenfield, which was abstracted in the issue of The Electrician for November 8, 1907. The same Paper gives a description of Ossana's arrangement, in which an auxiliary winding is placed in the slots of the armature, and so divided up into sections and connected at points to the main winding that tappings can be brought out to a slip-ring which thus becomes the middle point, in potential, of the dynamo, and may therefore have the middle wire connected to it. This is in many ways equivalent to incorporating a static balancer winding, described later, into the dynamo itself, but it has the very obvious disadvantage of absorbing valuable and costly space in the part of the machine where it can least be spared, thus increasing the whole size of the frame in such a way as to make it cost more than it does to use the external stationary windings of a static balancer.

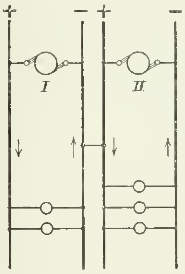

Fig. 1.—Elementary Three-wire System.

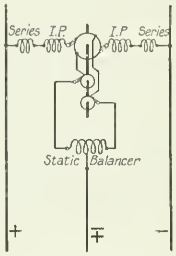

Fig. 2.—Connections of Field Windings in a Three-wire Dynamo with Static Balancer.

Still another arrangement, proposed by Pilger in the "Electrical World" for July 20, 1912, had an auxiliary winding also on the main armature, but differently arranged from Ossana's. It is apparently somewhat simpler than the latter, but has the same disadvantage of taking up valuable space on the machine, and, in common with all three-wire dynamos, is characterised by the imperfection that the voltages on the two sides cannot be independently regulated.

IV. GENERAL NOTE ON BATTERIES AS BALANCERS; ON STATIC BALANCERS AND ON ROTARY BALANCERS.

The arrangements already described are of more or less historic interest, and the apparatus for balancing continuous-current three-wire systems now consists usually of one of three alternatives, namely:—(*a*) A battery, (*b*) a rotary balancer, (*c*) a static balancer.

The first and second alternatives are in many respects cognate in character. Each of them works along with an ordinary two-wire dynamo which is coupled directly across the outer wires, the middle wire being connected to some point on the balancing arrangement in such a way that the out of balance current can return to the main dynamos only through one of the outer wires. There is, in this case, no connection between the middle wire and the armature winding of the main dynamo except through its commutator, and the practical result is that the positive brushes and the negative brushes are always dealing with the same current, and the distribution of load round the armature is in no way different from what it is in an ordinary two-wire system. The series windings and interpole windings, if any, may be arranged all on one electrical pole without in any way interfering with the working of the system, and any number of such main dynamos may be run in parallel with each other with no more complication than is demanded by the usual equalising arrangements. A battery used as a balancer, or a rotary set, may be made, by hand regulation or automatically, as the case may be, to adjust the voltages of the two sides of the system so as to have any predetermined relation to each other, and is, therefore, superior in this respect to any arrangement employing a three-wire dynamo. The principal difference between a battery and a rotary balancer is that while the former has an E.M.F. of its own which will enable it to give out energy to the system after it has been suitably charged, the latter cannot as a whole deliver any energy to the system, but can only transfer it from one part of the system to another.

The static balancer, which is the third alternative, is a piece of apparatus connected up directly to the armature winding of the main dynamo through special slip-rings, and the middle wire current, passing through the balancer and these rings, does not go through the outer wires, and therefore gets back to the dynamo without passing through the commutator at all. Thus, with a static balancer it is possible to have the full out of balance current on one set of brushes on the commutator, and no current at all on the other set. This necessitates a special arrangement of series and interpole windings, shown in Fig. 2, one half of each winding being connected to each electrical pole of the dynamo. This is done for two reasons: first, because in this sort of balancing the difference of voltage between the two sides of the system depends on the resistance drop in the armature and balancer, and, in order to make the two sides symmetrical, the resistance on each side must be the same; and, second, because if one side were carrying load and the other were not, it might happen that, if the interpole and series windings were all on one pole only, they would be carrying no current at all, and hence would be useless for their intended purpose. But if the windings are each divided, there is always a part of them in action, and the average result is that compounding is maintained correctly and the interpoles are acting sufficiently to maintain good commutation. But this necessity of splitting the windings causes considerable difficulty in arranging the equalising connections between such dynamos, if run in parallel with other three-wire machines, or with two wire machines supplying the outers only, in which case the static balancer looks after the middle wire for the whole system and distributes the out of balance current only amongst those dynamos which are connected to it. Any two-wire dynamo so used must equally with the three-wire sets, have its series and interpole windings split because it would not be correct to equalise the whole of the series windings of one machine with only half of those of another. Actually two equalisers are needed, connected to the series windings on both sides of the dynamos and this causes the difficulty referred to, namely, that the equalising cables are a possible source of a short circuit between the armatures of the two machines unless their voltages are very carefully adjusted before connecting them in parallel with each other. This makes it necessary to have extra circuit-breakers in this part of the circuit, so as to guard against possible damage from this cause, and consequently the switchgear, as well as in some circumstances the cables from the dynamo to the switchboard, may be greatly increased in cost. This should be debited against the three-wire dynamo in any comparison between it and a two-wire machine with a rotary balancer, as although the latter certainly also involves additional switchgear, its current capacity is small compared with that of the main machine; and if simplicity of working is of any value, there may be just as much to be said for the rotary set as for the static set. As has already been said, it is not possible to regulate independently the voltages on the two sides of a system using a static balancer, and this may be a further point against the arrangement, although in most cases the very small drop in volts which takes place is not likely to be objectionable. It is interesting to note in regard to working three-wire dynamos in parallel, each with a static balancer coupled to the middle wire, that there is no need to synchronise the alternating currents which are obtained from the slip-rings, nor does difference of frequency between the two machines matter at all. This is the case because the middle wire is connected to points in the alternating current systems of the static balancers between which and the outer wires there is, for all practical purposes, not an alternating, but a steady, difference of potential. Thus at the points joined together when the sets are in parallel there is no need to consider synchronising, or frequency, as the alternating-current systems are not, for themselves, really paralleled at all, and, therefore, phase difference or frequency difference does not matter. The correctness of this is borne out by experience.

This comparative statement of some of the merits and demerits of the systems which are practically used should be sufficient to indicate which is likely to be best for any given case. It must be remembered that even if the rotary balancer and its accessories should in some cases be more costly and need a little more attention than the static balancer, it is the more flexible and adjustable arrangement of the two, and advantages must always be paid for. It is scarcely possible to lay down any general rule to determine the selection of a system for all cases; in many instances the static balancer is quite good enough, while in others it is absolutely necessary to have the additional advantages of the rotary type.

V. THREE-WIRE SYSTEM WITHOUT A BALANCER.

In proceeding now to a consideration of some of the theory of balancers in detail, it is interesting in the first place to consider what would happen in a three-wire system if the potential of the middle wire were not constrained by some sort of balancing arrangement to remain more or less midway between the potentials of the outers. Fig. 3 shows such a system, and it is clearly unworkable. The object of all supply authorities is to give their consumers energy at a constant pressure within more or less close limits, and the disturbances caused by change of load on a system with an uncontrolled middle wire would be intolerable.

D is the main dynamo across the outers, supplying current at $2V$ volts. Consider first the case of two motors, A and B, across the outers in series with each other, and not mechanically coupled together in any way; and suppose that there is, meantime, no other load on the system. Each motor has to develop a torque equal to the resisting torque of its load in order to keep going. As the motors are in series, the same current is obviously passing through both of them under all circumstances, and if the external torque in each case is balanced by the torque produced in each motor by the same current, the system is stable. If e_1 and e_2 and r_1 and r_2 are the back E.M.F.s and resistances of the two machines respectively, the current is, neglecting the field, $\{2V-(e_1+e_2)\}/(r_1+r_2)$, and the voltages on the two sides of the system are, respectively,

$$e_1+[\{2V-(e_1+e_2)\}r_1/(r_1+r_2)] \text{ and } e_2+[\{2V-(e_1+e_2)\}r_2/(r_1+r_2)].$$

If we assume that $e_1=e_2$ and $r_1=r_2$ then these voltages are equal at the moment considered. But if now one motor, say on the left-hand side, be overloaded, it will not have enough torque to keep on driving its external load, and it will, therefore, drop in speed. This means an immediate drop in e_1, so that momentarily e_1+e_2 is diminished, and more current passes. This current, while tending to keep A up to its load, produces in B more torque than the latter requires for its load, and consequently B accelerates, as there is nothing else for it to do. Thus e_2 increases, and the current is kept down in consequence. This process goes on, A continuing to drop in speed and B to rise, simply because the system attempts to reach some stable position where there will be no further tendency to change; and this stable condition will be reached when A has stopped, and B has run up its speed so as to make e_2 just so much different from $2V$ as will allow the original current, $\{2V-(e_1+e_2)\}/(r_1+r_2)$, to flow, assuming that, during the process of changing the speed, the torque has not changed. Under these circumstances, the new e_2 will be equal to the old e_1+e_2, and B will have doubled its speed, while A has no speed at all. If the external torque on A were to fall off with reduced speed, and that on B to increase with increased speed, as might happen with certain classes of driven loads, some intermediate position might be reached where the current required to keep both motors going was the same, and then the system would become stable; but it is clear that, under the worst circumstances, the result of adding load to one side is to reduce the voltage on that side to practically zero, and to run the other side up to a voltage of practically $2V$ volts. The same thing applies if, instead of overloading A, another motor be switched in on the same side as A, as this means that B, carrying momentarily the current of A and the new machine, accelerates as before, increasing e_2, with corresponding diminution in e_1, and the process continues up to the same point as has already been indicated. This means that consumers would be so dependent on each other for the steady running of their motors that the system would be entirely unsatisfactory. In practice most motors are put across the outers, but smaller machines are coupled across half the total volts, and the foregoing description shows what would happen to these. There would simply be no stability at all.

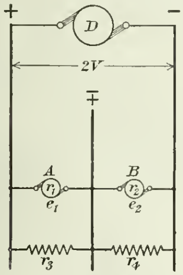

FIG. 3.—THREE-WIRE SYSTEM WITHOUT A BALANCER.

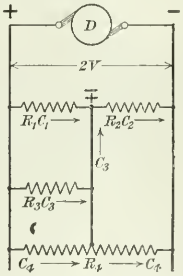

FIG. 4.—ELEMENTARY BALANCER.

Consider now the case of the other sort of circuit that may be fed from such a system, namely, a dead resistance, that is, a circuit with no E.M.F. in it, such as lamps or heaters or cookers. Let there be r_3 ohms on one side and r_4 on the other, and suppose everything else is switched off for the moment. As before, the same current flows through r_3 and r_4, and if these two resistances are equal, the voltages on the two sides are equal. If, however, r_3 be reduced, the total current is increased, since r_3+r_4 is less than before, but, as r_3 is less than r_4, the difference of potential across r_3 is less than that across r_4. Now r_3, when reduced, corresponds to the motor which became overloaded, because r_3, had the voltages remained equal, would take more current than r_4. But the latter will not let it do so, just as B refused to let A take the current it needed. Hence, when the middle wire potential is uncontrolled, the kind of result is the same in the two sorts of cases: the side which is overloaded, or tries to become overloaded, has its voltage lowered, and the other side necessarily has its voltage raised, in the process of becoming stable again.

VI. EQUIVALENT RESISTANCE OF THREE-WIRE SYSTEM.

While an actual load will consist of motors and lights and all sorts of other apparatus, it is possible to consider the whole replaced by one equivalent resistance. For every sort of apparatus takes some definite value of current for what it has to do, and as this current could be produced by allowing to act, across some ascertainable resistance, the same difference of potential as exists on the side of the system considered, it is possible to consider that piece of apparatus, even if it contain E.M.F. of its own, as replaced by such a resistance as would allow the same current to flow as is actually flowing in the circuit. For example, a motor running on V volts, with a back E.M.F. e, and a resistance r, allows $(V-e)/r$ amperes to pass. The equivalent resistance is, therefore, $Vr/(V-e)$. In all that follows, the circuit will be considered to contain resistance only, and all that is deduced for this condition will be universally true, although the sort of process taking place in apparatus replaced by equivalent resistances, as the system passes from one stable condition to another due to some external influence, may be quite different from that going on, under the same conditions of change, in the circuits which really contain resistance only. It is useful during the further consideration of the subject sometimes to go back mentally to the various sorts of circuits which may be taking current and see that the theoretical treatment applies correctly to anything that may be connected across the mains. All the actual and equivalent resistances so determined may clearly be further replaced by one circuit containing resistance only, of such a value that, under the action of the difference of potential actually existing, it carries the same total current as is at any moment passing from one main to another, this circuit being therefore equivalent, for the present purpose, to the whole network at any time.

VII. THREE-WIRE SYSTEM WITH MIDDLE WIRE CONNECTED TO ELEMENTARY BALANCER.

It is now possible to see the effect of putting a balancer of some sort across the outers, and connecting its middle point definitely to the middle wire. For the present preliminary purpose it will be sufficient to consider a balancer consisting merely of two equal resistances R_1 and R_2 as shown in Fig. 4. The equivalent circuit resistance is broken up into two parts, R_3 and R_4, such that R_4 may be considered to be carrying the same current on both sides of the system, and represents, therefore, the balanced part of the load, while R_3 represents the additional resistance on the overloaded side, necessary to be put in parallel with the part of R_4 on that side, in order to carry the surplus, or out of balance, current flowing there. It is clear that there actually are values of R_4 and R_3 which will give the desired result, though they may not always be readily ascertainable as the relation of the parts of the circuit change, and R_4 may change its value, consequent on changes in R_3, in order that R_4 may remain consistent with its definition. The two parts of R_4 are always in the same ratio as the voltages on the two corresponding sides of the system, as only then will the same current flow through the whole of R_4. Assuming R_3 and R_4 to be found, consider what happens in the system. First of all, think of R_3 as infinite: then the balancer carries a balanced current for itself, and R_4 is carrying a balanced current for itself, and the voltage on each side is half the total, namely, V, since $R_1=R_2$. Now suppose R_3 is switched in: it has been shown that the necessary effect of this is to reduce the voltage on the side containing R_3. Incidentally this alters R_4, and some new value must be found for the equivalent of the balanced part of the circuit; but R_4 carries C_4 amperes, and R_3 carries C_3 amperes. In the case already considered, without a balancer of any sort, C_3 could not exist, because there was only one path across the system, in which the total current had necessarily to be the same at all points. Now, however, there is the alternative path through R_2. The reduction in voltage on the left-hand side of the system, and the consequent increase of voltage on the other side, makes C_1 now less than C_2, these currents previously having been equal. As, therefore, in the balancer there are the unequal currents C_1 and C_2 and in the other part of the system the unequal currents C_3+C_4 and C_4, and as the sum of currents flowing out of a point is necessarily equal to the sum of currents flowing into it, there will be a current flowing upwards in the middle wire from the right-hand end of R_3 to the junction of R_1 and R_2, since some current in this direction will be necessary to fulfil the condition just laid down for both parts of the circuit. The voltage will keep on changing until the current so flowing represents the difference of the other currents at both points, that is, until the middle wire current is equal to C_2-C_1 as well as to $C_3+C_4-C_4$, or C_3. Note again that R_4 must be considered to be still changing with each change of voltage, but suppose, as is quite true, that R_4 and C_4 have at every moment some definite value, leaving R_3 to carry whatever current, C_3, is still unbalanced. The stable result, therefore, when R_3 exists as well as R_4, is that a balanced current, C_4, flows across R_4, and an out of balance current, C_3, actually flows along the middle wire towards the balancer, and finds its way back through R_2 to the negative pole of the dynamo, as is shown by the fact that $C_2-C_1=C_3$ is the necessary condition of stability. A limiting case occurs when R_4 is infinite, in which case no current could pass through R_3 at all if there were no balancer. But if R_1 and R_2 are present, then, as before, C_3 can find its way back to the dynamo through R_2, and the voltages will again adjust themselves until $C_2-C_1=C_3$, C_3 then being equal to the final value of the voltage on the left-hand side of the system, divided by whatever value R_3 may then have. All this simply means that the addition of some balancing arrangement, such as is represented in a very primitive form by R_1 and R_2, while it does not alter the fact that the total current across the system is the same on both sides, including the balancer part, does make it possible to have unequal currents on the two sides, external to the balancer, in the consumers' part of the system. That is, while $C_1+C_3+C_4$ is exactly equal to C_2+C_4, C_3+C_4 is not the same as C_4. The elementary form of balancer here used as an illustration necessarily makes the voltages on the two sides of the system unequal, because, although the total current on each side is the same, the total resistance on each side is not the same, but is less on the side which is overloaded by consumers. How far this inequality of voltage can be remedied by the various practical devices employed for balancing will be shown in what follows, but the general principle of all apparatus so used is as above described, or is only some simple modification of it, and it will be found that even in cases where the P.D. between the mains does not change when out of balance load is switched on, or actually becomes greater on the loaded side than it was on light load, other E.M.F. relations of the system are compelled to adjust themselves to allow a balancing current to flow.

(To be continued.)

POLYPHASE ALTERNATING-CURRENT COMMUTATOR MOTORS WITH SHUNT CHARACTERISTICS.

Alternating-current motors for driving machine tools and for similar service should have practically the same characteristics as the adjustable speed shunt wound continuous current motor. The features which make the continuous current motor so desirable for machine tool work are:—

1. The practical constancy of speed under varying loads.
2. The simplicity and ease with which the speed may be altered to meet requirements.
3. The wide range over which such adjustment is possible.

The first of these is also characteristic of the squirrel-cage induction motor which, in its simplest form, is essentially a single speed machine. It can be designed to run at either of two speeds, one of which is just twice the other, and, by providing an additional winding, at two other speeds bearing the same ratio to each other. A motor of this kind for use on a 50 cycle circuit, for example, might have windings designed for synchronous speeds of 1,500, 1,000, 750 and 500 revs. per min., but no intermediate speeds would be possible without considerable and complicated additions to both motor and control gear. In cases where it is desired to run a machine at two, three or four definite speeds bearing a simple ratio to each other and frequent changes from one speed to another are not necessary, this type of motor is quite satisfactory. Like all squirrel-cage motors it is not adapted for starting under heavy loads. This type of motor has been extensively used for driving small machine tools, and in larger sizes for textile printing machines, &c. The larger sizes are, however, open to objection on account of the occurrence of relatively heavy current rushes when a change is made from one speed to the next.

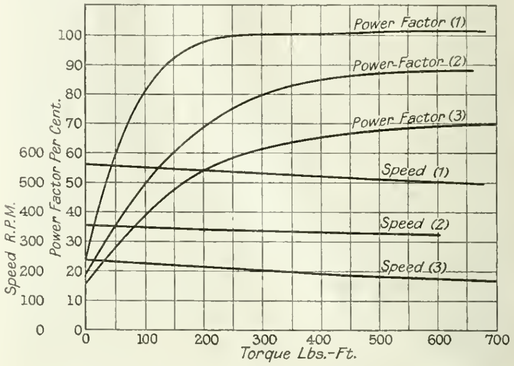

Fig. 1.—Power and Speed Curves of B.T.-H. Polyphase Commutator Motor. Full Load Torque, 485 lb. ft.

The normal slip-ring type of induction motor is also essentially a single speed machine, although the speed can be varied over a wide range with the greatest ease by introducing and regulating suitable resistances in the rotor circuit. When operated near synchronism its characteristics are similar to those of a shunt wound continuous current motor. At lower speeds they partake more and more of those of heavily compounded and series motors, and the plain slip-ring motor is therefore unsatisfactory in cases where it is desirable to have practical constancy of speed under varying load, such as is obtained with the adjustable speed shunt wound continuous current motor.

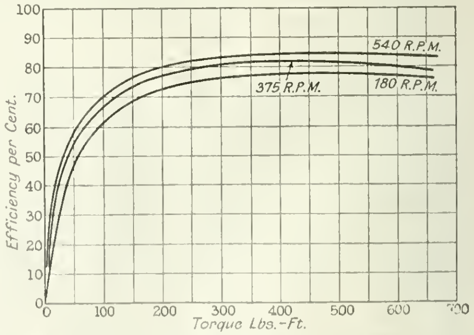

Fig. 2.—Efficiency Curves of B.T.-H. Polyphase Commutator Motor.

Like the squirrel-cage motor the slip-ring motor can be designed to run steadily at either of two speeds, one of which is twice the other, but this generally involves the use of three additional slip-rings and a more complicated controller. Such a motor has good starting properties and can often be used where only two steady speeds are required. As in the case of the squirrel-cage motor additional windings may be fitted to give a further choice of steady running speeds, but the complication and cost of the motor and its control gear then become excessive.

The use of a changeable pole squirrel-cage motor in cascade with a slip-ring motor affords a means of obtaining three definite running speeds, the ratios of which will depend on the numbers of poles in the machines. For instance, a 12-pole slip-ring motor in combination with a squirrel-cage motor designed for 4 and 8 poles will have synchronous speeds of 500, 375 and 300 revs. per min. when operated on a 50 cycle circuit. Combinations of this kind are generally too expensive and complicated for use in small sizes, but the main and auxiliary motor may be combined in one machine with considerable advantage. This has been done under Hunts patents. Cascade motors of this kind are on the market. They are subject to the limitation that one number of pairs of poles must be twice the other so that the maximum and minimum speeds are in the ratio of three to two. These machines are generally arranged for operation at the minimum speed; intermediate speeds can only be obtained by the use of regulating resistances as in the case of the ordinary slip-ring motor and, therefore, at the expense of constancy of speed under varying load and with greatly reduced efficiency.

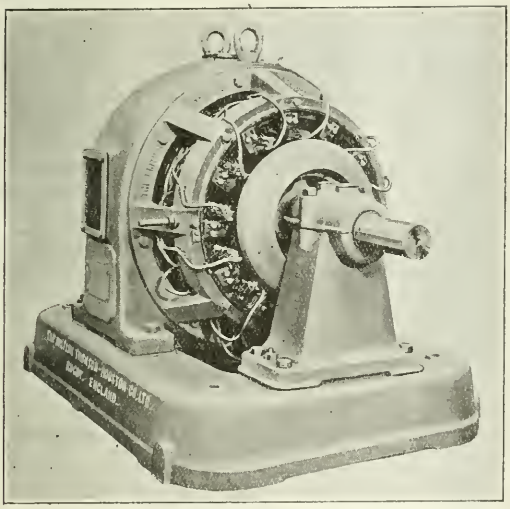

Fig. 3.—Polyphase Commutator Motor, 50 h.p., 540–180 revs. per min.

Each of the motors and combinations described above has its own special field of application, but none has the same operating features as the adjustable speed continuous current motor, and in view of the very general distribution of electric power by alternating current systems there is a wide field for an alternating current motor with the same characteristics.

To meet this requirement the British Thomson-Houston Co. has introduced an improved type of commutator motor which can be built for pressures up to 600 volts and frequencies up to 60 cycles. Speed adjustment is effected by moving the brushes by means of a large handwheel and may therefore be carried on continuously from the lowest to highest speed, as would be the case with a shunt wound continuous current motor if it could be provided with a field rheostat having an infinite number of steps.

When the brushes are adjusted for the minimum running speed the motor may be started by switching it straight on to the supply system; under these conditions the starting current is about one and a half times the normal full load current and the starting torque approximately twice the normal full load torque. The starting properties of this motor are therefore superior to those of a standard slip-ring machine and there is the advantage that a starting rheostat is quite unnecessary. There are no separate resistances or transformers, and the motor is quite self-contained, the only accessory required being the ordinary switch with overload and low voltage release or other standard protective devices.

The efficiency at the maximum speed is slightly lower than of a standard induction motor, but at the minimum speed it is much higher than that of an induction motor of the same speed and power.

The power factor is uniformly higher than that of an induction motor and at the maximum speed the machine will even draw a slight leading current over a wide range of load.

The output is proportional to the speed and, in this respect alone the new motor differs from the adjustable speed continuous current machine which is only capable of giving the same output over its whole speed range.

The curves in Figs. 1 and 2 show the results obtained by brake tests of a 400-volt three-phase motor designed for an output of 50 h.p. at 540 revs. per min. and for speed adjustment down to 180 revs. per min. They are self-explanatory and quite typical. It is interesting to note that with its armature locked and an input of 110 amperes per phase, this machine exerted a torque of 1,020 lbs. ft. or more than twice the normal full load torque with 1¾ times full load current. The motor from which these results were obtained is shown in Fig. 3, from which it will be noted that the brush spacing is much more open than is usually the case in polyphase commutating motors. The standard number of brush studs for motors of smaller output than 50 b.h.p. is 9 and for larger motors 12, and these numbers are quite independent of both frequency and speed range.

Standard machines are designed for speed adjustment between maximum and minimum speeds having a ratio of three to one, but this range may be increased to four to one at slight extra cost provided there is no objection to the standardised temperature rise being exceeded at the lower speeds. Motors for use on 25 cycle circuits may even be regualted from the maximum speed right down to standstill.

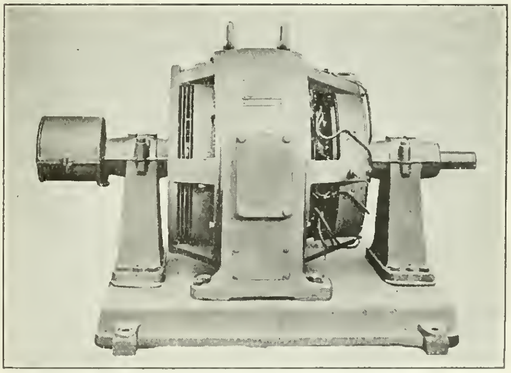

Fig. 4.—Polyphase Commutator Motor, 30 h.p., 720–240 revs. per min.

Fig. 4 shows a motor designed for an output of 30 h.p. at 720 revs. per min. and speed adjustment down to 240 revs. per min., and indicates the method of securing satisfactory ventilation at the lower speed. Air is drawn over the commutator surface and through the machine in an axial direction and then delivered radially through the openings in the end shield by a fan of large diameter.

These motors may be reversed in the same way as an induction motor, that is by interchanging two of the primary leads. Like the induction motor and the continuous current shunt wound motor this motor acts as a generator and returns energy to the line when driven above the no-load speed for which it happens to be adjusted. Dynamic braking can thus be carried out at any speed within the range of adjustment for which a motor is designed, a property which makes this type particularly desirable for the driving of hoists and small winding gears.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from **The Electrician** Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Proceedings" of the Institute of Radio Engineers. Edited by A. N. Goldsmith, Ph.D. (New York: The Institute of Radio Engineers.) Vol. IV. No. 6. Pp. 91. $6.60.

"Engineering" Directory.—No. 63.—October 1916. (London "Engineering," Ltd.)

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SOME LINES OF PROGRESS IN 1916.

Although technical developments in any direction under present conditions in this country are naturally hampered, or at least those developments which are not directly connected with warfare, some progress has nevertheless been made. Thus, in the electrification of our railways, may be mentioned the line from Manchester to Bury on the Lancashire & Yorkshire Railway involving 22 miles of single track. This work is of more than usual interest, because it is the first application in this country, on a commercial scale, of a pressure of 1,200 volts on the third rail, as compared with the 500 to 600 volts that is commonly employed. Owing to this increased pressure certain precautions were necessary to ensure the safety of the railway employés, and for this purpose a specially protected side-running third-rail was designed by Mr. J. A. F. ASPINALL, general manager of the railway company, and this appears to have given satisfaction.

Later on in the year we were able to give an account of the interesting application of electric traction to the Shildon–Newport branch of the North-Eastern Railway, the route being some 18 miles in length. In this case also the continuous-current system was adopted, but the pressure was 1,500 volts, and an overhead trolley wire was used. This electrification should give an impetus to electric traction on lines where mineral traffic is the main feature, as distinct from passenger traffic, for in all probability electrical methods will find a more profitable application to this class of traffic on main lines. The year has also been marked by the opening of a section of the North London Railway, the practical completion of the London and South-Western suburban lines, and by much progress on the London and North-Western Railway.

Beyond the railways to which we have referred, interest in electric traction has centred rather in the doings of engineers in America, where results obtained on the Chicago, Milwaukee & St. Paul Railway are of more than local value. There has also been much discussion as to the possibility of applying electric traction generally to the suburban lines of Chicago, but in this instance the advocates of electric traction appear to have carried their arguments too far, their object being the diminution of smoke rather than satisfying the needs of the traffic. This, we feel, is the wrong way in which to approach the question.

During the past year the development of electric power has been considerable in certain districts, owing to demands from factories, but the attitude of the Government has been unfavourable to the extension of electricity works, owing to the financial needs of the country. This has led to considerable difficulties in certain cities. For example, in Birmingham the tramway service has broken down very materially through lack of electrical plant at the generating stations. It has not been sufficiently realised by the Government that a generating station requires a certain proportion of reserve plant if there is to be freedom from breakdowns, but we trust that this elementary fact is now being appreciated by those in authority, and that the state of affairs in the future will be more satisfactory. The attitude of the Government has naturally resulted in the abeyance of new schemes, but recently the Board of Trade has expressed a willingness to entertain applications for provisional orders if it can be shown that the construction of the works and networks under the proposed schemes will be proceeded with as soon as practicable after the termination of the war. This will enable those responsible for such schemes to have everything in readiness to proceed as soon as the war terminates, which policy seems to be highly desirable.

In connection with power requirements the wastefulness of our present methods of numerous small generating stations has become very apparent, and for this reason a Paper read by Mr. E. T. WILLIAMS before the Institution of Electrical Engineers in the early part of the year, pointing out the desirability of a comprehensive scheme for the whole country by means of linking up such stations, was sympathetically received. Since then much progress has been made. The matter was emphasised later by a letter issued by the Board of Trade calling attention to the desirability of interlinking from the point of view of saving in working costs and in the capital involved. The first step was made in Lancashire and Cheshire, where a committee was formed under the chairmanship of Mr. S. L. PEARCE, the committee consisting of the engineers of many of the generating stations in those two counties. Later a joint committee was formed of the Incorporated Municipal Electrical Association and the Incorporated Association of Electric Power Companies. Thus the National Electric Power Supply Joint Committee, of which Mr. W. A. CHAMEN is chairman, issued a memorandum in October, showing how the whole country might be divided up into districts so mapped out. This work is now progressing. The Lancashire and Cheshire Committee remains as a committee for this purpose, while in London the work has been undertaken by a joint committee of engineers appointed by the Engineers' Committee of the Conference of Local Authorities of Greater London, on which there are representatives of both companies and municipalities. Committees have also been formed to deal with South Wales and with the West of England area.

Electric lighting has again been very adversely affected by the regulations for reduced lighting, and also by the operation of the Summer Time Act. Although there was a certain amount of scepticism as to what this Act would accomplish, whether there would really be any daylight "saved," or whether the lighting would be reduced, events have proved that stations depending largely on a lighting load have suffered to the extent of something like 25 per cent. in their output during the summer months. This loss the undertakings have sought to compensate in many cases by increasing their charges, and in some instances, such as Newquay, the Board of Trade has permitted the statutory charge to be raised.

The year has been particularly barren in the development of telegraphy and telephony as far as one may be permitted to dip into such matters at the present time. Doubtless a great deal has been done, but the transmission of news and perfection in signalling are matters about which secrecy is desirable.

During the past year we have had to mourn the loss of some notable workers in science and engineering, among whom may be mentioned Prof. S. P. THOMPSON, in physics and electrotechnics, Sir WILLIAM RAMSAY, in chemistry; and Sir HIRAM MAXIM, in engineering. To the war is due the loss of Sir H. F. DONALDSON, late Chief Technical Adviser to the Ministry of Munitions, and Mr. LESLIE S. ROBERTSON, for many years Secretary of the Engineering Standards Committee, as well as many very promising young physicists, chemists and engineers, whom this country could ill afford to spare.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Principles of Electrical Design: D.C. and A.C. Generators. By A. STILL. (London: Hill Publishing Co., Ltd.) Pp. xiv.+365. 12s. 6d. net.

Prof. Still is already known to many students of electrical engineering as the author of "Polyphase Currents," a book which is deservedly one of the most popular of its kind.

The book under review is intended mainly for the use of students following definite courses of study, and emphasis is laid on fundamentals and principles of general application. We share the author's opinion that the book will serve as a basis for a course of lectures on the subject, and we agree with the suggestion that for every hour of book study, four to six hours should be spent in the actual working-out of practical designs in the drawing office. No real knowledge of any branch of engineering can be acquired by mere book reading. After being grounded in fundamental principles a student learns the art of machine design from the mistakes he makes in the drawing office.

After an introductory chapter in which views are expressed regarding the qualifications of the successful designer, the author deals with the magnetic circuit and with the designs of electromagnets. Although few in number, the examples in these chapters are of the directly useful kind, and as such will be appreciated by those who have difficulty in making calculations on the magnetic circuit.

To the design of continuous-current machines seven chapters are given. In the first of these is set out a brief outline of the problem. The chapter on armature windings and slot insulation, although only 17 pages in length, covers a good deal of ground, and the matter is well-found. Losses in armatures, ventilation and temperature rise are next dealt with. The author rightly advocates the estimation of core losses from the results of tests conducted on built-up armatures, and he gives a curve based on experiments made by Messrs. Parshall and Hobart. Since the output of a well-designed dynamo-machine is determined by temperature-rise it is of the utmost importance that students should know how to ventilate a machine properly in order to limit the temperature rise, and should be conversant with the theory of heating and cooling. For this reason we think the subject deserves a somewhat fuller discussion than is to be found in this book.

We have nothing but praise for the chapters on Flux Distribution and Commutation. Both chapters are admirably written, and will be most helpful to those students who have experienced difficulty in getting clear conceptions on these subjects. A short chapter on the magnetic circuit, which, in our opinion, ought to be amplified, is followed by a numerical example in which the various steps in the electrical design of a continuous-current generator are given in logical sequence. The work is done with care, and is set out in considerable detail. It is possible that students would like to be able to obtain further copies of the design sheet gives on pages 201-204. They would certainly find them useful in answering home-work questions on dynamo design, as well as in the drawing office. The fact that the various steps in the design are set out in logical sequence means that if students use the design-sheet as a model they will learn to think in logical sequence, and will ultimately be able, with confidence, to make the short cuts of which the author speaks.

Chapters XI. to XV. are devoted to alternating-current generators. The first two follow the same general lines as the corresponding chapters in the continuous-current section, and deal respectively with fundamental considerations, and armature windings, losses and temperature-rise. We know of no better elementary treatment of air-gap flux distribution than that given in Chapter XIII., and the same remark applies to the next chapter in which the regulation of alternators is considered.

In the concluding chapter is given an example of alternator design. A design sheet is included and the consecutive items are worked out as was done for the continuous-current dynamo earlier in the book. The author rightly does what every teacher does, namely, digresses sometimes from the immediate subject when matters of interest suggest themselves as the work proceeds.

Although intended primarily for students, the book will in all likelihood prove useful to many a designer. It can be confidently recommended to those whose wish it is to be properly grounded before attempting to read larger and more ambitious works. The illustrations are well-drawn—there are no half-tones—and the press-work is excellent.

First Aid in the Laboratory and Workshop. By A. A. ELDRIDGE, B.Sc., and H. V. A. BRISCOE, D.Sc. (London: Edward Arnold.) Pp. v.+30. 1s. net.

Although we are not in a position to express a medical opinion on the merits of this little book, we may say that it gives information on the usual injuries occurring in a factory or a chemical works. The directions are given in a very concise manner, so that only the least possible delay need take place in deciding upon the course of action in any given case. There is a preface by Surgeon-General Sir Alfred Keogh, K.C.B., in which it is pointed out that in an emergency the appropriate treatment is often forgotten, even by those who have attended courses in First Aid. Managers of works would do well to have this little book by them.

The Slide Rule; Its Operation and Digit Rules. By A. LOVAT HIGGINS, A.Inst.C.E. (London: Whittaker & Co.) Pp. 13. 4d.

This is a convenient little pamphlet, measuring $2\frac{3}{4}$ in. by 4 in., for the benefit of students who wish to make themselves familiar with the working of the slide rule. It will probably fill a want, because, although there are small books published on the subject, the student generally needs something very much less bulky. The present little pamphlet sets out the various operations that may be carried through, and gives a digit rule in each case. Whether such rules are ever used by those who habitually employ the slide rule we are inclined to doubt, but it may be desirable to have them, provided the student is not made to rely too much on rules of this kind.

PRINCIPLES INVOLVED IN COMPUTING THE DEPRECIATION OF PLANT.[*]

BY F. GILL AND W. W. COOK.

A good deal of trouble has been caused by not strictly defining the scope of the subject under discussion and in the present instance the term "depreciation" is intended to be covered: (1) Provision for the diminution in value of plant in place and working, by reason of causes *outside* the owner's control; this provision is hereinafter called "renewals. (2) Provision to enable the owner to take plant out of commission before its physical life is exhausted in cases where it is economically advisable to do so; this provision is hereinafter called "improvements."

We propose to discuss the principles which govern this question, primarily from the engineer's point of view; and it is hoped that if this be successfully accomplished it will be found to lead naturally to the financier's and the accountant's view-points also. All three must come to a common decision and each in any calculations he has to make must work to it, otherwise nothing but chaos can result.

Depreciation as Affecting the Design of Plant.—While the first cost[†] of alternative plans is highly important, in most cases it is nothing like so important as the annual charges, and generally the decision as to which alternative to use can be made upon consideration of the annual charges alone.

It may be advantageous to spend extra capital to obtain low annual charges in respect to one portion of the plant and deliberately to incur high annual charges by reducing capital expenditure on another portion.

Again, it sometimes happens that even the annual charges of the whole plant will not furnish the desired criterion since they are not the same for each year, and in those cases they must of course be brought to some common time-base.

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[*] Abstract of a Paper read before the Institution of Electrical Engineers last night.

[†] The expression "first cost" is intended to mean any or all of the following as the context requires: (*a*) the original construction cost; (*b*) the estimated original construction cost; (*c*) the estimated construction cost to reproduce the plant new.

Annual Charges.—Annual charges are composed of four principal parts:—

1. Return on capital outlay, treated as a charge because no engineer, unless in special circumstances, is justified in putting down plant which will not pay a return on its own capital.
2. Depreciation—as defined above.
3. Maintenance, the cost of keeping the plant in as good condition as is desirable, but not of renewing it.
4. Operation—the cost of working the plant.

The first three enter into the annual charges of all plant, the fourth does not; for example, a boiler or a tramcar requires to be operated before it can perform its function, but this does not apply to a pole.

At this stage it is desirable to insist upon the importance of the utmost accuracy in the preparation of the annual charges. When it is remembered that the purpose for which they are required is to enable the engineer by their means to plan wisely and economically, it will be acknowledged that he must use his best endeavours to arrive at annual charges which are as correct in every possible way as he can make them.

If the cost of any plant is to be judged by its annual charges, they must be the true annual charges, and one cannot express these by the single statement that they are, say, 14 per cent. per annum of first cost, unless either the cost is uniform each year, or the rate mentioned is an equated rate taken over the prospective life of the plant.

With reference to uniformity:—

Return on capital.—The amount will be uniform if the capital has not been written down, that is, if the sums put aside for depreciation are kept in a separate fund until the sum that is required has been accumulated. If, on the other hand, part of the capital is paid off each year, the sum for return will decrease each year.

Depreciation.—Here again, the amount required will vary according to the method of making provision and to the treatment of the capital account.

Maintenance.—For the present, let it be assumed that this is constant each year. This point will be returned to later.

Operation.—This is also taken as constant.

It is seen then that the sums required for return on capital and depreciation both depend upon the treatment of the capital account and the depreciation fund; in fact, these two are so intimately connected that their costs cannot be treated independently.

Lives, Physical and Economic.—For the purpose of this Paper there are two lives which must be defined:—

(*a*) Physical life, that is, the period during which the plant would continue to perform satisfactorily the service to which it is adapted, if allowed to do so, but subject to all causes *outside* the control of the owner, such as wear and tear or accidents.

(*b*) Economic life, that is, the period of physical life shortened by causes *within* the owner's control, such as desire for economy, improvement of service, the taking out of plant because a greater capacity is required.

It is necessary to distinguish quite clearly between these two. The physical life affects the amount to be put aside each year for renewals, and there is no compulsion to renew before the conclusion of the physical life. The renewals fund thus ensures that the money invested in plant is always represented by the assets, provided that none of it is voluntarily destroyed.

In the conduct of a business, however, it is often desirable, in the interests of shareholders and consumers alike, to take plant out of commission before the end of its physical life.

In order that the owner of the plant may be always in a position to take advantage of developments and still be in a sound position, it is necessary to have a special fund available for the purpose, and such a fund is referred to in this Paper as the improvements fund. As such a fund is necessary for the successful conduct and progress of the business, the annual contributions are, in a continuing business, part of the annual charges against the plant.

The distinction between the renewals fund and the improvements fund must constantly be borne in mind.

Provision to be Made for Renewals and Improvements.—The methods of arriving at the deduction to be made for any plant which has already been in existence some time may be divided into two classes:

(*a*) Based on a detailed examination of the plant and an individual assessment of value for each item.

(*b*) Based on an estimated life which the various classes of plant will have under a given standard of maintenance, and providing for the diminution in value by writing off or setting aside a proper sum in respect of each expired year (or other portion) of life.

When carefully examined there is really no sharp dividing line between these two methods.

In the case of detailed examination (*a*), proper weight can be given to condition, but physical examination alone will not enable a proper deduction to be made for the depreciated state of the plant. In some cases, for some years, the plant shows no sign of wear or decay, yet obviously some provision ought to be made for the expired life during these years. It is usual, therefore, and necessary, to estimate the first cost, life, age, and residual value. If individual items of plant are dealt with, the life and sometimes the age can only be judged very approximately.

If, as in method (*b*), the bulk is considered instead of the individual items, the life and age can be estimated with much greater certainty, while consideration of the amount spent on repairs and upkeep, supplemented by inspection, will give the condition.

The measurement of the effects of wear and tear and the passage of time is essentially a financial operation, and one has to establish the first cost, residual value, life and age.

One cannot neglect capital charges, *i.e.*, return on capital and provision for depreciation; and the latter depends very largely upon life. Without estimates of lives one cannot logically arrive at a common rate for capital charges for various classes of plant capable of living for various periods. It follows, therefore, that of necessity estimates of life must be made.

Having discussed the questions of physical and economic lives, it seems advisable to turn first to the method of treating the provision for the capital portions of annual charges based on the economic life, and afterwards to the proportion chargeable to renewals and the calculation of the value of plant in place, based on the physical life.

Most of the examples in the Paper which concern economic life have been worked out on a basis of:—First cost £100; residual value 13 per cent.; economic life 19 years. The examples which concern physical life on a basis of:—First cost £100; residual value 2 per cent.; physical life 25 years. In both cases interest where taken is at 5 per cent. per annum.

In discussing these principles, the aim is to ascertain as precisely as possible the proper annual charge against each unit of plant for each year of its life. Let the essential conditions be that the plant shall be charged with a yearly sum sufficient to (1) pay for all maintenance, (2) pay all operating expenses, (3) at the end of the physical life renew the capital outlay on it, (4) provide sufficient money to enable the company to take out of commission, when desirable, plant which still has some years of life left in it, (5) pay the company an agreed return on the money invested, say 5 per cent. per annum, (6) let it be also assumed that the capital is £100 and that it and the plant do not increase during the whole time.

The problem then is to find how much should the plant contribute each year:—

1. *Maintenance.*—For the moment this charge is assumed to remain constant and can therefore be neglected.

2. *Operating.*—This is assumed to remain constant and can also be neglected.

3-4. *Renewals and improvements.* These involve the question of life and residual value. Assume the economic life is agreed at 19 years and that the residual value at the end of the life is 13 per cent. of the first cost after paying for cost of recovery.

5. *Return on capital.*—This needs no discussion.

6. *Fixed capital and plant.*—This is assumed so that a steady base may be taken throughout.

It must also be laid down what is to be done with the money received each year in advance for renewals and improvements. It cannot remain idle nor can it be invested in the business because by (6) the amount of capital is fixed; it must therefore be used to repay the capital gradually, or be lent at say 5 per cent. outside the business.

Since the matter can be treated in different ways, it is necessary to consider what tests shall be required of the various methods. There are two: (1) the total cost of all the annual charges for the economic life of the plant shall not exceed the real cost; and (2) the incidence of the annual charges shall not be such as to cause anomalies in the conduct of the business in different years or periods unless such incidence is due to some plant condition.

The simplest way to assess the whole transaction is to take the present value of all payments, and using the assumed rate of interest—5 per cent. per annum—it is found, apart from any particular method, that what is required is:—

The present value of 19 annual payments of £5 each for return on capital of £100 5 × 12·08532 = £60·13
The present value of £87 required 19 years hence 87 × 0·39573 = 34·13

£94·86

This present value, £94·86, is then the total cost, independent of any method, to be used in the first test of any method.

There are various methods of treating the provision for depreciation, but substantially they reduce to the following :—

1. Maintenance Method, wherein no regular sum is put aside, the plant being maintained and renewed out of revenue expenditure.
2. Reducing Balance Method, wherein a uniform percentage is deducted each year off the reduced capital cost.
3. Straight Line Method, wherein the annual charge is the ratio of one year to the total time or life.
4. Sinking fund, or Annuity Method, wherein value is given to the interest the fund will earn until it is wanted.

1. The Maintenance Method affords no means of calculation, it is bound to be irregular, and since no charge can be made until a renewal actually takes place, the method is always in arrear unless and until a complete renewal is affected.

2. The Reducing Balance Method is very frequently employed to ascertain the amount to be allocated for depreciation at the end of a year. It will be necessary to apply a rate of 10·18 per cent. per annum to the reduced balance to extinguish the £87 during the life, and the costs for return and depreciation are shown in Fig. 1.

This method results in a relatively heavy charge in the early years and a very light one in the last years. The present value of the whole series of payments is £94·86, and so this method satisfies the check as to total cost ; there only remains the check on incidence.

3. The Straight Line Method has been strongly advocated and requires extended consideration.

Assuming the same case as before, £87 is required in 19 years for renewal of plant or redemption of capital.

If the straight-line law is followed, but instead of accumulating a fund the capital is partly repaid each year, the present value is seen to be correct at £94·86 and there remains the question of incidence. Fig. 4 shows this.

4. Annuity Method. Fig. 5 shows the same case treated as an annuity, by which each year a part of the capital is repaid and a return is paid on the capital outstanding.

Here the total annual charge is uniform at £7·85 per annum, made up of the decreasing return component and an increasing depreciation component. At the end of the life all the capital has been repaid, except £13 which will be found by the sale of the plant. The plant (or consumer) gets the benefit of interest, because as capital is repaid the return thereon ceases. The present value of the series of payments is £94·86.

4. Sinking Fund Method. Fig. 6 shows the case treated by a sinking fund ; in this instance the capital remains fixed at £100 and a fund is built up gradually against the end of life, at which time, and not until then, the money will be required either to repay the capital or to replace the plant.

Here the total annual charge is uniform at £7·85 per annum, made up of uniform charges each year both for return and for depreciation. The present value of the series of payments is £94·86.

The depreciation fund is not required until the end of the life, and, of course, earns interest in the meanwhile ; this interest is earned by the money contributed by the plant (or person) and must somehow be credited to its source. In this instance the interest is added to the fund and because of that addition the annual charges are reduced.

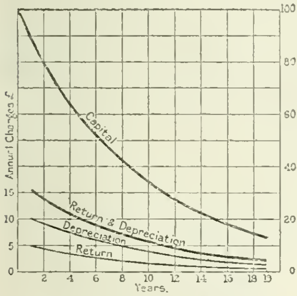

FIG. 1.—ANNUAL CHARGES. REDUCING BALANCE METHOD.

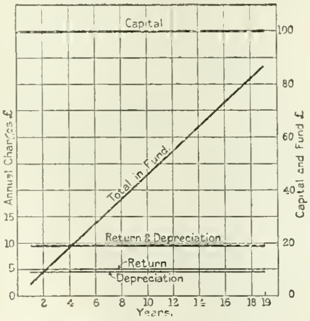

FIG. 2.—ANNUAL CHARGES. STRAIGHT LINE METHOD AS FREQUENTLY POSED.

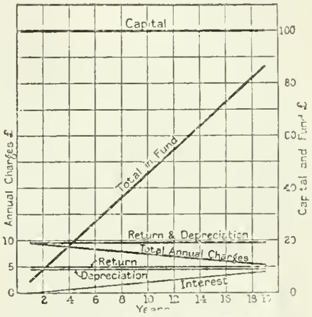

FIG. 3.—ANNUAL CHARGES. STRAIGHT LINE METHOD IN PRACTICE.

The straight line method, as usually posed, is simplicity itself, Fig. 2. £87 is to be found in 19 years ; therefore, all that is required is £4·58 per annum for depreciation and, with £5 for return, the total charges for these two heads are £9·58 per annum. This does not, however, pass the test of total cost ; the present value of 19 annual payments of £9·58 each at 5 per cent. is £115·77 instead of £94·86, an excess of £20·91. If £4·58 be set aside annually, there will of course be £87 accumulated at the end of the 19 years ; but since it is not prudent to leave money idle, it is plain that interest ought to be, and will be, earned by the money so set aside annually.

If 5 per cent. interest is added to the growing fund there will be at the end of the 19 years £139·84, so the yearly payments must be reduced below £4·58 per annum until the amount is just sufficient to accumulate only the £87 required, and this needs a yearly payment of £2·85 for the 19 years.

If the earned interest be not added to the fund but credited to the general revenue account, as is generally the practice of those who uphold the straight-line method, the effect is that the revenue is increased thereby, with the result that a higher return on the capital is obtained, the interest earned by the depreciation fund not being required for the plant. But this is a violation of the hypothesis, because a stated return on capital was to be earned, no more and no less.

This case is shown in Fig. 3. Here, again, the present value of all the payments extracted for the plant is too great, being £115·77. Testing the argument as already suggested in the light of the payment a consumer is to make, it is at once seen that if he pays the £9·58 each year, then, under the guise of annual charges, he is paying such a sum as will in fact provide the company with a higher return than allowed for by the hypothesis.

Tabulating the present values of the whole transaction by the various methods, we have :—

Present Value of the Annual Charges for 19 Years by the Various Methods.

Method.	Annual charges.	Present value.
	£	£
Real requirements	...	94·86
Reducing balance	15·18 to 2·19	94·86
Straight line as frequently posed	9·58	115·77
Straight line in practice	9·58	115·77
Straight line if proportion of capital is repaid each year	9·58 to 5·46	94·86
Annuity	7·85	94·86
Sinking fund	7·85	94·86

Now it is obvious that each method produces exactly the required present value, except that which takes up the position that interest will not be earned on the money received each year and in advance of being required, or while admitting that interest will be earned does not credit it to its source.

The reducing balance method is seen to be one of convenience and not of fact, because if it were really correct that the annual charges vary in such a marked fashion, then either there must be some counterbalancing increasing cost, or the charge would require to be a reducing one.

There is no such reducing charge in practice ; consequently, if the steady charge to the consumer is sufficient to give a return of 5 per cent. in the first year, then the same charge will give 15·8 per cent. return in the sixth year, 39·3 per cent. in the 12th year, and 94·8 per cent. in the 19th year.

The same reasoning applies to the method shown in Fig. 4; in ordinary practice there is no such reducing charge, except in book-keeping, and that has its foundation in convenience or prudence and not in the actual requirements of the plant.

On the other hand, both the annuity and sinking fund methods are correct in amount, satisfy all real requirements demanded by the plant, and being uniform, can be easily handled.

In practice it is not usual to repay the capital fractionally each year; the money set aside for depreciation is generally accumulated until wanted, and the sinking fund method satisfies all conditions of the problem so far.

Value of Plant in Place at any Time.—The engineer controlling a system must be able not only to know the annual charges on each kind of plant, but also to estimate the value remaining in the plant at any time.

In considering extensions of plant, or the adoption of improved plant, it frequently happens that the question arises whether it is economical to take out certain plant still performing satisfactorily the service it is adapted to, and replace it by new plant of a more economical nature. If the existing plant is taken out, there will be a wastage of its then value in place, plus the cost of taking it out and less the amount received for the recovered materials, the net result of this being a present loss when the change is made.

Against this loss there is to be set any economy in annual charges that may be gained by the new plant during the period which would have remained of the displaced plant's life. Further, since the wastage must be incurred when the change is made, while the prospective savings are in the future, the two sums must be brought to a common time for comparison; in fact, the problem is to find out if it is worth while to incur a present loss to achieve a future gain.

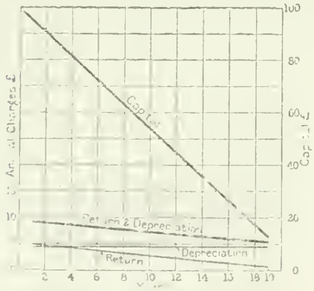

Fig. 4.—Annual Charges. Straight Line Method. Part of Capital repaid each Year.

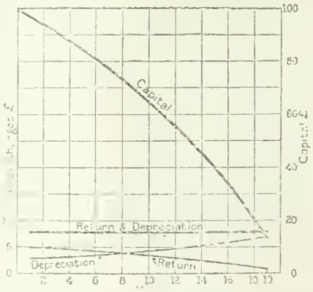

Fig. 5.—Annual Charges. Annuity Method.

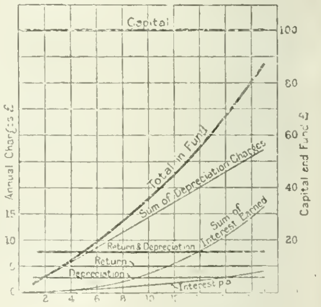

Fig. 6.—Annual Charges. Sinking Fund Method.

Unless the new plant will thus pay for the wastage, or unless there are compelling reasons which require the change irrespective of economy, the change should not be made.

The solution largely depends upon what is the value of the plant in place, still performing its service satisfactorily and capable of continuing to do so for some time longer, and the engineer must be able to estimate this value by some logical process.

If the first cost and the annual charges have been rightly estimated, the diminution in value is the amount which should be in the renewals fund, for that was the very purpose of the fund. That is, the first cost less the amount which should be in the fund is the measure of the remaining value; or it may be stated that the remaining value in the plant plus the amount which should be in the renewals fund is always equal to the first cost.

One easy way to test the equity of the value in place produced by the alternative methods used in treating depreciation is to examine how each would result if an undertaking passed successively to several owners, on the basis of the remaining value being the first cost less the amount which should be in the renewals fund.

In these cases, as already shown, the life concerned is not the economic life but the physical life, so that in calculating the following tables we must take the physical life of 25 years and the residual value, at the end of life, of £2.

Assume the original owner (whose conditions are set out in a Table in the original Paper, 5 per cent. sinking fund), to whom the user of the plant pays £7·05 per annum, sells at the end of the eighth year on the basis of this table. He will then sell for £100 less £19·61 (the amount in the fund) = £80·39.

This second owner's conditions will then be: Capital £80·39, remaining life 17 years, residual value £2, other conditions as before, and the table shows these figures for the next 8 years, [illegible]

If the second owner transfers to a third owner at the end of the 16th year, on the same basis, he will then sell for £80·39 less £28·97 = £51·42.

The third owner's conditions will then be: Capital £51·42, remaining life 9 years, residual value £2, other conditions as before, and the financial result is shown in the table.

If the third owner transfers to a fourth at the end of the 24th year, on the same basis, he will sell for £51·42 less £42·8 = £8·62.

This last owner's conditions will then be: Capital £8·62, remaining life 1 year, residual value £2, other conditions as before. He finds £2 from sale of materials and £6·62 from his renewals fund and thus gets back the money he had invested.

It is true that the portion of the annual charge allocated in this example to renewals becomes larger each year; but that is only one part of the transaction and the increase is exactly counterbalanced by the reduction of the charge in respect of return on capital, in this case. It will be observed that each successive owner has taken over the plant at what it would have stood at had part of the capital been paid back each year on the annuity method.

Thus each successive owner has had the same plant, the same annual charge, and has got back all his capital at the end of his term.

Of course if the renewals fund is not credited with the same rate of interest as the return on capital, the strict equality will not hold good, but the only reason for accepting a less rate than the plant earns is to obtain a greater security for the fund than for the main investment, and this course is based on prudence rather than on equity.

The authors next contrast what happens under the straight line law, the annual rental remaining constant at the amount fixed by the first year's annual charge, and show that each successive owner has had the same plant and has got back all the capital invested, but each successive owner has received a higher percentage return on the capital invested than any of the previous owners.

It may be argued that the amount of profit an owner can make has nothing to do with the value of the plant, and this is true. In the above cases the relative profits under the same conditions have merely been used to test whether the price at which the plant is valued seems a fair one or not.

When one finds that on one hand, when interest is brought into the transaction, there is absolute equality as between various years or various owners, and on the other hand, when interest is not brought in, the successive year or successive owner is always progressively favoured, one has good ground for the conclusion that all is not right with the method of valuation which neglects interest on the renewals fund payments.

(To be concluded.)

Illuminating the Statue of Liberty. An instance of the recent development of "spectacular lighting" in the United States is afforded by the illumination by concealed lamps of the immense Statue of Liberty in New York Harbour; 125,000 c.p. are allotted for the purpose, and the expense has been defrayed by public subscription. President Wilson and other State officials were present at the opening ceremony. The illumination will doubtless make the Statue an even more prominent object by night than by day.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

The article published in your issue of the 29th ult. illustrates one method of achieving the reform of our present unwieldy system of coinage. Mr. Parsons rightly lays stress on the importance of retaining as much of our existing system as is compatible with its rearrangement on a decimal basis.

The following general observations, which have been prepared by the Committee of the Manchester and District Decimal Association, may serve to focus attention on the chief points which deserve consideration :—

The British Empire stands alone amongst the nations of the world—excluding only Siam and Persia—in her neglect to adopt a decimal system of coinage. It should also be borne in mind that the British Empire is not united in her isolation, as Canada and Ceylon, for instance, have already adopted decimal coinage, and both Australia and New Zealand are now contemplating a similar step.

That it would be to our advantage to adopt a decimal system of coinage must be apparent from the fundamental fact that all our financial transactions involving such everyday questions as rates of interest, dividends, discounts, commissions, &c., are based on a rate *per cent.*—*i.e.*, per 100—and not per 20 or per 240.

Our present system could be re-arranged on a decimal basis without altering the existing values of our gold and principal silver coins. For instance, we could adopt our present *florin* as the *standard coin*, and divide it into 100 cents (instead of 96 farthings).

The sovereign and the half-sovereign would be retained, and the full set of coins would be as shown in the following table :—

Coin.		Value in present currency.	Cash entry (two columns only).	
			Florins.	Cents.
Gold	Sovereign	Sovereign	10	00
	Half-sovereign	Half-sovereign	5	00
Silver.	Florin	Florin	1	00
	Shilling	Shilling	...	50
	Quarter	Sixpence	...	25
Nickel	10 cents	2·4 pence	...	10
	5 cents	1·2 pence	...	05
Bronze	4 cents	0·96 pence	...	04
	2 cents	0·48 pence	...	02
	1 cent	0·24 pence	...	01

The 5 cent piece (say 1¼d.) would be available for such "pennyworths" as could not be supplied for the new 4 cent. piece (say, 1d.). An example of the utility of this 5 cent piece is provided by the recent situation when newspapers were advanced from 1d. to 1½d. If the 5 cent coin had been available this price revision might have resulted in a 20 per cent. instead of a 50 per cent. advance.

Hitherto the chief argument against the adoption of the above system has been that the values of our present *bronze* coins would be depreciated by 4 per cent., since there would be 100 cents instead of 96 farthings in the florin ; but in these days, with our normal conception of values so violently disturbed by the war, it surely cannot be argued that a 4 per cent. reduction in the purchasing power of the penny is a sufficiently powerful consideration to debar us from enjoying the benefits of decimal coinage.

The present period of widely fluctuating values is obviously a most opportune time for revising our coinage system, and we are further helped by the circumstance that millions of our people are now gaining practical first-hand experience in the use of the decimal systems of coinage employed by our Allies.

Alternate proposals, by which our present penny would be retained as the standard coin, involving the introduction of new coins representing decimal multiples of the penny, have been advocated from time to time, but hitherto with little success, probably because under any such scheme the £ sterling could not survive.

It will be noted that under the association's proposals, all the objects desired by your contributor are attained, and a further advantage is secured in that the £ sterling is retained as an integral part of our coinage system.

HARRY ALLCOCK, M.I.E.E.,
Manchester, Jan. 2. Hon. Secretary and Treasurer,
Manchester and District Decimal Association.

TO THE EDITORS OF THE ELECTRICIAN.

Mr. Parsons' article on the above is timely. May we hope that the time is not far distant when we will adopt a modern system of coinage, and thereby remove part of the reproach that we lag behind other nations in many essential things. May I add a slight correction to Mr. Parsons' table of equivalents ? He gives 8 cents as equivalent to 1d. Unfortunately, 8 cents is slightly less than 1d., and we may be quite certain that railways, the Post Office, trams, newspapers, &c., would not take a reduction in their gross takings, nor would it be reasonable to ask them to do so. Traders would ask the next higher coin, whether the florin or the shilling was used as the unit.

The following table shows the effect on the purchaser under the two systems, namely, the shilling and the florin :—

	Shilling equivalent				Florin equivalent		
1d.	9 cents,	8·0 p.c. increase		...	5 cents,	20·0 p.c. increase.	
2d.	17 ,,	2·0 p.c.	,,	...	9 ,,	8·0 p.c.	,,
3d.	25 ,,	...	,,	...	13 ,,	4·0 p.c.	,,
4d.	34 ,,	2·0 p.c.	,,	...	17 ,,	2·0 p.c.	,,
5d.	42 ,,	0·8 p.c.	,,	...	21 ,,	0·8 p.c.	,,
6d.	50 ,,	...	,,	...	25 ,,	...	,,
7d.	59 ,,	1·0 p.c.	,,	...	30 ,,	3·0 p.c.	,,

The differences after this are not important. The table shows, however, that the shilling equivalent has an immense advantage for ease in conversation, as the equivalents are much nearer than with the florin unit. Over a shilling, the benefit of the shilling unit for the ordinary user is still more pronounced, as people are already accustomed to the shilling as a unit for sums up to £5.

The sovereign is about the worst possible unit for foreign trade, being totally unlike the unit used in any country outside the Empire, and it is about the mean of the units used in Europe, so that it would be quite as good as the florin, and possibly better. At any rate, in this respect there would be little to choose between them.

Tynemouth, Jan. 1. C. TURNBULL.

TO THE EDITORS OF THE ELECTRICIAN.

I was very interested, as I am sure all draughtsmen who have occasion to do estimating would be, in reading the article by your correspondent, Mr. G. O. Parsons, on : "A Decimal Money System." I cannot agree with his statement "In such circumstances it is farly obvious that for us there are only two possible units. These are a coin of the value of 10d., which we might call a frank, after the French franc, and the present shilling." To my mind there is a much more obvious unit and that is a coin equal to the value of 2½d., 10 of these units equal a sum slightly larger than 2 shillings and 100 of them equal a sum larger than £1 and only slightly smaller than 1 guinea. Also one-tenth of this unit exactly equals one farthing. This unit would exactly correspond to the American nickel or 5 cent piece, which has proved to be of great practical value in business. The system proposed by your correspondent contains a coin equal to half a farthing. A consensus of opinion will probably regard this as too small.

Newcastle-upon-Tyne, Dec. 30. W. ROGERS.

AUDION OR PLIOTRON ?

TO THE EDITORS OF THE ELECTRICIAN.

Referring to Mr. W. C. White's article on the Pliotron oscillator in "The Electrician" of December 8th, page 327, I desire to give my reasons for the use, in my article of December 1, of the well-known term "Audion," following Dr. Eccles' inspiration to designate any vacuum tube comprising a plate, a grid and a filament.

Dr. de Forest was the first to present a tube of this description, and I believe it is just to retain the name which he gave to it.

It is true that from the patent point of view the following observations can be made: —

1. Neither Dr. de Forest nor Messrs. von Lieben and Reisz contemplated the use of the very high vacuum proposed by recent inventors. On the contrary, the imperfect vacuum corresponding to the presence in the tube of a more or less attenuated gas or vapour appeared to them to be indispensable to the operation of their apparatus. It is known to-day that perfect operation could even be obtained in a theoretically perfect vacuum. In other words, in addition to the ionisation of an attenuated gas or vapour described by von Lieben and Reisz it is possible to consider the phenomena from the point of view of the direct emission of electrons in a perfect vacuum.

2. Dr. de Forest does not appear to have immediately contemplated the use of the audion as an amplifier, and the audion regarded uniquely as a detector might be considered as a mere combination of the Fleming valve and the Zehnder detector.

We should not forget, however, that Dr. de Forest was the first to present a tube with the three electrodes, plate, grid and filament, and that these three elements are of capital importance from the point of view of the operation of the tube.

Paris, Dec. 28. M. LATOUR.

"A UNIVERSAL RESISTANCE STANDARDISING BRIDGE."

TO THE EDITORS OF THE ELECTRICIAN.

Owing to my having changed the notation, I find that in the proof of the working formula for the Universal Standardising Bridge (THE ELECTRICIAN, December 29th, p. 417), the letters *l* and *m* and *l'* and *m'* have been interchanged. The final formula should read:

$$\frac{R-S}{R}=\Delta+\frac{l-m}{p}+\left(\frac{l-m}{p}-\frac{l'-m'}{p'}\right)\frac{X}{2R}$$

which harmonises with the later formula (p. 441) for the bridge with unequal ratios. Also, in diagram No. 6, *l* and *m*, *l'* and *m'* should be interchanged, as the commutator interchange the connections between the potential contacts and the ratios.

London, Jan. 6. CHARLES V. DRYSDALE.

RUPTURING CAPACITIES OF OIL CIRCUIT-BREAKERS.*

BY STEPHEN Q. HAYES.

The object of this Paper is to suggest the proper basis for the guarantees to be made by manufacturers of oil circuit breakers or switches to enable the prospective user to determine the suitability of the breaker to the proposed service conditions. This guarantee should be a specific statement of what the oil switch can do, and should preferably be free from any assumptions as to reactance in circuit, generator characteristics, use of relays or similar features.

Oil circuit-breakers for large power systems must be suitable for the service they are to perform, their current-carrying parts must be ample, their insulation good and they must be capable of rupturing any amount of current they may be called upon to open. Such breakers should not only clear the circuit, but should be immediately re-operative without the necessity of inspection, adjustment, or repair, although inspection is advisable at the first suitable opportunity.

The term "ultimate rupturing capacity," as usually employed by American switchgear manufacturers, really means the maximum size of system on which a breaker could be safely used.

It has been standard practice to assume that the breaker is connected directly to the 'buses, and may have to open any amount of current that can be received from that bus in case a short circuit of negligible impedance occurs just beyond the breaker. In most cases it is the reactance of the circuit rather than the resistance that limits the current flow at times of short circuit. For cable systems or high-tension transmission circuits, the capacitance has to be considered. All of the generators and other synchronous apparatus connected to the 'bus will tend to feed into the short circuit whatever current they can deliver under these conditions, this current, as a rule, being limited only by the inherent reactance of the machines, and any external reactance that may exist between the machines, and the point where the short circuit occurs. This method of rating involves the momentary and sustained short circuit characteristics of the machines, the various reactances in the circuits, the speed of tripping of the breakers and other similar features.

Whether a breaker is to be used for automatic or non-automatic service, it can only open a certain fairly definite amount of power at the arc. For non-automatic service, the size of plant to deliver this would be determined by the sustained short circuit characteristics of the generators and other synchronous apparatus. For automatic service, this same amount of power could usually be delivered by a smaller plant, as the momentary short circuit current is almost always higher than the sustained.

In order to allow for certain of these variables due to the machine characteristics, one American manufacturer gives ratings for his oil switches for automatic and non-automatic service for two classes, A and B, the latter being systems where one or more generators are of the turbo type with reactances of less than 8 per cent. and the former applying for all other systems.

Another American manufacturer explains the ratings assigned by using a standard assumption of generators or other synchronous apparatus, having an average reactance of 8 per cent., a momentary short circuit current of 12½ times normal falling to half of this amount, or 6¼ times normal by the time the breaker opens, and a continued short circuit of one quarter, or three times normal. With this explanation it is evident that a breaker rated as having 10,000 k.v.a. rupturing capacity should be capable of handling 62,500 k.v.a. at the short circuit. This same breaker for non-automatic service where the machines are assumed as delivering three times normal, could, therefore, be used on a 20,000 k.v.a. system, or would have a non-automatic rating of 20,000 k.v.a.

In systems of large generating capacity, where current limiting reactors are used, or where the reactance of transformers and lines may limit the current flow on short circuit to a point well within the capacity of the system to supply continuously, it will be found that the breakers provided with time limit relays, or used for non-automatic service, have as severe rupturing conditions to meet as those used for automatic service.

These methods of rating are not directly applicable in all cases, and do not readily take into account certain features that really are vital in determining the adaptability of breakers to specific service. The rate at which the short circuit current of a generator dies down varies with its design, the period from the initial rush to the continuous short circuit value ranging from 0·2 to 0·8 second. The initial wave may be as high as 20 times normal, the continuous short circuit value as low as 1·4 times normal.

Owing to inertia it is impossible for a breaker to trip out instantaneously; consequently no breaker is ever called on to open the momentary short-circuit current that occurs during the first few cycles, but it has to be strong enough mechanically to resist the magnetic stresses set up during such a short circuit. With alternating-current coils energising the mechanism direct from the current transformers, large capacity breakers can be made to open in about 0·2 second. With the usual shunt trip relays the time of opening is about 0·3 to 0·5 second while with time limit relays the opening can be delayed either for some definite time or for a time that varies inversely with the load. With a non-automatic breaker the time of opening is left to the discretion of the operator. As most generators reach the condition of continuous short-circuit current in not over 0·8 second a definite time limit of 2 seconds or even less, secured through a relay, is equivalent to non-automatic service, in so far as rupturing requirements are concerned.

In order to simplify this question of breaker rating, it is proposed to use "maximum safe rupturing capacity," to describe the result obtained by the root-mean-square of the maximum peak of the current wave that occurs while the breaker is opening, multiplied by the root mean-square of the open circuit voltage that occurs immediately after the breaker opens.

All modern transmission systems employ generating apparatus giving essentially a sine wave for current and voltage, which sine wave has a ratio of peak value to root mean square value of 1·4 to 1. A breaker capable of rupturing 10,000 amperes maximum value at 10,000 volts maximum value, if rated on the root-mean-square basis, would be considered capable of handling 7,100 amperes at 7,100 volts, or would be given a rating of 50,000 k.v.a. If the peak value of the current, or 10,000 amperes, is used with the root-mean square-value of the voltage, or 7,100 volts, the rating would be 71,000 k.v.a. If the peak value of the current, or 10,000 amperes is used with the peak value of the voltage, or 10,000 volts, the rating would be 100,000 k.v.a. All of these ratings would cover the same duty to be performed, but as all power measurements are regularly based on the root-mean-square values of current and voltage this is undoubtedly the logical basis for circuit breaker rating.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

In case of an unsymmetrical wave, experience seems to show that the strain of opening does not differ appreciably from that produced by a symmetrical one. A current wave ranging from a positive maximum of 10,000 amperes to a negative one of 2,000 amperes can be taken care of as readily as one ranging from plus 6,000 to minus 6,000. This may be due to the longer time required for the arc to re-establish itself in the case of the unsymmetrical wave where the negative maximum is small. By the time the breaker actually opens the circuit the amount of assymmetry has greatly diminished from that experienced during the first few cycles.

There is a difference between rating a circuit breaker in terms of the maximum k.v.a. which it can open, and in terms of the maximum current which it can open. On certain systems with the machines of certain characteristics, heavy short-circuit currents are usually accompanied by reduced voltages. Again, after opening a very heavy short circuit, thus relieving the system, the voltage frequently has a tendency to rise. A certain breaker might be able to open 10,000 amperes successfully where the circuit voltage immediately after the short circuit only went back to normal, whereas it might not be able to do so if the open-circuit voltage went up to points considerably above normal.

It is realised that it will be extremely difficult for an engineer to determine in advance exactly how heavy a short circuit it is possible to get at a given point on a transmission system, but from the view point of the manufacturer it is simpler and better for him to make a definite guarantee as to just what service his breaker can accomplish, allowing the operating or designing engineer to determine whether such a breaker will meet the actual short-circuit conditions that may occur on any point of his system.

Almost all of the oil switches and oil circuit breakers now in service are operating satisfactorily, but they are far from perfect, and it is possible that some are over-rated. By having some definite rating in k.v.a. to work to, breakers of the smaller sizes could be tested to see that they actually met their guarantees.

The k.v.a. rating obtained as above is that which this breaker should be guaranteed to open, the breaker being immediately reoperative, without the necessity of replacement of oil or adjustment of contacts.

In alternating-current railway work, and similar installations where repeated short circuits are apt to occur, the breaker should be capable of opening such a short circuit at least ten times within the course of an hour; such short circuits not occurring closer together than two minutes to allow time for the gases that may be formed due to the short circuit to be properly vented from the breaker before a second short circuit occurs.

As most power circuits are three phase the rupturing capacities assigned to circuit breakers are those applying to three-pole breakers on that service. The corresponding rating for two-pole breakers on a single-phase circuit is 70 to 75 per cent. and the rating of a four-pole breaker on a two-phase circuit is considered 140 to 150 per cent. of the corresponding three-phase rating.

When considering switches for connection to 'buses fed from the generator units of motor-generator sets, the capacity of the system supplying energy to the motor-generator set, need not be considered. In such cases the sum of the rated capacity of the generator units on the motor-generator sets should come within the limits assigned to the breakers.

The k.v.a. ratings usually assigned to breakers are based on the listed voltage rating of such breakers, and any change in operating voltage from the listed voltage rating will usually change the k.v.a. rating in about the same percentage, that is, an increase or decrease in voltage of 20 per cent. would decrease or increase the k.v.a. rating by the same amount.

While this percentage rule is not strictly adhered to, a typical example might be noted of a certain moderate capacity breaker designed for 22,000-volt service with a nominal rupturing capacity, assigned by its builders, of 10,000 k.v.a. at 22,000 volts, 12,000 k.v.a. at 16,500 volts, 13,000 k.v.a. at 13,200 volts, 17,000 k.v.a. at 7,500 volts and 19,000 k.v.a. at 4,500 volts or less.

It is a well-known fact that the opportunities of testing the actual rupturing capacities of the largest capacity oil switches and breakers are almost nil and that the capacities assigned are really intelligent estimates based on the testing to destruction of small units and calculation as to the increase in rupturing capacity secured by greater volume of oil, greater head of oil, increase in strength of tanks, extra volume of expansion chamber and similar features.

On the assumption, more or less justified, that the strength of the breaker tops, insulators and fittings have been properly proportioned to the tank strength, and that the speed of opening is satisfactory, the rupturing capacity of an oil breaker may be considered as a function of the tank dimensions.

Where a breaker has been installed it should be remembered that with increase in capacity of system, failure to maintain breakers either as regards mechanism or insulation, changes in reactance, changes in method of operation and defective relays may so change the duty on a breaker as to lead to its destruction.

DE FOREST WIRELESS TELEPHONE.

We have recently received from the De Forest Radio Telephone & Telegraph Co. of New York, particulars of some of their apparatus along with some notes as to their progress. It appears that the De Forest wireless telephone played quite a part in the transmission of news during the recent Presidential election, messages being transmitted over a distance of 200 miles. The life of the oscillion bulb, when properly used, is stated to be 300 to 500 operating hours, equivalent to about a year's service.

$\frac{1}{4}$-k.w. Oscillion Telephone and Telegraph Transmitter for Aeroplanes.

This is a combination telephone and telegraph transmitter using undamped waves, and is stated to be the only telephone transmitter constructed for aeroplanes. The use of the direct-current generator and undamped wave telegraph transmitter offers many advantages over any type of quench spark alternating-current transmitter.

In the first place there is no spark frequency, and no critical alternator frequency, calling for careful speed regulation. The generator is direct driven by an aerofan, or if preferred can be belt-driven from the aeroplane engine shaft. The speed of the generator can be anything within reasonable limits, as an automatic voltage regulator takes care of the voltage regardless of speed. The makers state that the use of the undamped wave transmitter greatly diminishes insulation troubles in the aeroplane, and permits of greater secrecy in signalling, a very important feature in military use. Moreover, the undamped wave transmitter with the ultraudion receiver gives a clear musical note at the receiver, the pitch of which can be adjusted by the receiving operator.

The power plant consists of a special stream line generator enclosed in an aluminium shell, direct-driven by a two-bladed wooden propeller, 18 in. in length. In the fore part of the frame is a double commutator generator, generating 1,500 volts at 4,500 revs. per min. Behind this on same shaft is a 35-volt 75-watt generator for the lighting filament. A cable containing six conductors for current supply and field controls, leads from the tail of the generator frame to the voltage control box where a special vibrating contact operated by a solenoid in series with the B circuit controls the B field by cutting in and out a resistance. By this arrangement the B voltage remains sufficiently constant under great variations of speed.

The generator is intended to be mounted on the upper plane of the aeroplane directly above the fusilage. The control box is located within the fusilage, as is also the brake lever. This latter, by means of a Bowden wire, applies an asbestos-covered friction brake to the propellor. This brake is to be used when the aeroplane is going at very high speed, as when diving, &c. It is advisable, moreover, to bring the generator to a standstill by means of this brake whenever the wireless apparatus is not being used.

The transmitter panel carries three indicating instruments indicating the filament amperes, the flux milliapmeres and the radiation amperes. The 6 in. bulb is very flexibly mounted on spiral spring supports. On the back of the panel are mounted a litzendraht wire helix having six contact points, permitting various changes of wave lengths.

The filament ampere meter gives the operator all necessary information as to speed and voltage of generator, and he controls same if necessary by means of the friction brake above described.

There is provided a double antenna reel with 250 ft. of special antenna wire on each. This wire breaks at 30 lb. pull, so that if it catches it can cause no danger to the aeroplane. Tests have shown that a larger capacity than that furnished by a single antenna wire is of great advantage. Each antenna wire leads off to the bottom of the aeroplane through a flexible soft rubber tube so that the wire may be led out from any desired point of the aeroplane. A 1 lb. lead weight of stream line shape is suspended to the end of each antenna wire. This weight is sufficient to start pulling the wire out. It is recommended that a special system of small copper wires be placed around the frame of the aeroplane to give as large a con ducting and capacity surface as possible so as not to depend at all upon the steel stays of the aeroplane frame. The "counterpoise" connection of the panel is made to these counterpoise wires.

The generator weighs 40 lb., the panel and bulb 27 lb., and the total weight is 81 lb.

With two antenna wires 250 ft. long extending from the wing tips or extremities of the fusilage of an aeroplane, and when using a suitable counterpoise of copper or bronze, entirely independent of the bad damping effect of the steel guides of an aeroplane, the range of this ¼-kw. telegraph set is stated to be 100 miles. The telephone range is 20 to 35 miles.

LEGAL INTELLIGENCE.

Workmen's Compensation.

At Lambeth (London) County Court recently Judge Parry (sitting with a Medical Referee) heard an application for the review and termination of an award under the Workmen's Compensation Act made to Thos. Woolley, electrician, the employers being Watson, Marsh & Co. (Brondesbury), Ltd., electrical engineers.

On May 4, 1916, Woolley was injured, and on Oct. 5 last he was awarded £1 a week from the date of the accident as compensation.

Mr. **Kingsbury** (for the firm), in asking for the review and termination of the award, maintained that the man had entirely recovered from the effects of the accident on Nov. 3, a month after the award. At the last hearing mention was made of an X-ray photograph of the injured knee, but it was not produced. After considerable trouble they had been able to procure the photograph. The difficulty had been whether the condition of the man's leg was due to the accident or from some old standing disease, and the photograph showed that the condition of the leg was due to anthritis of the knee joint, and not to the accident.

Alfred R. Tothill, medical student in his fifth year, stated that he was in charge of the casualty department at Charing Cross Hospital on the day Woolley met with his accident and was brought there. He examined him, and he made an entry that the man had strained tho knee joint, treating him for that. He gave him a week in which to recover. He saw him again that week, but could find no development. He did not find any evidence of any loose cartilage, though he suggested to Woolley that was what he was suffering from, a suggestion he readily accepted as the cause for the pain from which he was suffering, or said he was. Witness came to the conclusion that he was exaggerating his condition. On June 9 he saw him once more, when he sent him to the consulting surgeon (Mr. Daniel), as witness would have nothing more to do with him. He came to the conclusion that at that time Woolley had entirely got over the effects of the accident. He never prescribed for a loose cartilage, because he did not believe it was there. On Nov. 3 he saw Woolley in conjunction with Mr. Cooge, consulting surgeon at the hospital. The man was able to walk easily, there being no impairment of the movement of the leg. There were then no signs of a detached cartilage. There was a certain amount of arthritis present in both knee joints, as was shown by the creaking of the joints, that being apparently of long standing.

Dr. **Pastell**, resident casualty officer at Charing Cross Hospital, said he examined Woolley in the hospital on Nov. 3; he was not suffering from any loose cartilage, but from arthritis in both knees. The X-ray photograph showed the disease in a more extended form, and no evidence of a loose cartilage. He thought then the man was quite able to work. It was impossible to say how long the man had suffered from arthritis, but it was present before the accident.

Dr. M. **Dutch** and Dr. I. **Davies** gave evidence that they had examined Woolley and found no evidence of fluid in the joint or of a movable body, but found arthritis present in both knees. The man was quite fit to do the same work as he did before the accident. Dr. Ivor Davies said there was no evidence of an accident to the knee joint.

On behalf of Woolley, Dr. **Robertson** said he had attended him for some years, and he had never complained of not being able to do his work through arthritis in the knees. He came to him during the time he was attending hospital, and found him suffering from a very swollen and inflamed knee joint. He was of opinion that the man had displaced a cartilage, and recently he recommended him to wear a bandage. He did not yet think he was fit for work, and certainly did not think he could climb ladders.

After the Medical Referee had examined Woolley, Judge **Parry** said he could work very well on the level if he tried, and now was the time to do something when [illegible] men were needed. The Medical Referee was of opinion that the condition of the left knee was due to the accident, and that the arthritis [illegible]. He [illegible] to suspend the present order to pay the man £1 a week, and grant him 15s. a week until Feb. 1, in which time he could try and find work, and the result could be reported to him.

Payment of Wages to Enlisted Men.

Recently the Court of Appeal (the Master of the Rolls, Lord Justices Warrington and Scrutton) decided in the case of Warburton v. Co-operative Wholesale Society (Ltd.) that a workman in receipt of compensation [illegible] under the Workmen's Compensation Act, 1916, who enlisted in the Army, was at the time in the service of the employers within the meaning of a notice offering to continue to pay wages to any employee who had been called up or had volunteered for service in H.M. Forces.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

12.748 **Chitty.** Dynamo-electric machines. (Cognate application, 3,192/16.)

The slots for the reception of the conductors are closed or bridged over with wedge pieces of magnetic material in such manner that while there is direct contact between the edges of the wedge pieces and the laminations by reason of the slots being closed or bridged over by them without insulation between, there is no closed magnetic circuit through the plane of the laminations around the conductors lying in the slots.

14.026 **Lancashire Dynamo & Motor Co. & Hargreaves.** Electromagnetically operated clutches, particularly applicable to reversing gear for reciprocating machines.

15.555 **British Thomson-Houston Co.** (General Electric Co.) Electric vacuum devices.

Comprises an electron emitting cathode, an anode and a third electrode so arranged in an envelope that over a given working range the current flows from the cathode to the third electrosde varies inversely as the potential applied thereto.

16.643 **Jenkins & C. I. (1914) Synd. (Ltd.)** Electrolytic cells.

16.765 **G. D. Peters & Co., Hibberd & King.** Electromagnetically-actuated contact makers or switches.

16.865 **Gibson & Benns.** Portable electric lamps.

16.992 **International Electric Co. & Le Noir.** Electrical signalling systems & annunciators chiefly for hotels.

16,993 **International Electric Co. & Le Noir.** Electric switches.

17,000 **International Electric Co. & Le Noir.** Audible signal devices.

17.125 **Turner.** Carbon saver for arc lamps.

17,155 **Schroeder.** Electric rotary converters.

The commutating poles of the converter or some of them, in addition to the usual series windings, are provided with auxiliary series or shunt windings, the excitation of which is controlled in any suitable manner by means of apparatus having series and shunt windings acting on a wattmeter principle which is energised in proportion to the output delivered or absorbed by the booster.

17,195 **British Thomson-Houston Co.** (Electric Controller & Manufacturing Co.) Electro-magnetic switches. (Addition to 20,534/11.)

17.260 **Orling, & Orling's Telegraph Instruments Syndicate, Ltd.** Apparatus for reversing the polarity of electric circuits for telegraphic and other purposes.

17.265 **Pickett, & Igranic Electric Co.** Means for effecting remote control of apparatus driven by electric motors.

17.276 **Schroeder.** Cooling of electric motors of the enclosed type.

17.386 **Relay Automatic Telephone Co. & Herink.** Automatic and semi-automatic telephone systems.

1916 Specifications.

203 **Modi.** Casings for electric wires. (5/1/16.) 102.387.

972 **Balding, Scantlebury & Scantlebury.** Coin-freed telephonic apparatus (20/1/16.) 102.396.

1.897 **Evans.** Sparking plugs. (9/2/16.) 102.403.

2,044 **Read, Franks & Brooks.** Wall boxes for containing electrical switches, plugs and the like. (11/2/16.) 102.404.

2.968 **Fuller, C., Fuller, L. & Fuller, C. J. A.** Galvanic batteries. (28/2/16.) 102,294.

3.599 **Siemens Bros. & Co., & Pettigrew.** Circuit arrangements for telephone or other installations provided with selecting devices. (10/3/16.) (Addition to 7.128/13.)

4.625 **King.** Electric torches. (29/3/16.) 102.426.

6.589 **Henderson.** Starting and stopping devices for electric motors. (8/5/16.) 102,434.

6.036 **Woltmann, E.** Electric welding apparatus. (1/5/15.) 100.401.

7.334 **Palmer, E.** Telegraph key. (29/5/15.) 100.590.

7,616 **Ritchie.** Electric signalling apparatus. (29/5/16.) 102.455.

8,310 **British Westinghouse Electric & Mfg. Co.** (Westinghouse Electric & Mfg Co.) Electric meters or relays. (12/6/16.) 102,335.

Comprises a motor having an armature the torque on which varies as the square of the current in the motor winding, and in which the motor winding is connected to the main circuit through a transformer having two windings, one of which is connected in parallel with the motor winding, and the other of which is connected in series with the parallel circuit comprising the motor winding and the transformer winding with which it is in parallel.

8,339 **Benjamin.** Holders for electric lamps. (8/7/15.) 100.836.

9,179 **Merriman.** Telephone systems. (29/6/16.) 102.454.

9.927 **British Westinghouse Electric & Manufacturing Co.** Methods of and apparatus for producing asymmetric waves of electromotive force. (14/7/15.) 100,893.

A method of producing periodic and relatively high potential electric impulses in one direction only in a circuit, in which a number of machines producing alternating currents of different froquencies are connected in series and the windings so arranged relative to the poles that the potential waves from said machines will recurrently agree in phase and a resultant asymmetrical potential wave will be produced whose negative amplitude periodically exceeds the amplitude of any of the component waves.

13.820 **Bignon, L. & Rousset, J. C.** Automatic ignition advancing devices for magnetos. (2/10/15.) 101,712.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 9, 1916

17,709 [illegible]. Electrical instrument for indicating instantaneous [illegible] current.

17,716 **Callender's Cable & Construction Co.** Electric fuses.

17,739 **B. T.-H. Co.** (G. E. Co.) Lighting fixtures.

17,74[illegible] **Entwistle & Marconi's Wireless Telegraph Co.** Wireless telegraph transmitters.

17,752 **Berry.** Electric [illegible].

December 11, 1916.

17,796 **[illegible].** Electric telephones.

17,798 **[illegible].** Secondary batteries.

17,8[illegible] **[illegible].** Telephone [illegible].

17,8[illegible] **[illegible] A. D. Riviere et Cie.** Electromagnet for lifting material.

December 12, 1916.

17,83[illegible] **[illegible].** Mercury vapour and other incandescent vapour lamps.

17,851 **[illegible].** Device for regulating commutator or collector.

17,852 **Baty.** Trolley heads or collectors.

17,856 **[illegible].** Control of electric motors.

17,867 **[illegible].** Manufacture of electric insulating materials.

December 13, 1916.

17,875 **[illegible].** Electric lamp holders.

17,878 **Law.** Sparking plugs.

17,[illegible] **[illegible].** Sparking plugs, electric ignition devices.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The Power Load in Sheffield. At the end of 1916 there were 3,915 electric motors, representing an aggregate of 68,739 H.P. connected to the Sheffield Corporation electric supply mains, compared with 3.423 motors and 45,916 H.P. in 1915, and 2,971 motors and 34,422 H.P. in 1914. The new connections (492 motors and 12,813 H.P.) therefore constitute a record in the history of the undertaking. In view of the increasing demand for electrical energy for power purposes the Corporation have decided to proceed with their Bill for powers to erect and equip a new power station outside the city boundary.

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Trading With the Enemy. A new consolidating list, containing the names of over 2,000 persons and firms with whom persons in the United Kingdom are forbidden to trade, has been issued by the Controller of the Foreign Trade Department.

The Controller points out that cases still come to the notice of the Foreign Trade Department in which firms are corresponding with persons on the statutory list. It is important that every one engaged in foreign trade should realise that he is under an obligation to make himself familiar with the list and to observe it in his dealings. Failure in this respect renders him liable to the heavy penalties provided by the Trading with the Enemy Acts, and these apply "to holding any communication whatever with anybody on the statutory list," and not merely to entering into an agreement or continuing to carry on business with such persons. In exceptional cases a licence may be obtained from the Foreign Trade Department exempting from the prohibition. Copies of the list may be obtained at a small cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

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Maximum Iron and Steel Prices. As stated in our last issue the Minister of Munitions issued an order on the 1st inst. fixing the maximum prices of steel.

Special handy heavy steel melting scrap is cancelled from the previous schedule.

The following were the new maximum prices fixed: Mild steel diamond pattern chequer plates, $\frac{1}{4}$ in. thick on plain or over, £13. 10s. per ton (altered on Jan. 5 to £13); under $\frac{1}{4}$ in. but not under $\frac{3}{16}$ in. on plain, £16. 5s., subject to list of extras **J** dated Jan. 1, 1917.

Higher high tensile steel plates 10 lb. thick and up, £22, subject to list of extras **K** dated Jan. 1, 1917; angles, 7 united inches and over, £21 (altered on Jan. 5 to £21. 10s.), subject to list of extras dated **L** Jan. 1, 1917.

Steel scrap sold without guaranteed analysis: heavy steel mild scrap £5. 5s. per ton, steel turnings and borings £2. 10s., special short extra heavy steel turnings £3. 10s.; all free on barge. Carriage may be charged to buyer up to a maximum of 10s. per ton.

* * * *

Glass Tubing and Rods. The Minister of Munitions has also ordered that no person shall manufacture any chemical or medical glass or glass tubing or rod unless the purpose for which the glass is required has been approved.

Manufacturers are required to render to the Director of Optical and Glassware Munitions, at regular intervals, full and accurate returns of their manufacture and output of chemical and medical glass and glass tubing and rod in accordance with the directions from time to time given by the said Director.

No person may buy, sell, or deal in any chemical or medical glass or glass tubing or rod situated or to be manufactured outside the United Kingdom unless a certificate authorising such purchase, sale or dealing has been issued on behalf of the Minister of Munitions by the Director of Optical and Glassware Munitions. Certificates will be granted to dealers to order reasonable quantities of chemical and medical glass and glass tubing and rod for the purpose of stock and/or export.

* * * *

Motor Work. The Minister of Munitions has prohibited, until further notice, any person, firm or company from carrying out (without a permit) any work connected with the manufacture, assembling or erection of any new or unused motor internal combustion engine designed or adapted for mechanical traction, or of any new or unused motor cycle, motor chassis, motor wagon or of any tractor or other motor vehicle of any kind propelled by mechanical means, except work required to complete contracts placed by the Admiralty, the War Office, the Minister of Munitions, or an Allied Government on or before Nov. 3, 1916.

* * * *

Registration of Names and Private Companies. The Wholesale Traders' Association has issued a report of the work of the Advisory Committee appointed at the public meeting in October last in connection with the passing of the Registration of Business Names Act. The report states that as a result of the deliberations of the Association and the Advisory Committee, amendments were formulated and submitted to the Board of Trade. The President of the Board also received a deputation from the Association, who submitted eight principal amendments, and five of these were incorporated in the Act. The directors are gratified at the success of their efforts, and the Association hopes to assist in endeavouring to bring about a similar alteration in regard to the law relating to limited companies, as, although the Registration of Business Names Act will be beneficial to the trade so far as private firms are concerned, it nevertheless leaves open a loophole for individuals to form themselves into private limited companies. and thus avoid the objects of the Bill. which only refer to private firms and persons.

The amendments put forward by the Wholesale Traders' Association and included in the Act are: (1) The addition of the true names of the owners of the business on all trade catalogues, circulars and business letters; (2) disclosure of nationality; (3) the exhibition in a conspicuous position in the principal place of business of the certificate of registration; (4) a legal representative or a trustee of a will or a trustee for creditors or other persons to be required to register: and (5) responsibility to be placed on persons and firms to register and increased penalties in default.

* * * *

Japanese Trade With Australia. The New South Wales Commercial Commissioner in the East reports that Australian exports to imports from Japan for the first ten months of last year amounted to £6,313,363, or £2,242,658 greater than those for a similar period of 1915. The Japanese trade in electrical fittings, porcelain, &c., is increasing very rapidly. The balance of trade in favour of Australia was £1,381,876.

* * * *

Electrical Exports of the U.S.A. The value of the exports of electrical goods for the nine months ended September, 1916, was $27,019,840, compared with $17,239,950 during the corresponding period of 1915.

With the exception of miscellaneous equipment and tungsten lamps, the 1916 exports will scarcely equal those of 1915 and previous years. Exports of generators, fans, interior-wiring supplies, arc lamps and carbon lamps were less in value, but insulated wires and cables, batteries, meters, motors, telephones, &c., show large increases. It is estimated that the electrical exports for the whole of the year 1916 should reach a total of over $36,000,000.

* * * *

Shanghai Switchgear. We have already commented upon the breakdown of A.E.G. plant at Shanghai, and in our issue of Dec. 1, 1916, quoted from one of Messrs. Arnhold, Karberg & Co.'s letters to the Council the following sentence:—"A breakdown of this description should not happen at all provided the switchgear with all its safety devices is of first-class design and in good and efficient working order; we should like to mention here that the switchgear was not supplied by us."

In this connection Messrs. A. Reyrolle & Co., switchgear experts and specialists in power switchgear control, write us as follows:—

It will interest you to know that the switchgear which the A.E.G. disavows is of our make. We have recently supplied two remote control Armourclad Draw-out panels for four 5,000 k.w. alternators for extentions to the original gear which was of Westinghouse make. The protective gear for which the A.E.G. representatives have drawn an unsolicited testimonial is of the Merz-Price balance type which operates conjointly with a field break switch so that the main circuit and then the field circuit are automatically opened in the event of a fault occurring. Incidentally the German agent's statement gives publicity to a very common dodge on the part of large firms, which is to press the buyer into buying switchgear from the alternator makers. In this case it seems, instead of using the argument prior to an order, they have made a bungle of using it in an endeavour to shift the responsibility for the faults of their plant on to somebody else. This is a typical example of the German method.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 30, 1916, *to* Jan. 6, 1917

IMPORTS.

London.—*U.S.A.:* Elec. carbons, £780; elec. machinery, £820; telephone material, £260; unenumerated, £4,051. *Japan:* Unenumerated, £1,441.. *France:* Elec. carbons, £532; glow lamps, £282. *Switzerland:* Unenumerated, £53. *Denmark:* Elec. machinery, £885. *Canada:* Unenumerated, £260. *Sweden:* Unenumerated, £1,267. *Holland:* Elec. lamps, £1,150; glow lamps, £6,040; unenumerated, £2,550.

EXPORTS.

To Australasia.—*Auckland:* Wire and cable, £104; elec. machinery, £820; unenumerated, £10. *Melbourne:* Elec. machinery, £4,101; wire and cable, £763; unenumerated, £631. *Sydney:* Elec. machinery, £180; wire and cable, £1,102; telephone material, £1,233; unenumerated, £1,175. *Wellington:* Elec. machinery, £41; wire and cable, £529; unenumerated, £368. *Lyttelton:* Unenumerated, £23. *Adelaide:* Elec. machinery, £78; elec. lamps, 525 n.o.; unenumerated, £356. *Brisbane:* Elec. machinery, £111; unenumerated, £47. *Perth:* Unenumerated, £26. *Habart:* Unenumerated, £26. *Dunedin:* Wire and cable, £50. *Christchurch:* Wire and cable, £188; elec. machinery, £138; telephone material, £70; unenumerated, £134. *Fremantle:* Unenumerated, £40. *Gisborne:* Unenumerated, £96.

Africa.—*Durban:* Wire and cable, £320; elec. machinery, £473; unenumerated, £302. *Cape Tawn:* Elec. machinery, £58; elec. lamps, 800 n.o.; wire and cable, £235; unenumerated, £54. *Port Elizabeth:* Unenumerated, £22. *East Landon:* Unenumerated £378. *Beira:* Elec. machinery, £83; unenumerated, £47.

Egypt.—*Alexandria:* Wire and cable, £104; unenumerated, £447. *Port Sudan:* Unenumerated, £90.

Aden.—Unenumerated, £83.

India, Ceylon, Indo-China and Straits Settlements.—*Bamhay:* Wire and cable, £1,519; telephone material, £200; elec. machinery, £295; unenumerated, £491. *Calcutta:* Elec. machinery, £285; telephone material, £25; wire and cable, £302; unenumerated, £552. *Madras:* Elec. machinery, £355; unenumerated, £114. *Ceylon:* Elec. lamps, 1,500 n.o.; wire and cable, £337; unenumerated, £97. *Singapore:* Unenumerated, £126. *Penang:* Elec. machinery, £664. *Bankak:* Unenumerated, £160. *Port Swettenham:* Unenumerated, £53. *Shanghai:* Wire and cable, £453; elec. lamps, 35,784 n.o.; unenumerated, £579.

China.—*Hongkang:* Elec. machinery, £474; unenumerated, £437. *Hankow:* Wire and cable, £76; unenumerated, £206.

South and Central America.—*Mante Videa:* Unenumerated, £10. *Buenos Ayres:* Wire and cable, £3,682; elec. machinery, £905; elec. lamps, 2,200 n.o.; unenumerated, £579. *Antafagasta:* Unenumerated, £149.

Holland.—*Amsterdam:* Wire and cable, £33; unenumerated, £205. *Rotterdam:* Wire and cable, £73; unenumerated, £153.

France.—*Paris:* Elec. machinery, £632; unenumerated, £50. *Dieppe:* Elec. machinery, £125. *Nantes:* Elec. machinery, £115. *Calais:* Wire and cable, £910; unenumerated, £475.

Canada.—*Montreal:* Elec. machinery, £1,401. *Toronto:* Unenumerated £33.

Malta.—Unenumerated, £62.

Gibraltar.—Unenumerated, £17.

Conception.—Unenumerated, £329.

Norway.—*Bergen:* Wire and cable, £763.

Denmark.—*Copenhagen:* Unenumerated, £41.

Russia.—*Vladivostock:* Unenumerated, £99. *Petrograd:* Elec. machinery, £319; unenumerated, £31.

Italy.—*Jensa:* Wire and cable, £622.

FOREIGN GOODS (duty paid and free).

New York: Unenumerated, £35. *Hankow:* Telegraph material, £70; unenumerated, £203. *Havre:* Unenumerated, £241. *Sydney:* Unenumerated, £316. *Cape Town:* Elec. lamps, 100 n.o. *Christchurch:* Unenumerated, £33. *Dieppe:* Unenumerated, £13. *Fecamp:* Unenumerated, £10.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL.

London School of Economics. Mr. Ernest J. P. Benn will deliver a public lecture on "The Organisation of Trades" at the London School of Economics and Political Science, Clare Market, Portugal-street, Kingsway, W.C., on Thursday, the 18th inst., at 5 p.m.

Mr. Benn, whose views on matters of trade organisation as expressed in "Trade as a Science," received widespread attention in the press, will elaborate the proposals for the reorganisation of trade with which his name is already associated. We notice from the syllabus that he will deal specifically with the interests of the State in trade, the increase of production and the right of labour to a share in control. It is generally conceded that the maximum of production is essential to the maintenance of commercial pre-eminence, and is vital to the interests of both labour and capital. Mr. Benn has already expressed the view on many occasions that that maximum can only be obtained by the careful organisation of each separate trade. On Thursday next he will detail a plan for co-operation between the State, the capitalist and the workman, which combines the advantages of present methods with the benefits of co-operation. The lecture, which is open to the public, commences at 5 p.m.

Teaching of Science. At the annual meeting of the Association of Public School Science Masters last week, Mr. E. R. Thomas (Rugby) opened a discussion on "Technical Bias in Schools."

Mr. Thomas thought that at present the bias was too much in favour of the boy who was going to wear the cap and gown as a University don at the expense of the boy who cared for things rather than words, and to whose future the discovery of the internal combustion engine was of more importance than the invention of the printing press. Whether England recovered her lost industrial supremacy or not would depend upon the work of science masters. At the present day the profession of the industrial chemist was in its infancy in this country. He deplored the absurd remuneration which the chemist was obliged to accept, and asked what was to be said of a Government official list which placed navvies and chemists in one group.

Lieut.-Col. Prof. Smithells urged the need for bringing science teaching into close touch with the realities of ordinary life.

Prof. H. E. Armstrong said that a fundamental failure hitherto had been largely due to the over-teaching of things which, got up for examinations, did not count at all. Our supremacy in the future would undoubtedly depend upon the science masters, but not upon giving training to a limited number of men. They must develop the receptive habit. There had been a failure on the commercial side to appreciate the real issues. We must look ahead, as the Germans had been doing, with the idea of prospective results. There must be a broadening of outlook, and he would like to see more time given to manual training.

Mr. Vassall (Harrow) brought up a printed scheme of science work for public schools which was formerly approved.

Earlier in the meeting Prof. H. H. Turner (Oxford), in his presidential address, said the energies of reformers should be devoted to specially training those who showed an aptitude for science. He advocated an advance on research lines and a widening of the existing Civil Service.

Prof. R. A. Gregory urged the growing need for training in the method of observation and experimental inquiry. When this was met, science would not be placed outside the circles of the so-called humanities.

BUSINESS NOTICES.

The office of the High Commissioner for the Commonwealth of Australia has been removed to Australia House, Strand, London, W.C. Telegraphic address: Crotonate Estrand London; telephone: City 1743 (nine lines).

The London Electric Firm have removed to Brighton-road, Croydon. Telegrams: Electric, Croydon; Telephone: Purley 68.

Messrs. James Livingston, Ltd., who have been for over 20 years at 30, Great St. Helens, E.C., have removed to Imperial House, Kingsway, W.C.

Messrs. Livingston are vacuum drying, solvent recovery and chemical plant experts, and are representatives for:—Messrs. J. P. Devine Co. (Buffalo, N.Y.), Maurice A. Knight (Akron, O.), the P. & K. Liquid Grinding Mill and the "K. E. K." Grinding Mill.

The offices of the Ceara Tramway, Light & Power Co., Ltd., have been removed to 119, Finsbury-pavement, E.C.

Mr. W. Ratcliffe Small asks us to announce that his address for the present is 159, Westminster Bridge-road, London, S.E. Telephone: Hop 4,703.

Sale by Tender.—An advertisement contains particulars of a sale by tender of 1,083 coils of insulated cables, ex "Montebello," lying at Hull. The sale is by order and for account of the Marshal of the Admiralty, and samples may be seen and tender form obtained at the offices of the selling brokers, Messrs. Robert Lyon & Co., A23 & 24, Royal Exchange-buildings, Liverpool, and 1, Lombard-court, London, E.C.

Patent Development.—The owner of patent No. 28,630 of 1913, relating to "Electrolytic converter for the transformation of a.c. into c.c.", desires to make arrangements for developing same in this country. Particulars from Messrs. Allison Bros., 84/6, Chancery-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Kilowatt Publishing Co. (Ltd.), 203/6, Temple-chambers, Temple-avenue, London, E.C., is being wound up voluntarily. Mr. Arthur Webster, 203/6, Temple-chambers, E.C., and Mr. Edward A. Burnie, 59/60, Gracechurch-street, E.C., have been appointed liquidators. A meeting of creditors will be held at 203/6, Temple-chambers, E.C., on Jan. 16.

In the winding up of the Leitner Electrical Co. (Ltd.), Maybury, Woking, a first dividend of 3s. 4d. will be payable on Jan. 24 at the offices of Messrs. Corfield & Cripwell, 119, Finsbury-pavement, London, E.C.

Claims against the Mitcham Motor Co. (Ltd.) (in vol. liq.) are to be sent by Feb. 26 to Mr. John Baker (Messrs. Baker, Sutton & Co.), Eldon-street House, Eldon-street, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barking.—A loan of £5,000 is to be taken up for extensions of the electric supply mains.

Battersea (London).—Agreements have been sealed to supply energy to Messrs. Dorman, Long & Co., Arding & Hobbs and the Sadlers Wells Theatres Co.

Bedford. The Corporation have adjourned the consideration of a proposal to put down additional turbo-generator plant, transformer, mains, &c., at a cost of over £34,000.

Cheltenham. The Council have decided to spend £750 in laying a cable to supply electric current to a factory.

Derby.—Last week the Corporation approved a proposal to expend another £29,500 upon additional generating plant and mains.

It was pointed out that the demand for electrical energy for power continued to increase at a rapid rate. The money would come out of the sinking fund, the calls upon which had diminished owing to the restrictions upon capital expenditure. The Government department interested in the extensions had expressed approval, and had promised priority in the delivery of the requisite plant and material.

Ald. W. G. Wilkins, chairman of the Committee, mentioned that during the year ended September last the electricity receipts amounted to £64,000, compared with £50,000 in the year ended Sept., 1914. For that supplied for power £29,700 was received, against £16,000. After allowing for the 10 per cent. advance in the charge to consumers, there was an increase of 75 per cent. in the receipts, notwithstanding that practically the whole of the street lighting had been discontinued, that there was a decline in the consumption for private lighting, and that the coal bill was £7,600 heavier. The gross profits had grown from £21,000 to £30,000 per annum. By the introduction of modern plant, 5½ lb. of coal was now used as against 9 lb. eight years ago, in generating a unit of electricity. That economy effected a saving of £10,000 per annum. When he became a member of the Committee 21 years ago the turnover was £4,800 a year, but it was now more than £5,000 per month. The committee were forced by the demand for electric energy for power to make the extension now suggested, by which the capacity of the works would be increased from £64,000 to over £80,000 worth per annum. The additional cost in sinking fund and interest charges would be £2,800 per annum. The extension would only meet immediate needs.

Manchester.—The Electricity Committee recommend the City Council to apply to the L.G. Board for borrowing powers to the extent of £30,000, for extensions of the undertaking.

The last sanction for a similar amount is fully earmarked for substations now being equipped, and before any further necessary contracts can be placed it is imperative that further powers should be obtained.

Sheffield.—Cables are to be extended at an estimated cost of £223, and supply is to be given to works outside the City boundary.

The Treasury has approved of the borrowing of £8,280 for rotary converters and sub-station buildings, including cost of purchase of a site for a sub-station.

GENERAL.

Accrington.—The salary of the acting electrical engineer (Mr. A. W. Clegg) has been increased from £350 to £400 per annum.

Mr. Clegg is also to be granted a special fee of £50 for loss of holidays, prolonged hours of duty and special work in connection with the installation of new plant. He receives a further grant of £140 from the chief electrical engineer (Mr. Gray) during his absence in the Army.

Tho new boiler feed pump has been erected, and a quotation has been accepted for overhauling the old pumps.

Alleged Preferential Charges.—In reference to the action which is being brought by the Gas Light & Coke Co. against Hackney (London) Borough Council to restrain alleged preferential charges for the supply of electricity, the Woolwich Electricity Committee reported to its Council last week that the question involved was one of great importance to the Council's electricity undertaking, and that the Council should bear an equitable proportion of the costs involved.

The Council were also recommended to request the Hackney Council and the Municipal Electrical Association, who are taking great interest in the matter, to make a representation to the Ministry of munitions with a view to the proceedings remaining in abeyance during the war.

Both recommendations were adopted by the Council.

Exeter and York Corporations are also supporting Hackney with financial assistance.

Battersea (London).—In December, 1915, the Metropolitan Water Board entered into an agreement for the supply of electric current for lighting and for power.

The price was fixed at 1d. per unit for power and 3½d. for lighting, plus 10 per cent. temporarily increased, but tho Board instructed its Committee to report on the result of the arrangement at the end of 12 months and as to tho trial of an alternative method offered by the Council, viz., for the supply of current at £4 per kw. of maximum demand per annum, plus ½d. per unit when the average prico of coal did not exceed 12s. per ton, 10 per cent. of the total consumption for power being allowed for lighting at power rate. The Chief Engineer now states that the portions of the buildings at Battersea where the principal use of electric power was contemplated, are at present in the temporary occupation of H.M. Government; that the total charge for power for the four quarters ended September last amounted to £14. 19s. 9d., of which 14s. 2d. only was chargeable to the Board and the remainder to the Government. Until there was a considerable increase in the power load the present method of purchasing the current was satisfactory.

Bedford.—Last week the Council rescinded the resolutions passed to supply current to proposed large works in the neighbourhood, and a Sub-Committee is to try to obtain better terms for the Council.

Colchester.—On the presentation of the Electricity Committee's report last week the chairman (Ald. Barritt) said the conditions under which electric current was now being generated and distributed were much more serious than formerly, and might become critical.

Those conditions were caused by the decrease in the staff, and he remarked that they might have to suspend temporarily the supply of current.

Mr. Wright suggested that tho Committee might send out a warning to the inhabitants to discontinue "the use of high-voltage lamps, and use those of lower voltage—say 5 volts."

Glasgow.—For the current financial year the receipts of the tramways department (up to Dec. 30) were £715,746, an increase of £54,702. 18s. 9d. on the corresponding months of the preceding year. The number of passengers carried was 223,613,743, against 207,631,023.

Increased Charges for Electrical Energy.—The charges for electrical energy are being increased at the following places:—

At Walsall the charges are being increased temporarily by 20 per cent.

Worthing Council has increased its charges by 20 per cent., making 30 per cent. over pre-war charges.

Hebden Bridge Council is increasing its prices for current for lighting by 20 per cent. and for power by 25 per cent. as from 1st inst.

Southwark (London) Electricity Committee propose to increase their charges for current to 30 per cent. over pre-war prices for lighting and 50 per cent. for power. It is also intended to increase the charges by 1 per cent. without further notice for each 6d. by which the contract prico per ton of coal exceeds 20s. on all accounts issued after Jan. 1, 1918.

Kensington Council will not object to the Kensington & Knightsbridge Electric Lighting Co.'s proposal to make a surcharge of 10 per cent. on customers' accounts from Jan. 1 to June 30, 1917. The maximum charge has hitherto been 5d. per unit.

Linking-up in North London.—Arrangements are being made for linking-up the North Metropolitan Electric Power Supply Co.'s undertaking with that of Hackney Borough Council. A cable is to be laid from Edwards-lane, Stoke Newington, to the Council's sub-station at Northwold-road.

Llandudno.—The electrical engineer (Mr. H. Morton) is reporting on the question of providing a storage battery available for small loads.

Luddenden Foot.—The Urban Council have made arrangements with Halifax Corporation for the supply of electric current for public lighting.

Marylebone (London).—In a report to the Electric Supply Committee, the general manager of the electricity department, Mr. A. H. Seabrook, refers to his interim report on the question of whether it would be commercially possible to gasify coke in producers, extract the ammonia and turn it into sulphate, and fire the boilers with gas.

Mr. Seabrook reports that the capital cost which would be entailed would far exceed any saving that could be made. The next best thing to do, and which was a big step in the right direction of the proper utilisation of coal, and furthermore would pay to do, was to fit two boilers with the Underfeed Co.'s type of travelling grate combined with forced draught. These grates would increase the capacity of the two boilers by 25 per cent.; instead of a boiler capacity of 2 they should get an equivalent of 2½. A half a boiler was worth between £3,000 and £4,000. Mr. Seabrook states that he has always been grateful to Mr. A. Wright for the class of boiler he installed at the generating station. Under the conditions they were required to work they were very large for their output, and by increasing the draught they could greatly increase their capacity. Two or three years ago it was agreed to increase the induced draught in the boiler house and a contract was placed with Messrs. Babcock & Wilcox, to be carried out gradually, and which was now half completed. That was as much as they could do to increase the boiler capacity by means of induced draught, but by adding forced draught as would be the case with the underfeed stokers, they got a still further capacity; at the same time that would not damage the boilers in any way, as they were so amply designed as to be capable of more work without detriment. The output of a boiler depended upon the fuel fed in, plus air necessary for combustion. Had their boilers been designed on a narrow margin it would not have been possible to have obtained a greater output from them by increasing the air supply. They were designed to evaporate normally 18,000 lb. of water per hour, and by increasing the draught, both forced and induced, they could bring that up to 25,000 lb., or 39 per cent. The boilers with Underfeed grates would work continuously on coke breeze and similar low-class fuels, or one of the two could be fed with the coke and gas obtained from the proposed distillation plant. The Underfeed Stoker Co. had submitted a tender for tho necessary plant at £1,781, but the work to be carried out by the station staff would amount to £319, a total of £2,100. The existing grates of the two boilers for which they proposed to substitute Underfeed grates being worn out, would next year cost £500 for renovation, so that the net cost was £1,600, less tho value of a number of parts that would be used as replacements for the other stokers.

Newcastle (Staffs.).—The salary of the borough electrical engineer, Mr. A. J. C. De Renzi, has been increased by £25 per annum as from Jan. 1.

Newport (Mon.).—The maximum load at the electricity works occurred an Dec. 21 when it exceeded 4,560 H.P., compared with 3,950 H.P. in 1915, or an increase of 17·7 per cent.

Tho increase in units generated, however, exceeded 30 per cent., owing to the much improved load factor on the works due to the power supply to factories, which is practically a day and night load. Notwithstanding the great restrictions in force, after allowing for disconnections, there was an increase of 78 in the number of consumers during 1916, the total number of consumers being 2,354. The domestic use of electricity has also shown a very considerable increase, and the recent exhibition has done a great deal to develop the use of electricity for these purposes. It is reported that the outlook for the electricity undertaking has never been more favourable than it is at present.

Purchase of Coal.—At the meeting of Bristol Corporation last week, Mr. Veale moved that a special committee be appointed to report upon the present method of the purchase and delivery of coal by the various Committees of the Council, and as to the desirability of appointing a committee to control the purchase and delivery of all coal required by the several Committees.

Mr. VEALE stated that there were 12 committees which bought their own coal. The Electrical Committee was the largest buyer and the Docks Committee was also a large purchaser. The Electrical Committee bought 44,600 tons per annum, and the Docks Committee 15,000 tons. In addition, there were 10 committees who were buying about 10,000 tons a year, but they could not store it. He would like a special committee to consider if something could not be done by which those committees could join together, and so buy at the right time and at the lowest price.

In the course of the discussion Sir WM. HOWELL DAVIES suggested that the motion would be more acceptable if the Docks and Electrical Committees were omitted. He could understand that co-operation in the purchase of coal for committees who used similar sorts might be advantageous. He was not sanguine it would mean a large saving to make any alteration, and he quoted figures to show that the Corporation as buyers obtained favourable terms. He did not think they were likely to get coal at very much lower prices than they were paying at present. The competition and the desire to serve the Corporation were so keen on the part of their fellow citizens that the prices were extremely low. If a depot were established they would find depreciation of material. At the same time, he had no objection to a committee to consider proposals so far as committees outside the Electrical and Docks Committees were concerned.

Mr. METCALFE thought the proposal was the thin end of the wedge in regard to municipal trading. Directly the Corporation began dealing in coal they would have to provide for horses, carts, yards, officials, weighbridges, losses by depreciation, strikes and insurance.

In reply, Mr. VEALE assured the Council he was entirely against municipal trading, but he thought they were justified in trying to buy in a better market. His proposal was not for war time, but for a permanency.

The motion was lost by 22 votes to 24.

Rotherham. It is reported that the electric supply department has made good progress during the past year, the demand for power having greatly increased.

The department has, therefore, been compelled to carry out extensions of plant in order to meet the demand.

Amongst the new businesses opened during the year is a manufactory for the production of alloys. To facilitate the output an electric furnace—one of the first of its type in the borough—has been introduced.

Southwark (London). The Electricity Committee has purchased five motors for power consumers (two on the hire-purchase system and three for hire), and also 140 yds. of cable will be bought and laid at a cost of £166.

Woolwich.—The salary of the borough electrical engineer (Mr. G. W. Keats) has been increased from £400 to £500 per annum, as from April 1, 1916, and the matter is to be reconsidered at the end of the current financial year, when the results of the working of the electricity undertaking are available.

Walsall.—The repairs to the rotor of an alternator at the generating station were completed on the 9th ult., but it was taken for another establishment.

The Town Clerk has been instructed to take steps to prepare the Council's claim for compensation in respect of loss sustained by reason of plant on order for the new station being required for State work. The commandeering of the plant will cause further delay in getting the plant at the station into commission. The question of increasing the present tariff for bulk supply (which provides for a coal clause and for a three years' agreement) has been deferred until the new station is in [illegible].

On the 1[illegible]th ult. the maximum load recorded at Wolverhampton-street Station was 2,096 kw., the effective capacity of the plant being 1,870 kw.

LIGHTING & POWER NOTES.

Banbridge.—The Council have decided to invite tenders for public lighting by electricity [illegible].

Dudley.—The Streets and Lighting Committee has decided upon an increase of street lighting, and a special committee is to prepare a practical scheme.

Electric Driving in Textile Works.—The new factory of Celltex (Ltd.) at Manor Park has been equipped electrically throughout by Messrs. Marryat & Place. The motors are from 1 h.p. to 15 h.p. and total about 100 h.p. in all. The lighting is by means of half watt lamps.

Electric Heating Boom.—The electrical engineer of St. Annes Urban Council (Mr. J. H. Clothier) reports that there was a particularly large demand for electric radiators last month.

Householders are turning to electric fires in preference to coal fires. Notwithstanding the reduced consumption for lighting Mr. Clothier states: "The load upon the station during the past fortnight has been exceptionally heavy, principally due to radiators; the load has constituted a record in the way of maximum, practically the whole of the plant has been in operation and the spare plant reduced to a minimum."

Lewes.—Seventeen new electric lamps are to be erected in Southover district.

Sheffield. In a review of the past year's trade it is stated that a new era in the local steel industry is created by the introduction of the electric furnace.

Though a number of electric furnaces have been at work for some years, the war has caused them to receive attention from the trade as a whole. Nearly 40 such furnaces are at work or contracted for, and many additions to the number are likely to be made in the near future. The Greaves-Etchells type is stated to have won general favour, and the small sizes are proving quite satisfactory for the manufacture of high-speed steel. In a number of cases electric steel has proved a reliable substitute for Swedish steel, and the extension of electric melting should lessen the city's dependence upon Swedish iron and steel products, which are scarce and very dear. The electricity department of the Corporation realise that electric melting has a great future and are arranging for a large increase in the supply of current. They are supplying current to 20 furnaces, and they expect shortly to couple up a further 16, the output of the whole being estimated at 100,000 tons per annum.

Seven firms are now making permanent magnets, a new local industry, and one is producing large electromagnets for lifting purposes.

TRACTION NOTES.

Halifax.—The Board of Trade has extended for one year from Aug. 18, 1916, the time limited by the Corporation Act, 1911, for the construction of certain tramways.

Huddersfield.—Owing to the pressure on the tramways the Tramways Committee have issued an appeal to passengers asking for forbearance.

The appeal states that 180 persons have enlisted or been drafted to other work by the Government, and the whole of the works staff has been taken. It is proposed to reduce the number of stopping-places on the routes, and it is hoped that no parcels may have to be carried after 5 p.m. Ladies are requested to shop as early in the day as possible or in mid-afternoon, so as to relieve the mid-day congestion. Persons who previously used the railways are now availing themselves of the tramways.

Manchester Tramways.—Owing to labour shortage and an increase in the number of passengers, great difficulty is being experienced in maintaining an adequate tramway service in Manchester and Salford.

At Salford the employment of women as drivers is under consideration, but the general manager of the Manchester tramways (Mr. J. M. McElroy) states that whereas when his Committee first asked for women as guards they were overwhelmed with applications, the number received now is exceedingly small and does not bring the right class of woman. At Manchester they have been able to get enough drivers to maintain the pre war services, but they lack skilled men for the work of car maintenance, which is the chief thing that prevents an increase in the number of tramcars run. Tramway managers regard the employment of volunteer or auxiliary men drivers as more practicable than the introduction of women drivers. The main difficulty is the training. At present a prospective driver gives to his training several hours a day for three or four weeks. Only a small part of it can be got by indoor instruction. Most of the time he spends on the cars, learning not only the practical work of a driver, but also—what is very important—the routes over which he may be called upon to run. A scheme of voluntary help could not be entertained unless a sufficient number of men came forward who were able to give a good number of hours per week, at any rate during the training period. A body of voluntary drivers once trained could be made good use of. Mr McElroy suggests that the public who use the trams might do a good deal towards a solution of the problem. It is only acute during an hour or two in the morning when people are coming into the city for business, and during a couple of hours in the evening when the stream of passengers flows homeward to the suburbs. Mr McElroy is appealing to those people who use the trams in these busy hours, but who are under no obligation to do so, to avoid the "rush" hours in the morning and evening. Mr McElroy also points out that a great number of school children are carried on the trams in the busiest hour of the morning. He thinks it not unreasonable to suggest that the schools should open at 9.30 instead of 9.

Women Conductors on the Underground Railways.—It is announced that owing to the number of men called up for service women conductors are to be employed on the Tube railways.

Sheffield.—Application is to be made to the Ministry of Munitions for a permit to have 100 tons of tram rails rolled.

Tramway Accidents.—An accident occurred at Bradford on Monday, when a tramcar ran down an incline between Wyke and Bailiff bridge.

A driver had to leave his car at the top of a steep hill to deliver some newspapers. After he had got off the car started, and on the way down the hill it crashed into another car full of passengers, wrecking it. Of the passengers 21 were injured, and the conductress of the runaway car was also seriously injured.

At Dudley, on the 4th inst., a tramcar accident occurred, resulting in the death of a passenger and injuries to 25 others. It appeared that the driver (Benjamin R. Davies), having brought the tramcar to the terminus at the top of the Tipton-road, applied his brakes, and for some reason left the car. The conductress (Maggie Jefferson) proceeded to reverse the poles. She afterwards boarded the car at the rear, in company with a learner (Annie Payne). The brakes were released before the driver returned to the car, and it started down the Tipton-road—a long and rather steep gradient—and near the G.W.R. goods station it jumped the metals and overturned. The learner Payne was fatally injured.

Tramways Employees Wages.—Sir Geo. Askwith has awarded a war bonus of 6s. 6d. per week to the male tramway employees in 14 Lancashire towns.

The amount awarded includes any increases granted since the outbreak of the war. Youths under 18 are to receive a war bonus of 3s. 3d No change is made in the wages or war bonus paid to female employees.

MISCELLANEOUS NOTES.

Electric Light Switching.—The results of the second batch examination in this subject are given below. Those desiring further particulars should communicate with Messrs. A. P. Lundberg & Sons, 477-489, Liverpool-road, London, N.

Advanced Grade (in order of merit).—W. A. McCall (Blackburn), H Grimshaw (Golborne), and J. J. Rogers (Dundalk).

Intermediate Grade (in order of merit).—John Moran (Bury, Lancs.), R. H. Lawrenson (Romsey), T. A. Holt (Birmingham), N. A. Jassawalla (Karachi, India), S. Booth (Warrington), J. Prime (Stafford), E. Emery (Old Hill, Staffs.), Sapper N. A. Robinson (Beaumaris), J. Wright (Grimsby), W. M. Fowler (Grimsby) and W. R. Clements (St. Margaret's-on-Thames).

Worked Another Paper.—J. Bibb (London, S.W.), and D. H. Keeling (H.M.S. "Ajax").

Preliminary Grade (in order of merit).—H. M. Osborne (Birmingham), R. F. Galea (Malta), P. F. Hood (Leith), J. Pendleton (Sheffield), "Parwin" (Hinckley), H. Pritchard (Rhymney), W. F. D. Morgan (Tredegar), M. C. Stoker (Manchester), S. Addyman (Leeds), R. P. Gilbert (London, N.), D. L. Little (Rugby) and G. Doudney (London, S.E.).

Worked Another Paper.—A. J. Tourle (Dunstable), R. C. Stripp (London, N.W.), J. Hamer (Dewsbury), Sapper R. Rees (B.E.F.).

Candidates whose Papers were in time for this batch, and who do not find their names above, have failed to qualify.

Enemy Firms Wound Up.—The Board of Trade have ordered the winding-up of 398 business controlled by alien enemies.

The latest list includes Carl Zeiss (London) (Ltd.), 13-14, Great Castle-street, Oxford-circus, London, W., opticians, &c. (Controller: L. H. Weatherley, 14, George-street, Mansion House, E.C.) Institute W. Lehimmelpfeng, 137, Cheapside, London, E.C. and elsewhere in the United Kingdom, inquiry agency. (Controller: R. E. Smith, 53, New Broad-st., E.C.

Claims against H. Uhlhorn & Co. (Ltd.), 11, Christopher-street, Finsbury-square, London, E.C., are to be sent to Mr. E. J. Webber (Messrs Percy Mason & Co.), 64, Gresham-street, E.C., by Feb. 28.

Engineers' Piece Rates.—At Manchester on Tuesday an inquiry was opened by the Chief Industrial Commissioner's Department into questions connected with piece-worker's rates and earnings in the Manchester engineering trade.

The Court was composed of Mr. W. Mackenzie, K.C. (chairman) and Mr. I. H. Mitchell, of the Chief Industrial Commissioner's Department, London, with the following as assessors: Messrs. F. S. Goodbehere, F. Coventry and M. E. H. Greg (representing the employers), and Messrs. J. Binns, G. Ashcroft and R. H. Coates (representing the workers).

The inquiry is the outcome of the recent award of the Government Productions Committee respecting the appeal of engineers and allied trades for an increase in wages. In the recent negotiations the trade unions protested that the piece rates were wholly inadequate, and Sir Geo. Askwith promised an inquiry into the whole question.

Evidence was given by piece workers in several engineering works in support of the contention that the rates allowed are insufficient.

Improper Use of Electric Current.—At Wolverhampton last week John C. Turton was summoned for having improperly used electricity supplied by the Corporation

In August last defendant applied for a supply of electricity for power purposes, and recently it was found that the current was being appropriated for lighting purposes.

For the defence it was explained that prior to Nov. 5 defendant's premises were lighted by a dynamo. On that date a mishap occurred to the dynamo, and defendant, who was working on munitions, obtained light from the power supply. The same day, or shortly after, a man from the electric supply department called, and at defendant's request the Corporation supplied another meter. There was no intention to defraud, as everything was done openly. Defendant's sole idea was to get on with the work.

The STIPENDIARY said no doubt electric current was wrongly applied, and fined defendant 40s.

South African Patent Law.—In a communication Mr. H. T. P. Gee, patent agent, of Croydon, points out that on the 1st inst. a new Patent and Trade Marks law came into force in South Africa, under which Transvaal, Cape, Natal and Orange Free State can now be covered by a single patent or trade mark registration.

Formerly this could only be done by taking a separate patent or trade mark registration in each province. Provincial patents and trade marks may be converted into Union patents and trade marks. The Union of South Africa is thus brought into line with the Australian Commonwealth, where, until a few years ago, a separate patent had to be taken out in each state in which protection was desired. This consolidation of the patent laws renders both the obtaining and upkeep of patents much less costly, and should encourage industry. The new Union law provides (inter alia) for the grant of: Provisional protection (lasting nine months), a single patent for cognate inventions, patents of addition, compulsory licences or revocations, and certain prohibitive or restrictive conditions in contracts will be invalid. Renewal fees will be payable before the expiration of the third, seventh and tenth year from the date of the patent.

Trading With the Enemy.—The "London Gazette" of Dec. 22 contained further additions and alterations to and removals from the statutory list of persons and firms with whom trading by persons and firms in the United Kingdom is prohibited.

Amongst the additions are: *Spain.*—Deutsche Sudamerikanische Telegraphongesellschaft, Tenerife; and Specht (of the same company), Santa Cruz de Tenerife.

Wills.—The late Sir Hiram S. Maxim left estate of the gross value of £33,000. The late Sir William Ramsay left personal estate of the value of £17,896.

Women Electrical Engineers.—A woman has been placed in charge of the electric supply works of the Bradninch & District Electric Supply Co.

TENDERS INVITED.

Electric Cranes.

Tenders are required until Feb. 12 for the supply of six 1-ton Electric Travelling Portal Jib Cranes for DURBAN Harbour. Specifications from Secretary to Tender Board, S. African Railways Headquarter's Offices, Johannesburg, or from the High Commissioner for South Africa, 32, Victoria-street, London, S.W., at which addresses tenders will be received.

Electric Light Wire.

The VICTORIAN RAILWAY COMMISSIONERS, Melbourne, require tenders by 11 a.m., Feb. 7, for supply of v. r. Electric Light Wire (p. d. ½ per cent.). Particulars from the Contractors' Room, Railway Commissioners' Offices, Spencer st., Melbourne.

Electrically Controlled Clocks.

The Deputy Postmaster-General, Sydney, will receive tenders until Jan. 22 for supply and installation at Newtown (N.S.W.) Post Office of 9 Electrically-Controlled Clocks (Schedule 599 N.S.W.), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmaster-General.

Electrical and General Stores.

MIDDLESBROUGH Corporation require tenders by first post Feb. 1 for 12 months' supply of Electric Lamps, Rubber Goods and General Stores. Specification, &c., from the Borough Engineer.

Turbo-Alternators, Dynamos, Switchboards, Motors, &c.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of MELBOURNE electricity works. Tender form, with specification, from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Agents for Melbourne City Council, Billiter-square-buildings, London, E.C., and tenders to the Chairman, Electric Supply Committee, Town Hall, Melbourne, must be received by noon of March 5.

The AUSTRALIAN COMMOMWEALTH NAVY DEPARTMENT, Melbourne (Victoria), require tenders by noon Jan. 31 for supply of Dynamos, Switchboards, Motors, Balancers and Control Gear for Flinders Naval Base. Specifications from Director of Navy Contracts, Melbourne, and the Naval Staff Offices, Brisbane, Sydney, Birkenhead (S. Australia), Fremantle and Hobart.

DUNEDIN (N.Z.) Council require tenders by 5 p.m. Jan. 24 for the supply of a Motor-Generator, with Accessories and Spares. Specification may be seen at the office of the City Electrical Engineer.

TENDERS RECEIVED AND ACCEPTED

BATTERSEA.—The Borough Council has ordered a 360 k.v.a transformer from the British Electric Transformer Co. at £368.

TWICKENHAM.—The Urban Council has accepted the tenders of Stuart & Moore to install fire call bells, for £48. 11s. 3d.

RAWTENSTALL.—The Council have placed an order with the British Westinghouse Co. for the supply of additional switch panels.

MARYLEBONE (LONDON).—The following tenders have been accepted by the Council :—

Babcock & Wilcox, ash conveyor, £1,590 ; coal conveyor under coal bunkers, £1,190 ; James Oakes & Co., c.i. parts, £265 ; Underfeed Stoker Co., travelling grate, &c., with forced draught, £1,781.

SHEFFIELD.—The Tramways Committee has accepted the tender of the British Thomson-Houston Co. for 50 tramcar motors.

The Electric Supply Committee has accepted the following quotations :—R. White & Sons, extending ashes roadway at Neepsend station, £1,096 ; A. Reyrolle & Co., 8 sets of panels of sub-station switchgear, £4,041 ; 6 panels of 3,300-volt 3-phase sub-station switchgear, £750' Vickers Ltd., supply and erection of two 750 k.w. rotary converters £2,444, plus 5 per cent. for contingencies.

The Health Committee has placed an order with Edisons Accumulators Ltd., for 5 additional electrical vehicles for refuse collection at the following prices :—One at £1,263 18s. ; four at £1,065 18s. each. The Water Committee has purchased a second-hand motor generator with starter from C. L. Turner for £77 10s.

JOHANNESBURG (TRANSVAAL).—The Council have accepted the following tenders :—

Telegraph Mfg. Co., cable, £367 ; R. H. Gould & Co., eight transformers and spares, £928. 10s. ; Griffin Engineering Co. (£181. 16s. 8d.),. Hadfields (£1,676). Scleraig's Colonial (£512. 9s. 8d.), H. M. Dawson (£558. 15s.) Reunert & Lenz (£168. 8s. 8d.), and H. Davies & Co. (£2,183. 6s. 10d), tramcar spares.

Government Contracts.—The following tenders were accepted by the Post-Office during November :—

Phœnix Telephone & Electric Works, protective apparatus ; India Rubber, Gutta Percha & Telegraph Works Co., telegraph apparatus ; British L. M. Ericsson Manufacturing Co., Peel Conner Telephone Works, Phœnix Telephone & Electric Works and Western Electric Co., telephone apparatus ; Siemens Bros. & Co., telegraph arms ; Bullers (Ltd.), pole brackets ; Telegraph Construction & Maintenance Co., submarine cable ; British Insulated & Helsby Cables, Craigpark Electric Cable Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips and New Gutta Percha Co., telegraph cable ; Taylor, Tunnicliff & Co., insulators ; Bayliss, Jones & Bayliss, insulator spindles ; Bullers (Ltd.), stay swivels ; British Insulated & Helsby Cables, Shropshire Iron Co. (Ltd.) and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire ; British Insulated & Helsby Cables, tinned copper wire ; Whitecross Co., g.i. and steel wiro.

FINANCIAL MATTERS.

NEW COMPANIES, &c.

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BRITISH ASSOCIATION OF TRADE AND TECHNICAL JOURNALS (LTD. (145,696.)—This company was registered on Jan. 4, as a company limited by guarantee and not having a share capital, with 200 members, each liable for 1s. in the event of winding up, to take over the assets and liabilities of the unincorporated association known as the British Association of Trade and Technical Journals, founded in April, 1915. The management is vested in a Council, the first members of which are: E. J. Benn ("Hardware Trade Journal"), J. N. Butler ("Grocer's Gazette and Provision Trades' Review"), H. G. Crockett ("Leather World"), G. K. Davis ("Chemical Trade Journal and Chemical Engineer"), E. J. Dodd ("Canadian Machinery and Manufacturing News"), E. Hille ("The Autocar"), H. Jeans ("Iron and Coal Trades' Review"), S. C. Phillips, chairman ("Paper Maker and British Paper Trade Journal") (all vice-presidents), W. Alderson Smith, hon. treasurer ("Electrical Industries"), T. C. Elder, hon. secretary ("Engineering Review," 104, High Holborn, W.C.), E. N. Davis ("Chemical Trade Journal"), A. B. Deane ("Licensing World"), J. L. Greaves ("Stationery World"), H. Hutchings ("Colliery Guardian"), A. S. Jennings ("The Decorator"), J. A. Kay ("Railway Gazette), H. C. Lafone ("Motor Traction"), P. Marshall ("Power User"), F. Nasmith ("Textile Recorder"), H. P. Shapland ("Cabinet Maker"), E. Slater ("Electrical Times"), W. A. Standring ("Motor Cycle and Cycle Trader"), P. A. Gilbert Wood ("Architect"), and A. G. Whyte ("Electrics").

BRITISH MADE MACHINE TOOLS (LTD) (145,706.)—Reg. Jan. 5, capital £1,000 in £1 shares, to carry on in the United Kingdom or elsewhere the business of designers and manufacturers of and dealers in machine and other tools of all kinds, engineers, engineering and general agents, &c. Private company.

BURY ELECTRICAL PLANT CO. (LTD. (145,680.) Reg. Jan. 2, capital £3,000 in £1 shares, to carry on the business of electrical engineers and contractors, suppliers of electricity, manufacturers of and dealers in railway, tramway, electric and other apparatus, &c., and to enter into an agreement with O. Ashworth, G. K. Haworth and W. A. Bale. Private company. First directors are O. Ashworth and G. K. Haworth. Reg. office, Castle Grounds, Bury, Lancs.

ERCOLE MARELLI & CO (LTD) (145,688.) Reg. Jan. 3, capital of £20,000 in £1 shares (preferred), to carry on the business of makers and importers of and dealers in electric and ventilating fans of all kinds, electric dynamos and alternators, direct and alternating current motors for galvano-plastic industries, &c., and to enter into an agreement with E. Marelli. Private company. First directors are E. Marelli, A. S. Benn and A. M. Baroni. Reg. office, 19-20, Garlick hill, E.C.

CITY NOTES.

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MEMORANDA (Jan. 10).—Bank rate 6 per cent. (since July 13, 1916), Consols, 54¼. Stocks and Shares Ticket Day, Jan. 25. Pay Days, Jan. 12 and 26. Price of Silver, 35¼d.

ANGLO AMERICAN TELEGRAPH CO. (LTD.))—The directors have decided to pay the following dividends : A balance dividend of £1. 10s. per cent. upon the ordinary consolidated and upon the preferred stocks, and a first and final dividend of £1. 10s. per cent. upon the deferred stock, for the year ended Dec. 31, 1916 (less tax in all cases). The above dividends are payable on Feb. 1, and together with those already paid will amount to £3. 15s. per cent. on the ordinary consolidated stock, £6 per cent. on the preferred stock, and £1. 10s. per cent. on the deferred stock, for the year.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved to pay an interim dividend of 2s. per share (less tax), being at rate of 4 per cent. per annum for the quarter ended Dec. 31, payable on 31st inst.

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.)—The directors recommend payment of a dividend of 6 per cent. per annum (less tax) on the preference, and a final dividend of 5 per cent. (less tax) on the ordinary shares for the half-year ended Dec. 31 last. A sum of £20,000 is set aside for renewals of rails and £7,000 for reserve and renewal fund, £13,359 being carried forward.

KAMINISTIQUIA POWER CO. The directors have declared a dividend at rate of 7 per cent. per annum, for the quarter ended 31st inst.

LIMA LIGHT, POWER & TRAMWAYS CO.—The directors have declared a dividend of 1 per cent.

MOUNT LYELL MINING & RAILWAY CO. (LTD.)—The directors' report states that the company has, in common with other Australian copper producers, sold its output for next year to the British Munitions Department, at a price equivalent to £120 per ton c.i.f. London. The sale is, however, subject to the renewal of existing contracts, and if the contract with the British Insulated & Helsby Cables (Ltd.) is renewed, this will mean that the bulk of the production will continue to be sold at average prices.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.) The directors are making an issue of 50,000 £1 B shares at £1 each.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.) The Western Telegraph Co. has offered to buy from the shareholders of the West Coast of America Telegraph Co. the shares in the latter undertaking at 25s. each. The shares are of the nominal value of £2. 10s., and the latest market price is 1¼-1⅜.

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NOTES.

Boiler Efficiency.

We need scarcely emphasise the importance of boiler efficiency, for the performance of this part of the plant in a power station greatly affects the cost, and it depends so largely upon the attention which it receives. On another page we reproduce details of a number of tests made in America which are of interest as showing the considerable variations that may still be found. For example, the lowest boiler efficiency there shown is 65 per cent, and the highest is 81·16 per cent., which must be considered a large range. Yet there is no inherent reason why any well-designed boiler should not give a high efficiency, and, therefore, if a high figure is not obtained we must look for the causes of such failure. In the case of the lower of the two figures just mentioned it is noticeable that the fuel used in this particular boiler was lignite, of which the calorific value is very low. Further, there are other causes than fuel which may lead to low efficiency, and it may be that the boiler itself is purposely not designed to give the best results. What is required is that the steam-raising plant as a whole should give the best commercial value. For this reason it is much better to construct the economiser as a part of the boiler, forming a combined unit, and to test such a unit as a whole. It may well be that the lower efficiency of the boiler is compensated by a higher efficiency in the economiser. Where, however, a single economiser is used for two or more boilers it is not possible to take this broader view of the subject. In that case the efficiency of the individual boiler must stand by itself.

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In looking at the tests it is noticeable that there is a considerable variation in the flue temperatures. In one case the temperature is as high as 7. 2°F., and, as might be expected, the efficiency in that case is low. On the other hand, omitting those cases where air leakage of the boiler setting has been noticed, many of the flue temperatures are below 450°F. The figures for the amount of combustible in the ash are not complete, but such as there are show considerable differences, the combustible reaching 41·1 per cent. in one case, and on the other hand being often in the neighbourhood of 20 per cent. In one case, however, the figure is only 6·73 per cent., which, moreover, is with a coal of low calorific value, but the boiler efficiency is high. Turning to the amount of ash from the boilers, this is not usually high, the highest being 17·6 per cent. in the case to which we have just referred; but presumably the ash of the coal was high to start with. More generally the amount of ash from the stokers is in the neighbourhood of 10 per cent., so that the quantity of combustible may be only 2 or 3 per cent. as a percentage of the coal. Taken as a whole, these figures show a lack of uniformity, which it should be the object of the station engineer to avoid.

The National Registration Muddle.

If any reliance can be placed on the accounts one hears of the proposed new National Register it is not at all unlikely that the new Register will be as useless a weapon and as still-born as the old Register proved itself to be, except, pehaps, as a *ruse de guerre*. It is said that the following are some of the particulars which are demanded from the recipients of the forms: Present work, past employment, references, present income and remuneration wanted. In addition to these particulars, and a score of others having little or no bearing on a man's ability, it is said that the luckless recipient is to be asked: "Are you at present in a fit state of health?" In addition to wondering for what are we in a fit state of health, we also wonder who is to be the judge of fitness on this occasion? Is it the intention of the authorities again to subject us to the indignity of a so-called medical examination by an overworked doctor in the presence of a dozen men in the same unhappy position and condition? If not, then how do the authorities propose to determine a man's fitness for a task the nature of which is as unknown to the man as it is to the authorities? This is nearly, but not quite, on a par with the particulars required of present work and past employment. It is probable that the words "engineer" and "engineering" will figure largely in the returns, and from this it will doubtless be concluded that many men are available for engineering work of some responsibility. If so, the muddle in the future will be even greater than it was in the past: and in the past, that is, on the last Register, consulting engineers were to our knowledge entered as metal workers by the incompetents who were entrusted with the highly technical work of classification.

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The State persistently refuses to recognise the difference between an engineer and an artisan, and between an electrical engineer and a wireman. It is for this reason that Government inspectors are men who do not inspect, and that viewers are men who have not the ability to view. Partly on account of this we are mortgaging an estate which we hold in trust for our children. Times without number we have directed attention to the fact that for many years there has been available a reliable National Register of all kinds of engineers and scientists of repute. The misuse of the excellent material on the membership rolls of the engineering institutions is about as illconsidered and stupid a performance as ever we have indulged in during the past two and a half years, and, like nearly everything else, it is well nigh too late to make any alteration for the better, because many of the men we have in mind are, unhappily, no longer available. We blame the engineering institutions themselves for taking "No" as an answer to their repeated offers of assistance: the more so since there was a straightforward method of forcing the State to secure their professional assistance. Now that it is "too late" it would be mere waste of time again to describe the manner in which we would have had the engineering institutions make recognition by the State compulsory. Many readers, without any prompting, know how strong is anything that is properly organised.

* * *

If there be any truth in the reports in the "well informed" daily press, Mr. NEVILLE CHAMBERLAIN is to ask what remuneration is expected by those who sign the register. In addition to being fed, the soldier is paid a shilling per day, and from this sum which we prefer not to call remuneration—certain deductions are made. The soldier in following his employment risks life and limb and, with one exception, everything that is worth while. Such being the case we also ask what remuneration is expected by those who stay at home in absolute security; by those who risk nothing that is worth risking and who, when their time comes, will die comfortably in their beds. In our opinion the present is certainly not a time for a man to bargain as to what he shall be paid, when his brother gets a shilling a day "out there" in the Hades that was once called France. Rather would we have him ask himself what he can do without hope or thought of reward other than that which comes to every man who does his duty.

* * *

Heating of Organs. In a recent issue we called the attention of our readers to a device for the heating of organs by means of gas, and suggested that electricity might very well be employed. We are glad to find that the Davis organ heater and ventilator is also made on electrical lines, so that those who have electricity in their service can take advantage of this device without recourse to gas.

Artificial Graphite.—An industry of some considerable importance that has developed at Niagara is the manufacture of artificial graphite, now largely used for purposes of lubrication. Graphite is also employed in many electrochemical processes. It is stated that the Acheson Co. produced as much as 2,512 tons in 1915, and has now at Niagara four furnace houses, accommodating about 10 furnaces in all

Electrically-Operated Tools.—In a recent article in the "Mechanical World" attention is drawn to the great variety of tools now operated electrically. Special reference is made to the development of electrical drills, grinders, and polishing machines. To these may be added magnetic chucks and separators and motor driven blowers. It is rather singular that up to the present no really successful electric riveter has been produced.

Magnet Manufacture in Sheffield. One example of the many trades that have sprung up since the outbreak of war is the manufacture of magnets of which Sheffield is now making a speciality. This little industry comprises quite a variety of work, including as it does the relatively small permanent magnets required for magnetos, ships' compasses, &c., and also the powerful electromagnets now coming into wider use for lifting heavy iron articles such as ingots, billets and castings

British Tungsten Ores.—Some specimens of wolframite and scheelite have recently been received at the Imperial Institute from the Federated Malay States. These ores furnish the metal tungsten which is now so widely used for high-speed tools and for the filaments of incandescent lamps. Wolframite occurs in the mountains of British Malaya, and scheelite is mined in Perak and Selangor. These sources of supply, lying as they do within the British Dominions, may be of considerable utility in the future.

Cost of Heating by Electricity.—A number of experiments on various systems of electric heating have recently been reported in the United States. One of the most recent investigations is that of Mr. F. A. Osborn in the "Electrical World" for Dec. 23, 1916. The experiment was conducted in a typical dwelling-house on a practical scale, the effects of a standard hot-air system, coal-heated, and a series of electric radiators, in some cases connected with a hot water heat-storage appliance, being compared. From these tests it is deduced that electricity selling at 0·29 cents (about one-sixth of a penny) per unit would be equivalent to heating by coal with the coal costing 7·75 dollars (approx. 38s. 6d.) per ton.

Interference Between Electric Circuits.—A problem that is now exciting some attention in the United States is the interference between adjacent electrical circuits, especially in the form of inductive effects. In view of the concentration of large power supplies within a small but crowded industrial area such effects are of more importance than in the past. When an area fully equipped with a telephone service is invaded by a power system the working of the former may suffer, and judgments have been sought and obtained against the offender. In commenting upon this matter, the "Electrical World" points out that litigation is really a confession of weakness. The remedy lies in a fuller study of the conditions which make inductive interference with telephone and telegraph systems possible, and an attitude of forbearance and co-operation between the companies concerned.

Workshop Methods of Optical Testing.—An exhibition of workshop methods of optical testing was arranged by the Optical Society at King's College (London), on Thursday, Jan. 11th. The exhibits included a variety of apparatus illustrating methods of testing the curvature of optical surfaces, the refractive indices of liquids and transparent solids, and the optical qualities of telescopes, binoculars, &c. There were also exhibits by the optical department of the Ministry of Munitions and the inspection department (D.I.O.S.), Woolwich. The Pointolite lamp shown by the Edison & Swan Electric Co. (Ltd.), is now available in a compact form, well adapted to optical testing. A demonstration was also given in a dark room of the method of testing luminous dials, painted with a mixture of zinc sulphide and radio-active material, as applied at the National Physical Laboratory.

Research in the Textile Industry.—At a recent public meeting in Huddersfield, the steps to be taken in connection with the scheme for co-ordinating and extending technical knowledge and research in the textile industry of the West Riding of Yorkshire was further discussed. A series of conferences at Leeds University on the subject was recently held, and the matter is now being brought before the notice of leading local manufacturers. Meanwhile financial help from Leeds, Wakefield, Bradford and other interested cities is anticipated. Sir Hugh Bell addressed the meeting on the national need for research. Mr. E. J. Bruce, President of the Chamber of Commerce, in proposing a vote of thanks to Sir Hugh, said that the "rule-of-thumb" period of industry was rapidly passing away and would soon be over. The scheme in contemplation includes new departments for the study of coal tar dyes, scribbling, weaving and finishing, and also for engineering, for which a gift has been promised by the local engineers' society.

"Safety First" and the Lighting of London. The first meeting of the London "Safety First" Council was held at the Caxton Hall on Jan. 15th, the Mayor of Hampstead presiding. The officers were elected as follows: President, Lord

Sydenham; Vice-President, Sir George Gibb, Chairman of the Road Board; Chairman of Council, Mr. Joyson-Hicks, M.P.; Vice-Chairman, Sir E. Smith and the Mayor of Hampstead (Alderman O. Bryen); Hon. Treasurer, the Mayor of Westminster (Sir George Welby); Hon. Secretaries, Messrs. H. E. Blain, A. P. Johnson and A. E. Cave. The Council elected a General Purposes Committee, a Street Dangers Committee and a Drivers' Educational Committee. Subsequently, a number of "safety first" suggestions were considered, several of which related to lighting. The Street Dangers Committee was asked to consider at the earliest opportunity the question of a possible improvement in the street lighting conditions.

The Training of Engineers.—A series of recommendations in the above subject has been issued by the Manchester Association of Engineers. Among the drawbacks in present educational methods referred to are (1) the lack of co-ordination among existing technical schools and colleges, (2) the divorce of technical instruction from practice in workshops, and (3) the lack of continuity in general education. Special stress is laid on the provision of opportunities for continuing education after boys have reached the age of 14 years. Classes should be attended during working hours and there should be no evening work. It is also suggested that engineering employers should be represented in any scheme for improving engineering education and that the chief technical societies should be invited to appoint representatives interested in the subject who, with an equal number of representatives of the local educational authorities, should form an advisory body to deal with these questions.

Tests of the Hardness of Materials.—A useful report has been issued by the committee appointed by the Institution of Mechanical Engineers in 1914 to report on a hardness test for hardened journals and pins. Two methods of testing hardness are usual, based respectively on (1) abrasion or scratch tests, in which particles of the material whose "hardness" is to be determined are torn away from its surface by sliding contact with some other substances whose corresponding resistance is so high that its surface remains unimpaired by the action; and (2) indentation tests, in which the surface of the material under test is permanently distorted by the pressure of a hard steel ball, cone or knife-edge. It appears, however, that while approximate agreement may exist between the methods when applied to metals which are relatively pure in their cast or normal state no comparison is possible in the case of highly-tempered materials. This is confirmed by a series of tests undertaken at the National Physical Laboratory, many special precautions being taken to secure uniformity of treatment. It was found that in the case of ordinary steels carbon variations in results are not nearly so great as in the case of special steels. The report also contains two appendices by Prof. W. C. Unwin and Sir Robert Hadfield respectively, in which a summary of the chief methods proposed for testing hardness is given, and the question of a suitable definition is discussed. One conclusion appears to be that while the natural hardness of materials can be measured in terms of the "yield-point stress" (except in the case of viscous materials such as pitch), there is no satisfactory method of determining hardness in the sense of resistance to deformation of materials deformed to its fullest extent.

PERSONAL.

War Honours.—Lieut. G. S. Marston, R.E., who was an electrical engineer in the service of Messrs. Siemens Bros. Dynamo Works at Stafford prior to the war, was commended in Sir Douglas Haig's recent despatch, and has been gazetted as temporary captain.

On Friday last Corp. Edwards, who recently received the Victoria Cross, was presented with a gold watch and chain by his fellow workers at the Western Electric Co.'s works.

Sapper John Wharton, R.E., who has been awarded the D.C.M. for gallantry in the field, was formerly an apprentice to Mr. James Morris, electrician, Bolton.

Sergt. James Smith (Cameronians), who was formerly a Blackburn tramway employé, has been awarded the Military Medal.

APPOINTMENTS VACANT.

The National Boiler & General Insurance Co. (Ltd.), St. Mary's Parsonage, Manchester, require additional electrical inspectors. Commencing salary £11 to £12 per month. Applications to Mr. Edward G. Hiller, chief engineer, *See advertisement.*

A temporary assistant is required to engineer-in-charge of h.t. electric sub-station in London district. *See advertisement.*

A working engineer is required to take charge of electric installation, &c., at Berks County Asylum, Wallingford. Wages 50s. per week, plus 4s. war bonus, with cottage, &c. Applications to the Medical Superintendent.

A working electrician and mechanic is wanted for the duration of the war at the University of Bristol. Applications to the Registrar.

INSTITUTIONS AND SOCIETIES.

Institute of Radio Engineers.—At the meeting of the Institute held on Jan. 3, a Paper on "United States Radio Development" was read by Mr. Robert H. Marriott.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Jan. 19th (to-day).

Royal Institution.

5.30 p.m. At Albemarle-street, W. Discourse on "Soap Bubbles of Long Duration," by Prof. Sir James Dewar, M.A., F.R.S.

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Paper on "The Manufacture of Gauges at the L.C.C. Paddington Technical Institute," by Messrs. A. G. Cooke, M.A., W. J. Gow, A.R.C.S., and W. G. Tunnicliffe.

SATURDAY, Jan. 20th.

Association of Mining Electrical Engineers.
Notts. & Derbyshire Branch.

3.30 p.m. At University College, Nottingham. Paper on "Electrical Experience at Collieries," by Mr. C. Jones.

Association of Mining Electrical Engineers.

4.30 p.m. At the Royal Technical College, Glasgow. Paper on "Modern Switch and Fuse Gear: Its Defects and Some Suggested Remedies," by Mr. Alex. M'Phail.

TUESDAY, Jan. 23rd.

Engineers' Club.

7.30 p.m. At Albert-square, Manchester. Paper on "The Empire's Metals and the German Octopus," by Mr. T. S. Bangham.

WEDNESDAY, Jan. 24th.

Liverpool Engineering Society.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "The Education of Apprentices to Engineering and Allied Trades," by Mr. T. R. Thomas, B.Sc.

FRIDAY, Jan. 26th.

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington, S.W. Papers on "A Clock of Precision," by Mr. C. O. Bartrum, B.Sc., and "The Effect of the Water Vapour in the Atmosphere on the Propagation of Electromagnetic Waves," by Dr. F. Schwers.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At Bolbec Hall, Newcastle-on-Tyne. General Meeting.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding: : Lieut.-Col. C. B. Clay, V.D.

Orders for the Week:—

Officer for the Week.—Platoon Commander H. de P. Birkett.

Next for Duty.—Platoon Commander G. H. Parker.

Monday, January 22nd.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.25 to 8.

Tuesday, January 23rd.—School of Arms, 6 to 7. Lecture 7.15, "Musketry," by the Instructor of Musketry.

Wednesday, January 24th.—Instructional Class, 6.15. Platoon Drill. Platoon No. 2.

Thursday, January 25th.—Platoon Drill, Platoon No. 7. Ambulance Class by M.O., 6.30.

Friday, January 26th.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill 6.25 to 8.25.

Saturday, January 27th.—N.C.O.'s Class, 2.30, by Company Commander E. G. Fleming.

Sunday, January 28th.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office) 8.45 a.m. Uniform. Haversacks. Water-bottles. Mid-day rations to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters. These Orders are liable to slight alterations.

TEMPERATURE DISTRIBUTIONS IN ELECTRICAL MACHINERY.*

BY B. G. LAMME.

Summary.—The Paper deals with certain fundamental principles governing heat distribution and temperature in electrical apparatus. The general problems of heat generation, heat flow and heat dissipation, upon which the resultant temperatures depend, are discussed at some length. Some of the fallacies in temperature guarantees and in temperature indications are pointed out, and some of the more common errors in the methods of measurement are described. In conclusion, it is stated that no hard and fast rules can be made to cover the facts, except in a very general way, and that commercial temperature measurements should be considered as approximate.

One object of this Paper is to indicate, in a comparatively simple manner, some of the conditions which fix the temperatures in different parts of electric apparatus.

What makes the problem unduly complicated in electrical machinery is the fact that there are several different sources of heat generation, which may be, and often are, all active at the same time. Moreover, the heat losses may be distributed through the various heat conducting paths in such a way as to render any calculation very difficult and more or less inexact, except in a general way. As these different losses may act in different parts of the heat conducting circuit, it should be evident that the problem of determining the exact heat distributions and the temperature is a very complex one; but certain general conditions are of interest to all users of electric apparatus.

Consider first the general conditions of heat dissipation from an armature coil. In Fig. 1 is represented an armature slot with the surrounding iron, and with two separate coils per slot, as is now the most common practice. Let it be assumed that the point *a* represents the hot spot, or part at highest temperature in the apparatus. The heat from this part can flow along two general paths—namely, longitudinally through the copper conductor itself to the end windings, and thence to the air, and laterally through the insulation to the surrounding iron, or to the ventilating ducts. From the iron the heat flow is then through various paths to the external cooling air.

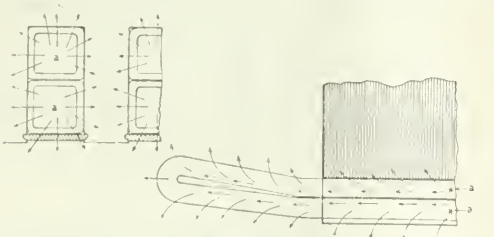

FIG. 1.

Longitudinal Heat Flow.—Considering first the longitudinal conduction of heat in the coil, then starting at the point *a*, the first unit of length conductor will have a certain loss. If the heat generated by this first unit loss were all that need be considered, then the drop in temperature, from the point *a* to the end windings, would be simply a function of the heat-conducting properties of the conductor itself; but the next unit length is also generating its own unit loss, so that the heat flow from the second to the third unit length is due to two units loss. In the same way the flow to the fourth unit length will be due to three units loss, &c. Therefore the temperature drop, or temperature difference per unit length of conductor, increases more rapidly as the point *a* is departed from, and if it is at a considerable distance from the end winding, and the losses per unit length are comparatively high, a very high temperature may be required at *a* to conduct all the heat longitudinally to the end windings. In very wide core machines the longitudinal drop may be so great that the temperature at *a* in practice will be so far above that of the surrounding iron that a very large percentage of the actual heat is conducted laterally through the insulation to the iron, even if the iron is at a comparatively high temperature. However, in narrow cores the drop to the end windings may be in some cases so very low, possibly 5 deg. to 10 deg., that with good heat dissipation from the end windings themselves the point *a* may have, for instance, an actual temperature of 40 C. If the iron next to *a* also has a temperature of 40 C., then there would be no flow of heat from *a* to the iron. Furthermore, in such a case, as the iron temperature over the whole width of the core may be fairly uniform, and as the copper temperature decreases from *a* to the end windings, obviously as we depart from the point *a* there would be heat flow from the iron to the copper, and thus the windings would tend to cool the core. This is frequently the case with light loads on a machine, for in such conditions the coil loss is low, while the iron loss remains fairly constant for all loads. In such case there may be heat flow from the iron to the copper along the whole length of the buried portion of the coil. At some higher load, the copper loss varying as the square of the load, the increased longitudinal drop will bring the copper temperature above that of the iron, so that the heat flow is from copper to iron. This condition is illustrated by Fig. 2.

It must be recognised that the lateral flow of heat from the coil to the iron reduces the longitudinal drop, such reduction depending upon the relative percentages of heat flow along the two paths. It must also be borne in mind that, in order to have such longitudinal heat flow, the end windings must be able to dissipate their own heat at lower temperature than would be attained at *a*, or in the core. If the end windings have little or no ventilation or heat dissipating capacity, then their own generated heat may bring their temperatures higher than those of the armature iron, so that the heat flow actually may be from the end windings toward *a*, and then laterally through the insulation to the core. In such case the hottest spot will be in the end winding rather than in the buried part of the coil. Obviously when such condition occurs there is no possibility of either the end windings or the buried part of the coil being cooler than the iron, for the heat flow throughout is toward the iron.

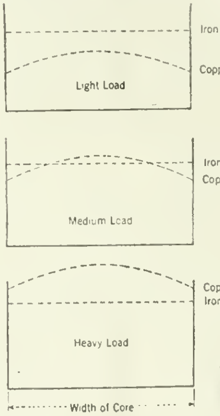

FIG. 2

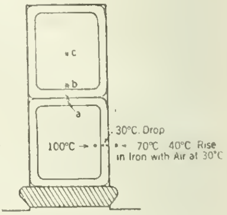

FIG. 3

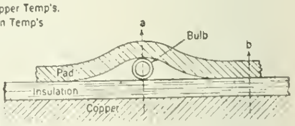

FIG. 4

Lateral Heat Flow.—Considering next the lateral flow of heat through the insulation to the iron, the amount of heat conducted is a function of the temperature difference and the resistance of the conducting path.

To illustrate this problem more concretely, let Fig. 3 represent the temperature conditions in a section of an armature. Assuming, for example, the temperature of the copper inside the coil insulation as 100 C., the iron temperature as 70 C., and the air temperature as 30 C., then the following conclusions may be drawn.

(*a*) From the outer coil (the one next to the air-gap) through the wedge to the air-gap the temperature drop will be 100 − 30 = 70 C. Obviously, any temperature measurement made outside the wedge next to the air will approximate the temperature of the air, and not of the copper. If the temperature drop through the wedge should be equal to that through the insulation, then a measurement underneath the wedge should show half the temperature drop through insulation and wedge, and obviously the measured temperature would be far below that of the copper.

(*b*) If the temperature is measured at the outside of the coil, between the iron and the insulation, it would approximate the average of the temperatures of the iron and of the outside insulation, or practically the temperature of the iron. If the iron should be at different temperatures at the sides of the slot and at the bottom, then obviously different readings would be obtained, depending upon the location of the measuring device. It is evident that such temperature measurements give no indication whatever as to the true internal temperatures of the coil, for the heat flow and the resistance of the insulation are nowise involved in the measurement.

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* Abstract of a Paper read before the Am. Inst. E.E.

(*c*) At a point *a*, between the two coils, there should be but little heat flow through the insulation, unless the copper is comparatively narrow. If there is but little heat flow through the insulation at this point, then eventually the temperature at the point *a* must rise to approximately that of the copper in the two coils. Therefore a measuring device located at *a* will approximate the temperature of the copper itself, and is in general a good indication of the hot spot at that part of the winding. Therefore, as a practical method of temperature determination, a thermocouple located at *a* is about the most satisfactory device. In selecting the point *a* the direction of heat flow in the coil itself must be taken into account. This is usually determined, in a general way, for a given type or line of machines by locating several thermo-couples along the slots.

Flow through Iron Parts.—The direction of the heat flow to the iron depends upon the arrangement and location of the heat dissipating surfaces. There are two general paths of heat conduction in all armature cores—namely, a flow along the laminations to where their edges come in contact with the air or with other material, and a flow across the laminations toward heat dissipating surfaces. The flow along the laminations may be calculated with fair accuracy. Across them it is difficult to determine such flow. According to the various figures available, the heat flow per unit volume of material along the laminations is from 10 to 100 times as great for a given temperature difference as across them. In the vast majority of rotating machines the heat dissipation is largely across the laminations. The reason for this is that, by placing ventilating ducts parallel with the laminations, the density of flow is very low. By the same procedure the length of the heat path is made quite short. Thus, the temperature drop through the laminations may be made relatively small compared with other drops. However, not all the heat in the iron passes across the laminations to the ventilating ducts, for where the length of the path along the laminations to any heat dissipating surface is not large, a very considerable amount of the heat may be dissipated from the edges of the laminations themselves. It is evident, therefore, that the flow of heat and distribution of temperature are dependent upon the arrangement of the iron, dimensions and location of the ventilating surfaces.

Heat Flow to the Air.—After the heat has passed from the copper to the iron, the resultant of the copper and iron heats must be conducted to the surrounding air, and there is usually a considerable drop in temperature from the solid surface to the cooling air itself, the amount of such drop depending upon the ventilating conditions. In practice there appears to be a film or layer of air which adheres very closely to the solid surfaces. One of the principal actions of air ventilation appears to be that of scouring away the hot contact film, while a second action is to carry the hot air away without mixing it with the incoming cooler air. Whatever portion of the dissipated heat is absorbed by the incoming cooling air adds that much to the temperature of the air itself and eventually to that of the apparatus to be cooled. In such cases the ventilation of the machine may only be useful in equalising or re-distributing the temperatures in the various parts.

From the preceding analysis, it would appear that the temperature t the hottest part of the coil is fixed principally by the heat flow hrough the copper and its surrounding insulation directly to the air, and by the flow from the copper to the iron, and from the iron o any exposed air surfaces, and then to the air. Along the first path here are three principal temperature drops—namely, in the copper tself, then through the insulation and then from the outside surface of the insulation to the air. Along the second path there are also hree temperature drops—namely, from the copper through the nsulation to the iron, then from the iron to the exposed air surfaces, nd then from the surfaces to the air. Along the first path each part f the copper path is generating its own heat, to be conducted away, n addition to that which is to be conducted from other parts of the path. In the second path each part of the iron path may be generating its own heat, which adds to that coming from other parts. The elative amount of heat conducted along each path is dependent pon so many conditions which vary with the load that no one but n analytical designer backed by experience could even approximate he values by calculation. However, it should be obvious that any measuring device applied to the outside or cooling surface does not, nd cannot, directly approximate the temperature of the hottest art, except in those rare cases where the hottest part is dissipating eat directly to the air.

Equalisation of Temperature, &c.—Difference in temperature in an rmature winding, for instance, is maintained by the continual eneration of heat in the various parts; but the moment such eneration of heat is stopped there is a tendency for equalisation of emperatures. In good heat conducting materials, as copper, uch equalisation may be very rapid, so that a temperature indicating strument of a sluggish type may not indicate anything like the true maximum temperature of the spot where it is placed if applied after the load is removed, especially if the rate of heating of the thermometer bulb is much less than the rate of heat transfer from one part of the winding to another.

A second condition which tends to make such temperature measurements fallacious lies in the cooling action in the interval between load removal and shut down to take temperature measurements. This is particularly true of high-speed machines, which require considerable time to come to a standstill. It is, therefore, desirable in such machines to obtain all possible temperature readings at normal speed and with load. One method of lessening the sluggishness is to heat the thermometers up to practically the normal operating temperature of the part to be measured while the machine is still carrying load. At the moment of shut-down the heated thermometer is applied.

Fallacies in Temperature Guarantees and Measurements.—In the older methods of determining temperatures it was assumed that the thermometer readings obtained on a winding, for instance, was a true indication of the temperature of the winding as a whole. The manufacturers of electrical apparatus long ago recognised the fallacy of this method, as they had found from bitter experience that there were liable to be hotter parts in the machine than any thermometer readings would indicate. They therefore designed machines with regard to the possible hot spot temperatures as encountered in service rather than any temperature which the exposed parts of the machine would show. Thus, in designing a certain machine for safety at the hottest part, not infrequently the exposed parts of the winding would show, by thermometer, comparatively low temperatures, such as 25°C. to 35°C rise. Therefore, as the observable temperature readings came so low, it became the fashion to call for 35°C. guarantees, and in many cases the operating public lost sight of, or perhaps never knew, the real meaning of such low temperatures. Among the designers of electrical machinery it was recognised that a temperature rise of 35°C. was absurdly low, but that the object in operating at such low temperature on a part which could be measured was simply to protect the machine in some inaccessible hotter part, where the temperature could not be measured. The whole problem is a good deal like that of a determination of the voltage generated in a given power house by measuring the voltage at the end of a transmission line. In electrical apparatus a reasonable internal temperature drop may be approximated, which, added to the observable temperature, gives a fair approximation to the hottest part; but *the result is an approximation, and must be recognised as such.* Primarily, the manufacturer must make a safe machine for a specified service regardless of the temperature guarantees, and the temperature measurements made on most classes of apparatus should be considered simply as rough approximations to indicate that the manufacturer has made a reasonable attempt at a safe machine. This may seem a rather bald statement, but, nevertheless, it is a fair statement of the case.

Errors in Temperature Measurement.—It may now be shown that even the observable temperatures obtained by the usual means are in themselves only crude approximations in many cases. The resistance method gives only average results, and may be very misleading. However, in those cases where it is known, by past experience and otherwise, that there is very little liability of hot spots, the resistance method of determining temperature is often quite satisfactory. However, the method is limited to comparatively few types of windings.

Considering next the thermometer method of measurement, the theory of this is quite simple, but apparently it has been very much misunderstood. In windings, except in rare cases, the thermometer is not applied directly to the heat generating material itself, but is applied outside of an insulating covering. Usually the temperature drop through this insulating covering does not receive any consideration, and yet everything depends upon this. Assume, for example, an insulated coil, thermometer and covering pad, as shown in Fig. 4. Assuming the copper inside the coil as being of uniform temperature, and the cooling air at *a* and *b* as also at a uniform but much lower temperature than inside the coil, then the temperature drop from the copper to *b* will be the same as through the insulation, thermometer bulb and covering pad to the air at *a*. Obviously, if the temperature drops through the insulation and through the pad are equal, then the thermometer bulb will show a midway temperature. This is, of course, assuming that the surface drop to the air previously referred to is very small, or that it is included as part of the drop through the pad. Thus it is seen that all kinds of results may be obtained, depending upon the relative drops through the pad and through the insulation. There are so many conditions entering into the interpretation of the thermometer and resistance methods of determining temperature that in certain classes of apparatus it has been very desirable to find more accurate methods. One of these is in the use of so-called resistance coils. In this method a coil of fine wire of a known temperature coefficient, and of known resistance at a given temperature, is placed at the place where the temperature is to be measured, and the temperature rise is determined from the increased resistance of the coil. One serious objection to this arrangement is that the resistance coil must have considerable length and breadth, so that it really indicates the average temperature of a considerable area instead of a point. When placed between two coils it usually occupies so great a proportion of the slot that it indicates an average temperature considerably lower than the spot temperature; but this average may be limited to a comparatively small area, whereas in the resistance method in general the indicated rise is an average of the whole winding. However, in the resistance method, the temperature of the conductors themselves is measured, whereas with the resistance coil the temperature measurement is outside the insulation. The resistance coil method is, therefore, a relatively crude approximation, although when brought out it was really an important step in advance. In its early application many misleading results were obtained, due largely to lack of understanding of the principles governing temperature distribution and temperature drop. In some cases the resistance coil was placed under the wedge, and in other cases it was placed at the side of the slot next to the iron, or at the bottom. Very rarely was it placed midway between the two coils, probably because this was a more difficult application, and also because the greater accuracy of such location was not recognised. From the use of resistance coils many good engineers drew the conclusions that the upper limit of permissible temperature for fibrous insulations was only 80°C. to 90°C.

A later development than the resistance coil is the thermo-couple. One great advantage of the thermo-couple is its very small size, so that it can indicate the temperature at practically a point instead of a very considerable area. If properly placed, it furnishes the most accurate temperature indicator which we now have, as it can be located in all sorts of normally inaccessible places. However, its use is practically limited to stationary apparatus. In rotating apparatus or rotating parts it can be used only after shut-down, which introduces errors, as already shown.

Fig. 5.

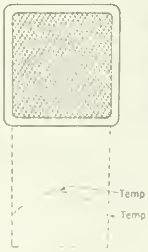

Fig. 6.

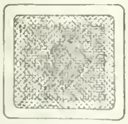

Fig. 7.

Many-conductor Coils.—In all the preceding considerations it has been assumed that the copper inside the coils itself is at a uniform temperature in any given unit of length. When several coils or conductors are placed side by side, as in Fig. 5, it would appear at first glance that the middle coils should heat much more than the outer ones, but in reality, unless there are many layers of coils, the temperature of the different coils will not vary greatly from each other. For instance, in Fig. 5, the heat generated in the middle conductor is only one third that of the total generated in the coil, and yet the two side surfaces through which the heat passes to the adjacent [illegible] almost as much as the total outside dissipating surface of the whole coil, through which all the lateral heat [illegible] passes. Considering further that the insulation between the middle [illegible] and its neighbours is relatively thin compared with the [illegible] covering, it is obvious that the temperature drop from the middle to the adjacent ones will be comparatively small, possibly not over [illegible] per cent. of the drop through the outside insulation.

However, with a large number of coils side by side, the conditions become somewhat [illegible]. Here the drop from the centre conductor to the next one may be small, but the drop from the second conductor to the third will be considerably greater, due to the heat of two conductors [illegible]. From the third to the fourth there is a drop corresponding to the losses of three conductors, &c. Thus there is a constantly increasing temperature drop from the centre of the coil toward the outside surface, and if the coil be very deep—that is, if it consists of many insulated layers—the sum total of the drops may be quite large. Or, putting it in another way, with a comparatively deep coil the temperature rise from the outside surface of the coil itself toward the centre will be very rapid at first and gradually taper off, as indicated in Fig. 6. This is indicated very clearly in the case of an over-heated field coil of fine wire, where the first outside layers will usually be found in a fairly good condition; but at a comparatively little distance inside the coil there may be severe roasting or evidence of overheating, which may be almost as bad as at the centre (*see* Fig. 7). In such case the temperature measurement on the outside of the coil is no satisfactory indication of the hot-spot temperature. A temperature measurement by resistance, while a closer indication than that by thermometer, also may be very misleading. It may be stated that modern design tendencies are toward comparatively shallow field coils, largely on account of this condition.

Conclusion.

The whole object of this Paper is to show the problem of temperature distribution and temperature measurement as it actually is. It is the writer's desire to show that no hard and fast rules can be made for determining the facts in the case, and that the best rules and methods now practicable are only approximate. The present limitations set for insulating materials are much higher than were considered practicable only a few years ago. This is not because the limits have been raised, but because, through a better understanding of the facts, the real upper limits of temperature as fixed by durability of insulation are now known to be considerably higher than was believed to be the case only a short time ago. If the real limits were in accordance with former beliefs, then all the evidence of the more accurate modern tests and data would indicate that the vast majority of the existing electrical machines should have "roasted out" comparatively early in their operation. The higher temperature limits were there, but were not recognised. Now we recognise them, and attempt to make reasonable allowances for differences between the measurable temperatures and the actual hottest parts. The present method may be crude, but we are not going at it blindly, as was formerly the case. Formerly the manufacturer took the real responsibility for making a machine that was safe for the service whatever the guarantees called for. To day the responsibility is still his, but he is attempting to educate the public to a knowledge of his real problem, and to a recognition that temperature determination is far from being an exact art. There is no sharply defined lin between *good* and *bad* in the insulating materials as affected by temperature, consequently there is no sharp line between *safe* and *unsaf* temperatures.

HYDRO-ELECTRIC STATION IN THE MÖHNE VALLE WESTPHALIA.*

BY E. TREIBER.

This power station was opened in February, 1915. The water i the valley is collected into a reservoir, which holds 130 million cub metres of water. The flow of the river Ruhr is regulated by 1 reservoirs, of which this is the largest; the Möhne is a tributary the Ruhr. The construction of the various dams has been unde taken by a company formed among the local industrialists. But this particular case, the difficulty in utilising the available wate power lies in the great variability of the amount—the reservoirs ma at certain seasons be almost empty. The hydraulic station therefo had to be worked in conjunction with some of the steam-pow stations, of which there are many in the district—the neighbourhoo in fact, abounds in collieries—and the Möhne hydraulic station the fore helps to take the peak of the load at times when the stea stations tend to be overloaded. The whole of the output of t hydraulic station is taken by the Westphalian Verband-Elektri tätswerk in Dortmund, which also controls the working of the static The greater part of the energy is transmitted at 25,000 volts ove distance of 33 kilometres to the town of Neheim, and thence to transformer sub-station at Menden. Here there are four transfo mers, each with an output of 1,500 kilovolt-amperes. Here t power is transformed to 10,000 volts, and transmitted a furth distance of 38 kilometres to a power station at Kruckel, near Do mund. The power stations at Kruckel and in the Möhne vall usually run in parallel. The yearly flow of water from the Mö is about 250 million cubic metres; about 53 per cent. of this amou can be stored in the lake. The mean flow of water is about 7·8 cu metres per second. The available fall varies from 33 to 13 metr according to the depth of water in the storage lake. The mean o put may be taken at about 1,200 kw., measured at the terminals of the generators, but seeing that the output is only spread over the hours of the peak of the load the output is reckoned on a basis of four times this amount. The station therefore contains four machines, each of 1,200 kw. capacity. Water is conveyed from the storage lakes through four wrought-iron pipes of 1·4 metres diameter. There are also three other similar pipes, which are used at times of heavy load. It has been already stated that the amount of available fall varies over wide limits; this makes the economical design and working of the machines rather difficult. A speed of 375 revs. per min. was eventually chosen. Each generating unit consists of a polyphase machine, coupled to two water turbines, of which one is bigger than the other. The whole machine has three bearings, two of which are water-cooled, and the third is lubricated under pressure. The larger turbines are of the double Francis type, while the smaller ones are of the single type. The larger turbine can drive the polyphase machine at full output with falls from 32 to 26 metres; if the smaller turbine is also coupled up, the full output can be given by the two with falls as low as 20 metres. The efficiencies are then well over 80 per cent. Three-quarters of the full load can be given with falls from 32 to 20 metres at an efficiency of 79 per cent. The speed regulation is effected by an automatic regulator, working with oil under pressure; there are also a variety of safety devices, in case the regulator should not act properly. The revolving parts of the machines have been so designed that they can withstand speeds of 700 revs. per min.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," 12 and 13, 1916.

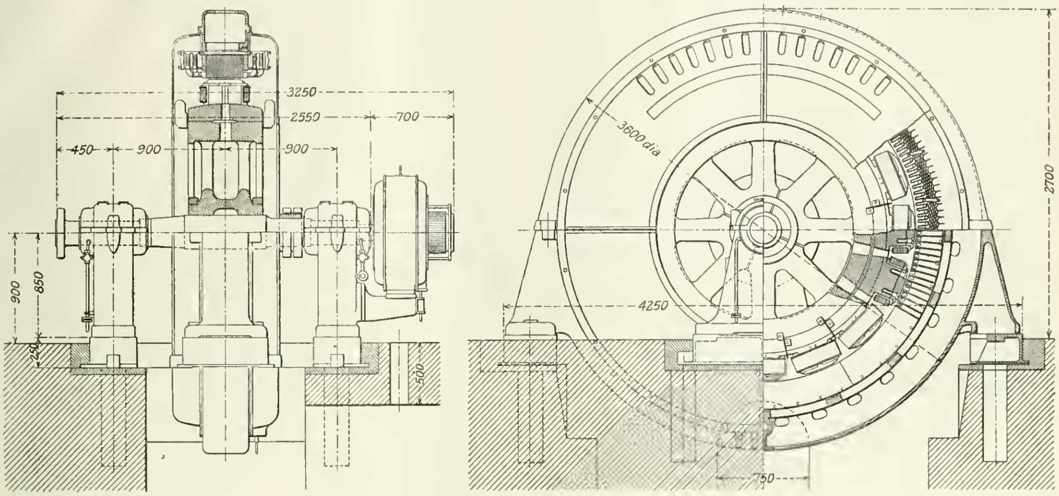

Fig. 1.—General arrangement showing Construction of Polyphase Generators.

The polyphase generators are designed for a continuous output of 1,200 kw. with a power-factor of 0·7; the apparent output is thus 1,720 kilovolt-amperes. Their general design is shown in Fig. 1. The two bearings are cooled by water and lubricated on the ring system; they are lined with white metal through which the spirals of copper tube, conveying the cooling water, are passed. The rotor is secured to the shaft by two strong rings; it consists essentially of a cast-iron flywheel; the pole-pieces are of cast-steel and are shrunk on; the pole shoes, also of cast-steel, are bolted on. The shape of the shoes is carefully designed so as to exclude the possibility of the formation of harmonies, which might result from irregularities in the magnetic flux; there is, therefore, no risk of resonance effects. The profile of the shoe-pieces is such that the voltage-wave is practically sine-shaped. The magnet coils consist of copper strip; the insulation between the windings consists of presspahn. Each coil is firmly held in position by the pressure of the bolt, which holds the pole-shoe. The slip-rings are of Siemens-Martin steel, and are insulated by a micanite ring. The whole is carefully tested before delivery, so as to see that the rotation takes place without any trace of vibration. The machine can be brought from rest to full speed in rather less than 12 seconds. The stator consists of a cast-iron frame, divided into halves, the active iron being kept in position by a large number of bolts. The slots are so shaped that the conductors can easily be withdrawn or inserted on the spot; this is convenient both in the workshop and for repairs. The sides are closed by cast-iron plates in sections. The conductors are insulated with micanite, which is wound on spirally in the form of a tape. The machine is cooled by air, which is sucked in by the rotating masses and discharged through openings in the upper portion of the stator. Each generator is coupled to an exciter, and each exciter is of sufficient capacity for two generators. A further reserve consists in a motor-generator set of 80 kw. capacity, which is normally used to charge a battery of accumulators. A travelling crane, capable of lifting 18 tons is provided, its span is 19 metres and it is electrically operated.

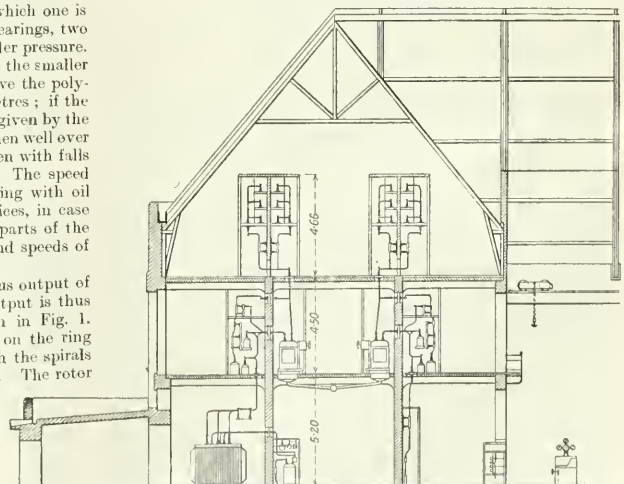

Fig. 3.—Cross-section through Switch House.

The switchroom is built at the side of the machine house; the main switchboard controls the output of four generators, giving

1,200 kw. at 1,500 volts, together with that of the four transformers which convert from 1,500 to 25,000 volts. It is also connected to an auxiliary transformer, which has an output of 200 kilovolt-amperes and re-converts to 250 volts. There is also a small auxiliary power station, which is used at certain times when the flow of the water permits, and this is also connected to the switchboard. Fig. 2 shows the general construction of the switchroom. The high-tension parts are separated from one another by sliding fireproof doors. On the ground floor are placed the oil switches for the generators; the 25,000-volt switches for the transformers and transmission lines are on the first floor. The double set of bus-bars for 25,000 volts is on the second floor, and they take the form of two open symmetrical rings. All oil switches are of the three-pole type, and can be operated by the attendant at the switchboard; they can also be operated by hand on the spot. Petersen's method of protection against surges has been adopted. Precautions are taken to lessen the risk of fire in case an explosion should take place in a transformer or oil switch; pipes are laid down through which the burning oil can be transferred to a reservoir. There is also a reservoir for holding dirty oil, which is then passed through a filter press; it is thus ready for further use. Cocks are provided in each compartment on the first and second floor through which the oil supply for transformers and oil switches can be passed. Three single-phase transformers are provided for testing the pressure to earth on each set of bus-bars; the corresponding instruments are mounted on the switchboard. All the conductors used for the purpose of earth tests, are inserted in well earthed iron pipes.

Beside the main power station, there is a second smaller auxiliary station, already mentioned, which is used on certain occasions when sufficient water is available. There is also a low-pressure station, lower down on the Möhne, and another station, using water from the valley of the Lister. There is a storage lake in connection with the latter, holding 22-million cubic metres. The total output of the four stations is about 12,500 kw.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(*Continued from page* 470.)

VIII. General Treatment of Balancers, except Static Balancers.

A general treatment of all balancers will now be given, including all cases except that of the static balancer, which will be separately referred to in a later section, and leading up particularly to a full consideration of the rotary balancer. This is to say, all balancers which will work with an ordinary two-wire dynamo will now be considered, while the special case involving a three-wire dynamo will be dealt with by itself afterwards. Fig. 5 shows a circuit with $2V$ volts across outers, and a three-wire system containing some sort of balancing arrangement, resulting, with no out of balance current, in voltages V_1 and V_2 on the two sides between outer wires and middle wire. V_1 and V_2 are generally equal in practice, but that is not necessary, and for the general case they may be assumed to have any values. The balancing arrangement contains, on the left-hand side, a back E.M.F., e_1, and a resistance, R_1 and, on the other side, the corresponding quantities e_2 and R_2; e_1 and e_2 may have any value from zero upwards. e_1 and e_2 will be called positive when they are, in respect to $2V$, back E.M.F.s; should they be reversed, and so act in series with $2V$, their sign will be negative. The resultant current in Fig. 5 flows only through the balancer, and is denoted by C. Now assume some load switched in on both sides of the system, as shown in Fig. 6, and let this be so divided that C_4 flowing in R_4 is the balanced part of the load, while C_3 flowing in R_3 is the unbalanced part. The circuit R_4C_4 is of no particular interest in the further discussion but it must always be remembered that R_4 is not necessarily fixed, and may change as load conditions change. It is, however, always ascertainable, even if only by a trial and error method in the last resort. It is also to be borne in mind that R_3 is only a theoretical quantity, being the equivalent resistance, already defined, of the unbalanced part of the circuit. As has been shown, a current, C_3, comes into existence in the middle wire in consequence of the presence of R_3. Let the convention be adopted that currents flowing into a point are positive, and those flowing out of it are negative, when considered for summation purposes relatively to the point in question. Then, in Fig. 6, C_3 is positive in regard to the point where the middle wire is connected to the balancer. But C_3 may also be negative in regard to the same point, and the way to produce this would be to have R_3 on the right-hand side of the system. This, however, may be looked at mathematically from another point of view, which, although it involves a physically meaningless quantity, is correct because R_3 is only an equivalent expression introduced for convenience. The current C_3 is always equal to V_3/R_3; as R_3 is made greater and greater, C_3 approaches zero, remaining positive, and finally, when R_3 is infinite, C_3 is actually zero. When a function passes through $+\infty$, it may be expected to reappear at once at $-\infty$ and then to have successively smaller numerical values on the negative side of some axis. If it be considered that R_3 on reaching $+\infty$ and so making $C_3=0$, then becomes negative, making C_3 negative because V_3/R_3 is then negative, this is, as far as the middle wire is concerned, exactly equivalent to some unbalanced load on the negative side of the system, and therefore it is mathematically possible to consider the equivalent resistance of the unbalanced circuit as always on one side of the system, if the conception of resistance be extended so as to include all values, positive or negative. Exactly the same results would be reached by considering R_3 transferred to the other side of the middle wire, but as the present discussion is more concerned with what happens as a result of the existence of C_3 in the middle wire, than with what goes on in R_3, or what the hypothetical R_3 really represents, the mathematical conception is adopted, and the circuit is treated as if R_3 were always on the same side of the system. This leads to continuity both of consideration and of results.

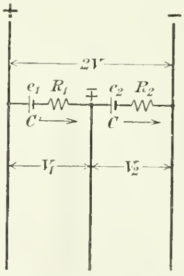

Fig. 5.—General Diagram of Balancer without Load.

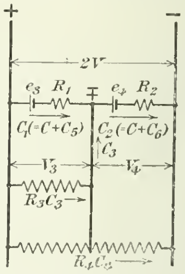

Fig. 6.—General Diagram of Balancer with Load.

As Fig. 6 indicates, it is assumed that the switching on of current may in some way have altered e_1 and e_2 to e_3 and e_4 respectively, while V_1 and V_2 become, correspondingly, V_3 and V_4, and C becomes C_1 on one side and C_2 on the other. R_1 and R_2 are assumed not to change, which is usually correct within sufficiently close limits. In a battery they would change slowly in course of time, unless the change in e_1 and e_2 were caused by switching in or out cells, in which case suitable allowances would have to be made; and in a rotary balancer armature they might change slightly with change of copper loading in the winding owing to the altered C^2R loss. It is sufficiently accurate for the present purpose to consider them as not subject to change.

In Fig. 5 $\quad C=\{2V-(e_1+e_2)\}/(R_1+R_2)$;

$V_1=e_1+CR_1$; $V_2=e_2+CR_2$;

$V_1+V_2=2V$.

In Fig. 6 $\quad C_1=(V_3-e_3)/R_1$; $C_2=(V_4-e_4)/R_2$;

$C_3=V_3/R_3$; $C_2=C_1+C_3$;

$V_3+V_4=2V$.

Hence $(V_4-e_4)/R_2=(V_3-e_3)/R_1+V_3/R_3$,

or $(2V-V_3-e_1)/R_2=(V_3-e_3)/R_1+V_3/R_3$.

Hence $2VR_3R_1+e_3R_2R_3-e_4R_3R_1=V_3(R_1R_2+R_2R_3+R_3R_1)$.

Denote $R_1R_2+R_2R_3+R_3R_1$ by $\Sigma_2R_1R_2R_3$; then

$$V_3=\frac{2VR_3R_1+e_3R_2R_3-e_4R_3R_1}{\Sigma_2R_1R_2R_3}=\frac{2VR_1+e_3R_2-e_4R_1}{R_1R_2/R_3+R_1+R_2},$$

and

$$V_4=2V-V_3=\frac{2V(R_1R_2+R_2R_3)-e_3R_2R_3+e_4R_3R_1}{\Sigma_2R_1R_2R_3}$$
$$=\frac{2V(R_1R_2/R_3+R_2)-e_3R_2+e_4R_1}{R_1R_2/R_3+R_1+R_2}.$$

The difference between V_3 and V_1, which represents the amount by which the previous voltage on one side has been altered, is the same as the difference between V_2 and V_4, that is,

$$V_3-V_1=V_2-V_4, \text{ and } V_1+V_2=V_3+V_4=2V;$$

also $(V_3-V_4)-(V_1-V_2)=V_3-V_1+V_2-V_4=2(V_3-V_1)$, or twice the change on each side. Thus the difference between the two sides for any given condition, minus the corresponding difference for any other condition, is always twice the change on each side due to the alteration of conditions.

$$V_1=\{2V-(e_1+e_2)\}R_1/(R_1+R_2)+e_1$$
$$=(2VR_1+e_1R_2-e_2R_1)/(R_1+R_2);$$
$$V_2=2V-V_1=(2VR_2-e_1R_2+e_2R_1)/(R_1+R_2);$$

hence $V_3-V_1=\frac{(2VR_1+e_3R_2-e_4R_1)R_3}{\Sigma_2R_1R_2R_3}-\frac{2VR_1+e_1R_2-e_2R_1}{R_1+R_2}$,

which, by multiplying up and straightforward simplifying, becomes

$$V_3-V_1=\frac{R_1R_2\{2VR_1+e_3R_2-e_4R_1\}+\{(e_1-e_3)R_2-(e_2-e_4)R_1\}\Sigma_2R_1R_2R_3}{(R_1+R_2)\Sigma_2R_1R_2R_3},$$

and this is also equal to V_2-V_4.

The change in current on the left-hand side of the balancer is from C to C_1, and is equal, therefore, to C_1-C, which may be written

$$C_1-C=(V_3-e_3)/R_1-(V_1-e_1)/R_1=\{(V_3-V_1)+(e_1-e_3)\}/R_1$$
$$=\frac{R_2\{2VR_1+e_3R_2-e_4R_1\}+\{(e_1-e_3)R_2/R_1-(e_2-e_4)\}\Sigma_2R_1R_2R_3}{(R_1+R_2)\Sigma_2R_1R_2R_3}+\frac{e_1-e_3}{R_1}.$$
$$=-[R_2\{2VR_1+e_3R_2-e_4R_1\}-\{e_1-e_3+e_2-e_4\}\Sigma_2R_1R_2R_3]/(R_1+R_2)\Sigma_2R_1R_2R_3.$$

Let this change in current, C_1-C, be called C_5, and let the change from C to C_2, which is C_2-C, be called C_6. Then, by a similar process to the above,

$$C_6=C_2-C=(V_4-e_4)/R_2-(V_2-e_2)/R_2$$
$$=+[R_1\{2VR_1+e_3R_2-e_4R_1\}+\{e_1-e_3+e_2-e_4\}\Sigma_2R_1R_2R_3]/(R_1+R_2)\Sigma_2R_1R_2R_3.$$

It is thus possible to regard the system in Fig. 6 as having the current C still flowing, and, superposed on C, the current C_5 in R_1 and the current C_6 in R_2, having the values

$$C_5=-\frac{R_2\{2VR_1+e_3R_2-e_4R_1\}-\{e_1-e_3+e_2-e_4\}\Sigma_2R_1R_2R_3}{(R_1+R_2)\Sigma_2R_1R_2R_3}, \text{ and}$$

$$C_6=+\frac{R_1\{2VR_1+e_3R_2-e_4R_1\}+\{e_1-e_3+e_2-e_4\}\Sigma_2R_1R_2R_3}{(R_1+R_2)\Sigma_2R_1R_2R_3}.$$

Now $C_2=C_1+C_3$, hence $C_3=C_2-C_1=(C+C_6)-(C-C_5)$
$=C_6-C_5$.

Therefore $$C_3=\frac{2VR_1+e_3R_2-e_4R_1}{\Sigma_2R_1R_2R_3}=\frac{V_3}{R_3}.$$

It is, therefore, further possible to regard the out of balance condition of the system as setting up a current, C_3, in the middle wire which is equal to the difference between C_6 and C_5, the currents superposed on C in R_2 and R_1 respectively, as well as to the difference between C_2 and C_1, the actual currents in R_2 and R_1, since C_2 and C_1 each differ from C_6 and C_5 by the same amount, C. Considering the out of balance part of the circuit only, the current C_2 is the amount actually passing into the negative outer main and returning to the main dynamo; C_2 is, therefore, the current taken from the dynamo at $2V$ volts in order to get the load represented by C_3 in R_3, at V_3 volts. Now, C_2 is made up of C and C_6, and C is the original current in the balancer in Fig. 5, that is, C represents the current which the balancer naturally takes from $2V$ volts when there is no out of balance current flowing. In the case of a rotary balancer, C is related to the natural no-load losses of the set; in the case of a battery, it may represent a certain amount of charging current. C may, therefore, be regarded as the balanced part of the balancer current, just as C_4 is regarded as the balanced part of the consumers' current, and the important conclusion is arrived at that in order to get C_3 an additional current, which is C_6 as long as R_3 is mathematically positive, is required from the main dynamo, and nothing more. The superposed system of currents is shown in the skeleton diagram, Fig. 7. It has not yet been ascertained what relation there is, as regards sign, between C_6 and C_5; this will be considered in later sections, but it is universally true that, whatever this relation be, the middle wire current $C_3=C_6-C_5$. Hence, in Fig. 7, C_6, coming from the dynamo, may be regarded as passing down to R_3, along it, up the middle wire, along R_2, and back to the dynamo, while C_5 may be regarded as having a local circuit of its own, and flowing by itself in R_1, but joining up with C_6 to make C_3 as a whole in all other parts of the local circuit indicated by the arrows marked C_5. When R_3 is on the other side of the system, and is mathematically negative, so that C_3, which is always V_3/R_3, whatever side R_3 be on, is also negative, it is C_5 that comes from the dynamo and goes back again by way of R_1, the middle wire, and R_3, while C_6 has its own local circuit in R_2 and R_3; but the principle remains the same. This condition is shown in Fig. 8. The true physical fact at any point in the circuit is that the current there is the algebraical sum of all the superposed partial currents. When the components are in the same direction, each may be regarded as flowing in its proportional part of the whole cross-section of the circuit; but when the components are opposite in direction, the parts of them which cancel out, and leave their difference flowing as a real current in a real circuit, must be considered as flowing in opposite directions at once in an imaginary conductor, which, as the resultant current is zero, has, therefore, no resultant section, and hence physically need not exist. Even the components, therefore, have some sort of physical meaning, though they have no separate physical existence, and it is possible to trace out the differences of potential which cause them to flow in the various parts of the circuit. To elaborate this further would, however, take up more space than it is worth.

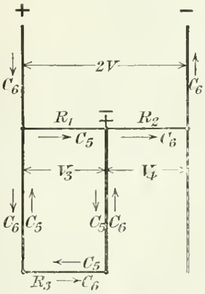

FIG. 7.—SCHEME OF SUPERPOSED CURRENTS FOR A POSITIVE R_3.

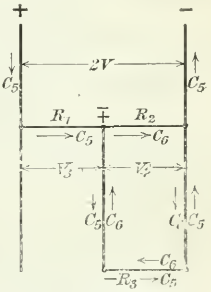

FIG. 8.—SCHEME OF SUPERPOSED CURRENTS FOR A NEGATIVE R_3.

IX. RESISTANCE ALONE AS BALANCERS.

Consider now some special cases of what has been put down generally in the previous section, passing at once to actual balancing sets. For this purpose, since the whole object is to maintain as equal a voltage as possible on the two sides of the system, and as the two sides of the balancer must be symmetrical, so as to deal with positive and negative out of balance currents of equal numerical value with the same amount of change in each case in the various parts of the circuit, it is necessary to put $e_1=e_2=e_0$, say; $R_1=R_2=R_1$, say; and $V_1=V_2=2V/2=V$. The various expressions already deduced become, under these conditions, rather simpler, and are as follows, the new circuit being shown on light load in Fig. 9 and on out of balance load in Fig. 10.

In Fig. 9 $C=(2V-2e_0)/2R=(V-e_0)/R$; hence $V=e_0+CR$, and $e_0=V-CR$.

In Fig. 10 $C_1=(V_3-e_3)/R$, that is, $V_3=e_3+C_1R$;

$C_2=(V_4-e_4)/R$, that is, $V_4=e_4+C_2R$;

$C_3=V_3/R_3$; $C_2=C_1+C_3$; $V_3+V_4=2V$;

$$V_3=\frac{2V+e_3-e_4}{R/R_3+2};\quad V_4=\frac{2V(R/R_3+1)-e_3+e_4}{R/R_3+2};$$

$$V_3-V=V-V_4=-\frac{R(2V+e_3-e_4)-(R+2R_3)(e_3-e_4)}{2(R+2R_3)}$$

$$=-\frac{VR-(e_3-e_4)R_3}{R+2R_3};$$

$$=-\frac{V-(e_3-e_4)R_3/R}{1+2R_3/R};$$

$$C_5=-\frac{R(2V+e_3-e_4)-(R+2R_3)(2e_0-e_3-e_4)}{2R(R+2R_3)}$$

$$=-\frac{2V+e_3-e_4}{2(R+2R_3)}+\frac{2e_0-e_3-e_4}{2R};$$

$$C_6=+\frac{R(2V+e_3-e_4)+(R+2R_3)(2e_0-e_3-e_4)}{2R(R+2R_3)}$$

$$=+\frac{2V+e_3-e_4}{2(R+2R_3)}+\frac{2e_0-e_3-e_4}{2R};$$

$$C_1=C+C_5=-\frac{2V+e_3-e_4}{2(R+2R_3)}+\frac{2V-e_3-e_4}{2R};$$

$$C_2=C+C_6=+\frac{2V+e_3-e_4}{2(R+2R_3)}+\frac{2V-e_3-e_4}{2R};$$

$$C_3=C_6-C_5=C_2-C_1=\frac{2V+e_3-e_4}{R+2R_3}.$$

Consider, first, the case of resistances used to find a middle point, with, therefore, $e_0=e_3=e_4=0$. Then $C=V/R$ is the current flowing through the balancer before the system is unbalanced. When some resistance, R_3, is switched across, or when some load is applied having an equivalent resistance of R_3 alone the currents set up are as follows:—

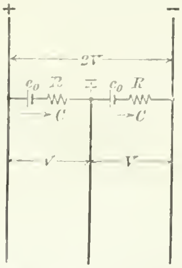

Fig. 9. Diagram of Symmetrical Balancer without Load.

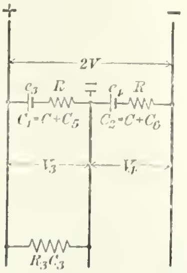

Fig. 10.—Diagram of Symmetrical Balancer with Load.

$$C_1=V_3/R;\quad C_2=V_4/R;\quad C_3=V_3/R_3;$$

also $$V_3=\frac{2V}{R/R_3+2};\quad V_4=\frac{2V(R/R_3+1)}{R/R_3+2};$$

$$V_3-V=V-V_4=-\frac{VR}{(R+2R_3)}=-\frac{V}{1+2R_3/R};$$

$$C_5=-\frac{V}{R+2R_3};\quad C_6=+\frac{V}{R+2R_3};$$

$$C_1=-\frac{V}{R+2R_3}+\frac{V}{R}=\frac{2VR_3}{R(R+2R_3)}$$

$$C_2=+\frac{V}{R+2R_3}+\frac{V}{R}=\frac{2V(R+R_3)}{R(R+2R_3)}$$

$$C_3=C_6-C_5=C_2-C_1=\frac{2V}{R+2R_3}.$$

The meaning of the signs of these expressions is important. The convention, already mentioned, about the sign of currents meeting at a point deals with one way of looking at positive and negative currents; but these signs denote something different. They indicate the direction across the system in which the currents are flowing, a positive current being considered to be one flowing in the direction from positive outer main to negative outer main, and vice versa. While, therefore, C_6 is in the same direction as C, so making C_2 greater than C, C_5 is in the opposite direction to C, and so makes C_1 less than C; not only, then, are C_5 and C_6 opposite in direction as regards the system, but they are equal in magnitude, being each half of C_3 numerically. Hence, in the case of resistances used as a balancer, the middle wire current has the effect of superposing on the balancing part of the system two equal and opposite currents, one in each side of the arrangement.

The equations $C_2=C_3+C_1$ and $C_6=C_3+C_5$ are true for this case, as for all others, due regard being had to the sign of C_5, which is intrinsically negative. The voltage on the loaded side falls from V to $\frac{2V}{R/R_3+2}$, or $V_3-V=-\frac{VR}{R+2R_3}$. If the percentage change in voltage on the loaded side be called q, so that the new voltage is $(1+q/100)$ times the old, then $V_3=V(1+q/100)$, and $q/100=(V_3-V)/V=-R/(R+2R_3)=-1/(1+2R_3/R)$. Similarly $V_4=V(1-q/100)$, and $(V_4-V)/V=-q/100=+1/(1+2R_3/R)$. Therefore, the smaller R_3 is for a given value of R, or the larger R is for a given value of R_3, that is, the smaller R_3/R is, the worse will be the balancing, and if R_3/R becomes zero, either by R_3 becoming a short circuit or by R becomong infinite, $q/100=-1$, and V_3 drops right down to zero. To get any sort of reasonable balancing at all, then, with this arrangement, R would have to be as small as possible relatively to R_3. But if R is small, C is large, and the wasted energy in the balancer would be relatively enormous; and hence the plan of using resistances leads either to bad balancing or to low efficiency of the whole system as a balancing arrangement. This efficiency is the ratio of the watts in R_3 to the watts given out by the main dynamo in order to produce this out of balance load and is, therefore, equal to $V_3C_3/2VC_2$, since C_2 is the current given by the dynamo. This expression may be written $(V_3/2V)\times(C_3/C_2)$, and is equal to

$$\{1/(R/R_3+2)\}\times\{R/(R+R_3)\}=1/\{(R/R_3+2)(R_3/R+1)\}$$
$$=1/(2R_3/R+3+R/R_3).$$

By differentiating the denominator with respect to R_3/R and equating the result to zero, it is found that the maximum efficiency occurs when $R_3=0{\cdot}707R$, and by inserting this value in the expression for efficiency the maximum efficiency under any circumstances is given as only $3-2\sqrt{2}=0{\cdot}172$ or 17·2 per cent.

This shows, then, that resistances alone are of no practical use as a balancer, as they are extremely inefficient, and as inequality of voltage on the two sides of the system cannot be avoided, and becomes worse steadily as the load is increased. The very defects in such an arrangement, however, show how to improve it. The efficiency may be written in a different form from the above by expressing it as—

$$(C_3^2/R_3):(C_3^2/R_3+C_1^2/R+C_2^2/R),$$

which is the same as—

$$1/\{1+(C_1^2+C_2^2)R/C_3^2R_3\}=1/[1+\{2C^2+2C(C_5+C_6)+C_5^2$$
$$+C_6^2\}R/C_3^2R_3]=1/\{1+(2C^2+0{\cdot}5C_3^2)R/C_3^2R_3\},$$

(since $C_6=-C_5=C_3/2$), $=1/(1+2C^2R/C_3^2R_3+R/2R_3)$.

If, therefore, C and R are both small, the efficiency is high, and, in the limit, if C and R were both zero, the efficiency would be unity, which simply means that the efficiency is unity when the balancer losses are zero. Further, as has been shown, one of the conditions of good balance is that R shall be small. Now, with resistance only in the balancer C cannot be small while R is small, but if some back E.M.F. be introduced into the balancer circuit, R may be very small while C is kept small, because its value is due to the net E.M.F. acting across the balancer terminals.

X. Batteries as Balancers.

This leads to the consideration of the battery as a balancer. The equations are the same as those put down, at the beginning of section IX., for Figs. 9 and 10, except that, if the two halves of the battery are equal in all respects in regard to the state of their plates and other details, e_3 will be equal to e_4, and each will be equal to e_0, since the E.M.F. of the battery will not be changed, at least for the time being, by the out of balance current. Putting $e_0=e_3=e_4=e$, gives

$V=e+CR$; $C_1=(V_3-e)/R$; $C_2=(V_4-e)/R$; $C_3=V_3/R_3$; $V_3=e+C_1R$;

$V_4=e+C_2R$; $C_3=C_2-C_1=C_6-C_5$; $V_3+V_4=2V$; $V_3=2V/(R/R_3+2)$;

$V_4=2V(R/R_3+1)/(R/R_3+2)$; $V_3-V=V-V_4=-V/(1+2R_3/R)$;

$C_5=-V/(R+2R_3)$; $C_6=+V/(R+2R_3)$; $C_3=2V/(R+2R_3)$;

$C_1=-V/(R+2R_3)+(V-e)/R$; $C_2=+V/(R+2R_3)+(V-e)/R$.

It will be noted that the expression for V_3-V is here exactly the same as for the case of resistances, so that, as before, $-q/100=+1/(1+2R_3/R)$. But the efficiency is altogether different. It is again given by $(V_3/2V)\times(C_3/C_2)$, which becomes, when the values in terms given above are inserted,

$$\eta=\frac{1}{R/R_3+2}\times\frac{2V}{R+2R_3}\times\frac{R(R+2R_3)}{2V(R+R_3)-e(R+2R_3)}$$
$$=\frac{1}{R/R_3+2}\times\frac{1}{(R_3/R+1)-(e/2V)(2R_3/R+1)}$$
$$=\frac{1}{(2R_3/R+3+R/R_3)-(e/2V)(4R_3/R+4+R/R_3)}.$$

If the denominator of this be differentiated with respect to R_3/R, and the result be equated to zero, so as to get the value of R_3/R when the efficiency is a maximum, it is found that this occurs when $(R_3/R)^2=V^2/(V-e)(2V-e)=1/(1-e/v)(2-e/v)$, and the value of the efficiency is then

$$1/[(1-e/V)^{\frac{1}{2}}\{2/(2-e/V)^{\frac{1}{2}}+(2-e/V)^{\frac{3}{2}}/2\}+(3-2e/V)].$$

An examination of these expressions shows that when $e=V$, so that the battery is just floating on the line, the maximum efficiency is unity, and occurs when R_3 is infinite, and there is no out of balance current. As out of balance current comes on, the alteration in efficiency and other variables can be easily discovered. For the case of the battery floating, which is chosen because it is simple, and gives a sufficient indication of what sort of changes would take place under slightly different circumstances, the efficiency, η, is $1/(1+\frac{1}{2}R/R_3)=2/(R/R_3+2)$. The value of V_3 is always $2V/(R/R_3+2)$, so that for this case $V_3=\eta V$. Further, $C_3=V_3/R_3$ may be written $\eta V/(RR_3/R)$. The following table shows what happens as R_3 is diminished from infinity downwards to a short circuit :—

R_3/R	∞	20	10	1·0	0·5	0·2	0·1	0
η	1·000	0·975	0·955	0·667	0·500	0·285	0·167	0
V_3	1·000 V	0·975 V	0·955 V	0·667 V	0·500 V	0·285 V	0·167 V	0
C_3	0	0·049 V/R	0·095 V/R	0·667 V/R	1·000 V/R	1·428 V/R	1·667 V/R	2·000 V/R

From this it is possible to form an idea of the limits of actual out of balance conditions in a practical case. For suppose that the volt drop in the battery, due to its resistance, is 10 per cent. of $2V$ at the maximum normal current it carries, and, further, that the out of balance current in the middle wire is allowed to be as much as half this battery current, say, $C_3=\frac{1}{2}C_b$, as a maximum, then, since $C_bR/V=0·1$ and $C_b=2C_3$, $2C_3R/V=0·1$ also, and $C_3=0·05V/R$ as a maximum. This corresponds to an efficiency of 97½ per cent. on the balancing system, and V_3 is also only 2½ per cent. below V. This is the general order of magnitude of the quantities dealt with, and the improvement as compared with a resistance balancer is seen when it is remembered that for $R_3/R=20$, which is the minimum value in this case, the efficiency of a resistance balancer would be $1/(40+3+0·05)=$ about 2·3 per cent., although V_3 would be just the same in the two cases. This shows that the introduction of a back E.M.F. into the balancer, while it does not improve the balancing as long as $e_3=e_4$, enormously increases the efficiency, and makes a satisfactory piece of apparatus.

When the battery floats, $C=0$, and $C_1=C_5$ and $C_2=C_6$. A reference to the expression for C_5 and C_6 shows that $C_6=-C_5=\frac{1}{2}C_3$. The out of balance current may, therefore, be considered as dividing into C_6, a charging current, in the right-hand side of the battery, and C_5, a discharge current, in the left-hand side, as C_6 acts against e, while C_5 acts with it. The effect of unbalancing is thus to cause one half of the battery to charge and the other to discharge, and C_3 may therefore again be considered as made up of a current C_6 from the dynamo plus a current C_5 given out by one half of the battery. If the battery be not floating, but have, say, a charging current, C, originally going through it, unbalancing will cause a superposed charging current, C_6, on one side, and a superposed discharge current, C_5, on the other side, and if C_5 is greater than C, C_1 will be a discharge current actually; otherwise C_1 will be less of a charge current than C_2, but even then it is possible to consider the left-hand side of the battery in Fig. 10 as actually discharging C_5 through the resistance R_3. In the case when C and C_5 are equal numerically, C_1 is zero, and one side of the battery is thus floating while the other side takes the whole of C_3 as a charging current. This happens when $C=-C_5$, that is, when $(V-e)/R=V/(R+2R_3)$, or when $(V-e)/V=R/(R+2R_3)$, which gives, when transformed, $R_3/R=e/2(V-e)$. After R_3/R passes this value, C_1, as a whole, becomes a current in the discharge direction, V_3 then being less than e.

(To be continued.)

A STUDY OF THE LAW OF RESPONSE OF THE SILICON DETECTOR.*

BY LOUISE S. MCDOWELL AND FRANCES G. WICK.

The special form of silicon detector receiver designed by E. Merritt for use with short electric waves, and reported upon at the meeting of the Physical Society, February 27, 1915, showed certain peculiarities which made desirable a further study of the device. The investigation described in the following Paper includes, first, a study of the receiving device and the conditions under which it can be used to best advantage, and, secondly, a study of the law of response of the silicon detector with a variation in the energy of the incident wave produced by the rotation of a screen of parallel wires.

The oscillator, receiver and screen were arranged as shown in Fig. 1. The oscillator S consisted of a small spark gap in kerosene, extended by two straight aluminium wires WW, to a length of 51 cm., and connected through water resistances, HH, to the secondary of a small automobile induction coil, K, using about 6 volts. The water resistances introduced served to damp any oscillations from the coil which might have produced disturbances.

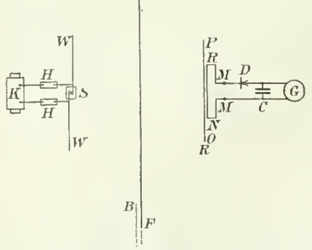

Fig. 1.

The receiver consisted of a silicon detector, D, in series with a paper telephone condenser, C, of 1 mfd. capacity, and with a loop of wire, NR. The connections to this loop were made by mercury cups, MM. A sensitive galvanometer, G, Leeds & Northrup type H, was shunted around the condenser. An aluminium rod, *OP*, acting as a resonator, was supported parallel and close to the outer wire of the loop. The length of the resonator was 44·5 cm., giving the maximum response to the wave-length used, about 100 cm.

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* Abstracted from the "Physical Review."

Between the receiver and the oscillator and parallel to them was placed a screen, *EF*, which could be rotated through known angles. It consisted of iron wires stretched parallel to each other about 3 cm. apart, upon a wooden frame 2 metres square. An additional fixed screen of tin and wire netting, *XY*, 3 metres high and 4 metres broad, completely divided the room, except for an opening, *AB*, left in the centre. The rotating screen was placed close to this opening, on the side toward the receiver, at distances varying from 5 cm. to 10 cm. for different sets of observations.

Merritt, in his experments with the receiving device, had noted that when the screen was placed with its wires parallel to the oscillator, the position which should allow no transmission, there was still considerable effect upon the receiver, amounting at the least to about one-fifth of the maximum effect, when the wires were vertical (the position for complete transmission). The cause of this residual effect was unknown. He observed, also, that as the wire screen was rotated through 360 deg. there was a variation in the response in the different quadrants. Early in the present experimental work it was found that when the resonator *OP*, Fig. 1, was removed the receiving apparatus still responded, although weakly, to waves from the oscillator. The receiver was then studied in order to discover what changes in the design would affect the response without the resonator, and how it could be reduced to the minimum consistent with sensitiveness of the receiver as a whole; also to discover the cause of the residual effect when the screen was in the position of no transmission. Experiments were made with the plane of the receiver both vertical and horizontal.

Receiver in the Vertical Plane.

The receiver was mounted on a T-shaped board and suspended by rubber bands from a cross-bar rigidly fastened to the ceiling. To prevent reflections, practically all removable metal was taken from the room and from the adjoining rooms. To reduce any difficulties arising from reflections from surrounding metal objects, the room was completely divided cross-wise by the fixed screen described above, and the rotating screen was placed in front of the opening. The residual effect was then found to be considerably reduced.

The screen was then rotated through 360 deg. and readings were taken every 20 deg. both with and without the resonator. From the observations made three curves were plotted, in which the ordinates were galvanometer deflections and the abscissæ the angles between the parallel wires of the rotating screen and the vertical.

The curve obtained with the resonator had a maximum at 15 deg. and a minimum at 100 deg., whereas without the resonator four maxima at the 45 deg. positions were obtained. Curves taken out of doors were similar in form to those obtained indoors.

To determine the effect of the design of the receiver upon the response without the resonator, series of observations were made with loops of various shapes and sizes. To get the effect upon the loop alone, the receiver was screened by a tin cylinder up to the mercury cups *MM*, Fig. 1. To test the response to the vertical and horizontal components of the transmitted waves, loops were made with the lengths of the vertical and horizontal portions of the wire in varying ratios. Curves showing extreme variations were obtained. The conclusion to be drawn from these curves is that the horizontal portions of the loop give a maximum response at 0 deg. and 180 deg., the vertical portions at 45 deg. and 135 deg. The receiver responds both to the horizontal and vertical components of the waves received, and the position of the maxima will vary with the particular form.

Receiver in the Horizontal Plane.

Since for the study of the law of the detector it was desirable to eliminate as far as possible all response to the vertical component, the entire receiver was placed in the horizontal plane and suspended as before by rubber bands. To reduce still further the response without the resonator the short loop which had given the minimum effect was used. The screen was rotated through 360 deg. and readings were taken every 20 deg. with and without the resonator as before. The curves obtained showed the effect without the resonator to be a much smaller fraction of the entire response than under the best conditions with the receiver vertical. As a further precaution, oscillator, receiver and rotating screen were carefully centred. Curves obtained under these conditions both with and without the resonator had their maxima at 0 deg. and 180 deg., and their minima at 90 deg. and 270 deg., and the effect without the resonator was extremely small.

The effect for the 90 deg. position of the rotating screen, the position of no transmission, was still to be considered. This residual effect with the resonator was about 15 per cent. of the maximum, and indicated that with the screens used there were diffraction effects which, as might be expected, were more noticeable with the resonator than without. In order to investigate the diffraction the receiver was placed in a tin box. The response to the waves did not entirely cease until the tin cover was made completely to enclose the receiver; even a small opening in the cover produced a decided deflection of the galvanometer. That the effect was due to the action of diffracted waves on the receiver was further shown by the fact that with the rotating screen in the position to allow no transmission a wire reflector back of the receiver at varying distances clearly indicated the presence of nodes and loops at distances apart which showed the wave-length to be that of the original wave. The average distance from node to node was found to be slightly more than 50 cm., making the wave-length approximately 100 cm. A similar effect was obtained by motion of the reflecting screen in various parts of the room, and motion of an observer produced an effect of such magnitude that it was found necessary to maintain fixed positions when any observations were in progress.

Final observations were made with the receiver in the horizontal position at a distance of 225 cm. from the fixed screen, and with the oscillator at distances from the screen ranging from 120 cm. to 230 cm. The maxima and minima of the curves with and without the resonator were at the same points, and the effect upon the receiver without the resonator was very small.

The Law of the Silicon Detector.

Since for the final curves obtained the receiver was so adjusted as to respond only to the horizontal component of the transmitted wave, it seemed possible to use the data to determine the law of response of the silicon detector with a variation in the intensity of the incident wave. The data already obtained showed the response of the receiver tor each position of the rotating screen. Since only the component of the wave at right angles to the wires of the screen could be transmitted, the amplitude of the transmitted wave varied as the cosine of the angle between the wires and the vertical. As the receiver was capable of responding only to horizontal waves, the transmitted component suffered a second resolution at the receiver, which again cut down its amplitude by the cosine of the same angle. Hence the amplitude of the component of the wave to which the receiver responded was proportional to the square of the cosine of the angle between the vertical and the wires of the screen. Presumably the amplitude of the oscillations set up in the receiver for different positions of the screen was proportional to the amplitude of this received component, and hence to the square of the same angle. The rectified current through the detector should, therefore, be proportional to some power of the cosine of this angle.

In determining the law only those data were considered in which the values of the current obtained without the resonator were small. With the galvanometer used the deflections were proportional to the current. For each set of readings two curves were plotted, with the galvanometer deflections as abscissæ and in one case the second, in the other the fourth powers of the cosines of the angles as ordinates.

From these results it seems safe to conclude that the rectified current is proportional to the fourth power of the cosine of the angle between the vertical and the wires of the rotating screen.

Since the amplitude of the oscillations in the receiver is presumably proportional to the square of the cosine, this result indicates that the rectified current through the silicon detector is proportional to the square of the oscillating current in the receiver. Austin,[*] in his study of the silicon detector, reached the conclusion that for alternating currents of ordinary frequencies and for oscillating currents of a frequency of 140,000 the rectified currents are approximately proportional to the square of the alternating currents. The results of the investigation of the writers confirm this law for a frequency of approximately $3 \cdot 10^8$.

PERFORMANCE OF BOILERS OPERATING AT OVER RATING.[†]

The data presented in the accompanying table shows the test performance of various types of boilers operated by 22 different companies and equipped with Taylor underfeed stokers burning different grades of fuel. The range of boiler rating is from 130 H.P. to 2,365 H.P. Since the conditions under which the tests were made

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[*] "Bull." Bur. Stand., 5, 133, 1908.

[†] Abstract of an article in the "Electrical World."

Results of 51 Boiler and Underfeed Stoker Tests Conducted under Different Conditions.

Name of company.	Type of boiler.	Water heating surface, square feet.	Steam pressure (pounds gauge.)	Draft over fire, inches.	Flue gas temp. (avg. deg. Fahr.)	Feed water temperature (avg. deg. Fahr.)	Kind and size of fuel.				Refuse from combustion (percentage of coal fired).	Combustible in refuse per cent.	Water evaporated per hour (actual).	Factor of evaporation.	Water evaporated per pound coal as fired, pounds.	Equiv. evaporation per sq. foot heating surface.	Combined furnace and boiler efficiency (per cent.).
							Name and size.	Volatile matter, per cent.	Fixed carbon, per cent.	B.T.U.							
Interborough Rapid Transit Co., New York City	B. & W.	5,200	176·9	0·09	539·7	137·4	Berwind & White Somerset mixed crushed R.O.M.	16·89	71·48	13,775	16·0	26·19	42,852·0	1·125	8·84	9·26	70·2
	,,	5,200	174·5	0·05	464·9	135·0	Berwind & White Somerset mixed crushed R.O.M.	17·04	73·40	14,101	11·1	20·66	23,190·0	1·128	10·10	4·94	78·2
Iowa Ry. & Light Co., Cedar Rapids	Edge Moor	6,270	184·0	0·0147	464·0	84·0	Iowa Lakonta slack	26·2	36·8	9,130	..	..	28,750·0	1·263	5·88	5·80	79·3
	,,	6,270	184·0	0·0065	447·0	82·2	Springfield, Ill., slack......	27·2	47·06	9,302	..	..	25,840·0	1·256	6·72	5·18	79·0
	,,	6,270	198·0	0·05	540·0	68·0	Springfield, Ill., slack......	26·0	45·6	9,840	..	..	42,700·0	1·272	5·76	8·68	72·5
	,,	6,270	198·0	0·0886	528·0	70·3	Springfield, Ill., slack......	26·0	45·5	9·840	..	..	35,100·0	1·288	5·65	7·20	71·7
Boston Elevated Railway Co.	B. & W.	6,000	206·6	..	527·4	95·0	..	19·41	69·21	13·860	..	..	41,022·7	1·257	8·14	8·59	71·62
	,,	6,000	202·84	0·025	448·75	153·4	..	20·21	68·38	13,850	..	..	30,552·7	1·184	9·34	6·03	77·7
	,,	6,000	202·26	0·042	428·96	140·19	..	19·35	69·13	13,860	..	..	22,804·5	1·185	9·48	4·5	78·62
	,,	6,000	205·06	0·406	498·2	84·1		..	..	13,419	..	..	40,061·12	1·262	7·96	8·4	72·6
Long Island City ..	..	5,245	188·7	0·037	529·3	55·8	Sonman Wilmore Pa. R.O.M.	20·73	69·03	14,150	11·3	28·4	23,960·0	1·289	8·67	5·9	76·6
	..	5,245	190·3	0·136	600·7	55·1	Sonman Wilmore Pa. R.O.M	19·97	67·73	13,738	10·1	13·1	32,198·0	1·304	7·9	8·0	72·8
Pressed Steel Co., McKees Rock, Pa.	B. & W.	2,500	134·6	0·035	493·4	104·5	Pittsburgh slack..........	32·88	51·80	12,668	..	41·10	11·294·0	1·147	8·42	5·2	76·3
	,,	2,500	133·0	0·08	728·0	111·0	..	34·8	54·35	12,042	..	..	16,825·0	1·15	7·72	7·74	71·2
Parker Webb & Co., Detroit	Wickes	3,090	137·0	0·045	675·8	184·7	..	..	..	12,582	..	..	21,765·0	1·0725	8·29	7·55	68·2
	,,	3,090	140·2	0·08	522·0	192·0	..	..	..	13,547	..	..	22,126·8	1·0657	10·29	3·82	78·2
National Tube Co., McKeesport, Pa.	B. & W.	5,202	161·0	0·05	447·6	157·0	Monongahela crushed run of mine	33·4	55·7	13,822	..	..	25,633·0	1·1089	10·0	5·47	77·93
	,,	5,202	158·0	0·09	472·0	153·0	Mosongahela crushed run of mine	31·7	56·5	13,587	..	..	35,645·0	1·107	9·26	7·53	72·75
Detroit Edison Co...	B. & W.	23,654	195·0	0·2	487·0	187·0	..	34·07	59·62	14,188	9·7	27·2	65,663·0	1·1545	9·87	3·22	77·9
	,,	23,654	210·0	0·84	651·0	188·0	..	33·48	60·58	14,061	9·35	36·1	147,435·0	1·1697	9·4	7·29	75·84
	,,	23,654	206·0	0·84	647·0	177·0	..	33·21	61·53	14,272	8·53	28·8	128,105·0	1·1822	9·52	6·40	76·42
	,,	23,654	203·0	0·45	545·0	184·0	..	32·92	60·44	13,983	7·07	29·9	98,073·0	1·1648	9·6	4·83	77·66
	,,	23,654	200·0	0·2	493·0	181·0	..	32·46	61·63	13,965	6·2	27·1	76,052·0	1·1579	9·9	3·72	80·28
Louisville Cement Co., Speeds, Ind.	B. & W.	3,000	141·5	0·12	..	180·5	Jellico Bituminous East Kentucky 60% slack, 40% nut	32·8	52·75	12,160	13,38	26·6	19,500·0	1·06	8·95	6·92	75·6
Cleveland Municipal Plant	Sterling Class W	10,130	225·5	0·06	510·7	71·26	Pittsburgh No. 8 slack	31·82	53·94	12,977	13·7	17·28	29,159·0	1·2769	8·49	3·68	81·08
		10,130	237·48	0·09	731·87	69·10	Pittsburgh No. 8 slack	31·45	53·31	12,817	18·2	33·44	52,866·0	1·308	7·30	6·83	72·3
J. R. Foster & Sons, Philadelphia	Badenhausen	3,910	96·8	0·0291	429·0	76·0	Clearfield Co. Pa. R.O.M. ..	20·87	67·87	13,988	9·97	30·0	17,794·0	1·1835	9·62	5·38	78·95
	,,	3,590	92·47	..	418·0	105·9	Clearfield Co. Pa. R.O.M. ..	..	..	14,174	..	..	22,750·0	1·1518	9·89	6·7	77·98
American Brass Co., Waterbury, Conn.	Bigelow Hornsby	5,000	127·0	0·12	507·7	197·0	New River	23·55	69·09	14,421	10·25	18·5	57,900·0	1·09	10·55	4·2	77·3
		5,000	126·0	0·30	526·0	213·0	Elizabeth................	69·08	21·78	14,349	10·12	..	61,000·0	1·078	10·2	6·59	74·3
Old Colony Street Ry. Co., Quincy Pt., Mass	B. & W.	6,875	173·0	0·35	599·0	131·0	George's Creek	..	..	..	..	..	36,400·0	1·203	9·15	6·56	74·4
New York Edison Co.	B. & W.	6,500	193·4	0·39	455·0	154·0	..	19·4	71·4	14,546†	7·3	12·8	22,780·0	1·154	9·9	4·12	78·5
	..	6,500	193·7	0·38	468·0	161·2	..	18·8	71·6	14,291†	8·7	14·9	25,040·0	1·151	10·0	4·52	79·8
	,,	6,500	194·1	0·37	475·0	172·8	..	19·9	71·1	14,702†	7·3	17·7	28,080·0	1·135	9·93	4·99	76·5
	,,	6,500	193·2	0·35	519·0	172·0	..	19·9	70·7	14,858†	8·4	26·1	36,360·0	1·143	9·5	6·51	72·7
Narragansett Elec. Lt. Co., Providence, R.I.	..	..	172·73	0·085	544·2	195·2	New River	11·00	80·01	14,501	6·5	..	25,365·0	1·07	10·68	6·15	76·04
Fort Worth (Tex.) Power Co.	Edge Moor	6,000	207·0	0·07	390·0*	191·7	Texas brown lignite crshd., R.O.M.	29·57	27·88	7,037	..	36·76	24,887·0	1·149	4·11	4·77	65·0
	,,	6,000	206·4	0·09	390·0*	186·5	Craig R.O.M. crushed to nut and slack	34·72	52·6	12,751	14·2	12·72	31,773·0	1·149	9·05	6·1	79·1
	,,	6,000	206·5	0·26	362·0*	192·3	Ark. semi-anthracite, very fine slack	..	..	10,275	..	..	26,724·0	1·142	6·99	5·12	75·5
National Tube Co., Kewanee, Ill.	Edge Moor	6,132	122·9	0·056	510·3	184·0	Illinois bituminous scrngs	..	..	9,976	16·5	10·98	38,359·0	1·1318	6·27	5·92	69·92
	,,	6,132	117·6	0·011	412·0	194·9	Springfield, Ill., slack......	..	..	9,302	17·6	6·73	21,721·0	1·1049	7·022	3·28	80·95
Commonwealth Edison Ch., Chicago	..	..	163·6	0·16	553·0	52·5	Duff No. 5	..	..	9,468	12·3	22·5	24,144·1	1·217	5·85	5·78	72·4
Milwaukee Electric Ry. & Lt. Co.	Return tubular	..	176·9	0·167	499·3	112·1	..	32·77	52·9	12,538†	14·33	..	34,000·0	1·2274	7·77	..	78·2
Penobscot Ch. Fibre. Great Works, Me	Dillon H.R.T.	7,200	81·0	0·06	595·0	145·0	New River R.O.M.	20·05	67·23	13,541	..	..	27,334·0	1·105	9·882	4·2	78·25
		7,200	85·0	0·05	..	145·0	New River R.O.M.	20·05	67·23	13,541	..	..	35,721·0	1·106	9·53	5·5	75·5
Everett Mills, Lawrence, Mass	Manning	1,300	117·1	0·187	600·0	142·54	Pocahontas semi-bituminous R.O.M.	19·89	73·12	14,490†	6·26	..	6,708·0	1·14	9·86	4·89	76·38
	..	..	130·2	0·187	598·0	144·15	..	19·89	73·12	14,490†	6·4	..	6,814·0	1·148	9·10	5·01	71·03
	..	..	123·65	0·187	599·0	142·35	..	19·89	73·12	14,490†	6·72	..	6,855·0	1·144	9·24	5·02	71·85
	..	..	125·24	0·187	599·0	143·114	..	19·89	73·12	14,490†	6·32	..	6,780·0	1·146	9·26	4·97	72·12
Public Lighting Plant, Detroit	..	4,013	162·44	0·22	516·0	158·0	Meadow Creek, W. Va.	36·35	57·0	14,584†	5·8	..	13,065·0	1·107	10·68	3·59	78·5
Columbia Enamelling & Stamping Co., Terre Haute, Ind.	Bass W.T.	2,000	108·6	0·02	521·8	183·9	Speedwell No. 4 screenings (Ind.) lumpy and coarse	30·75	41·0	10·556	..	..	6,293·0	1·0698	8·253	3·36	81·16

* Air leaks in boiler setting. † Dry coal.

were different in many respects, the data do not indicate the superiority of one boiler over another, but merely afford an opportunity of studying what results could be obtained under similar conditions. Inspection of the data will reveal the fact that equivalent evaporations as high as 9·26 lb. per square foot of heating surface have been obtained, and rates of 6, 7 and 8 are not unusual. While the higher rates, in general, have been attended by decreased efficiency, the combined furnace and boiler-efficiency did not drop much below 70 per cent. even for the highest evaporative rate. It may be pointed out that the manufacturers' ratings were exceeded in practically every case.

According to tests at one of the New York Edison Company's stations, 9·4 to 12·3 per cent. of the heat available from coal is lost through flue gases, 0·7 to 3 per cent. is wasted by incomplete combustion, 6·8 to 15·1 per cent. by radiation, and only 0·2 to 0·3 per cent. by evaporation of moisture in coal. In one of the Detroit Edison Company's stations, on the other hand, the radiation is only 2·43 to 3·54 per cent., while the other losses are about the same as in New York, 10 to 13·48 per cent. escaping through flue gases, and 1·8 to 3·58 per cent. being lost by incomplete combustion. In the Chicago and Detroit plants the average equivalent steam consumption required to operate the stokers and blowers was about 3 per cent.

Charging Storage Batteries by Rectified Currents.—A recent patent taken out in the United States deals with the use of rectified or pulsating currents for charging batteries. Such methods are admittedly inefficient, and this is ascribed by the inventor to the fact that an appreciable time is necessary before chemical change in the battery can begin. The phase waves must, therefore, be cut at appropriate points, so that the rectified current passes at a voltage considerably below the normal voltage of the battery. The chemical changes are thus allowed time to operate before the full P.D. from the rectifier is applied. This result is secured by special design of the segments of the mechanical rectifier.

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1916 AND AFTERWARDS.

A fortnight ago in commenting on the development of the power load we remarked on the impossibility either of describing what had been done during the year or of referring to what is contemplated in the immediate future. The same conditions limit one's freedom in recording the progress that has been made in electrical engineering as a whole. The items on which comment can safely be made are few in number and last week a review of certain of these was given.

We look forward to the time when greater freedom will be given to the Technical Press, and to the time when the arrangements are such that officials at the Press Bureau will be able to give the same opinion on consecutive days to different persons. The ever-present possibility of suppression tends to make over-cautious those responsible for the conduct of newspapers; and notwithstanding over-caution one may do the things which, in the eyes of the official, one ought not to do.

On at least one occasion we have been called upon to explain why certain articles have been allowed to appear in our columns. To our knowledge the matter to which exception was taken was familiar to German engineers, for in the piping times of peace—when our Statesmen told us what a thoroughly good fellow the German really was, and how completely he was misunderstood—we had discussed the things with engineers from that unhappy land. On another occasion an article submitted to the Censor was condemned, and the same week a similar article appeared in one of our contemporaries.

Although little, one might almost say next to nothing, has been recorded during the year on the progress made at home in electrical engineering it must not be inferred from this that nought has been done worth recording. Such an inference would be very wide of the mark. The fact is that great progress has been made in each and every branch of electrical engineering as regards the manufactured product, and, most important of all, in the method of manufacture as well as on the business side.

For a long time electrical engineers have known that electrical energy as a motive power stood alone; but for a number of years the imparting of this knowledge was like unto the voice of one crying in the wilderness. At the present time the electric-drive is coming into its own. It is especially satisfactory to note that the heavy industries are making considerable demands for plant. The electrification of steelworks, of collieries and of textile and other factories is going forward. Starting as a ripple, works electrification has become a wave, and the triumph will be complete when one of these days an Order in Council prohibits the use of any other motive power for industrial purposes. It does one good at times to indulge in a little speculation

The three main problems vital to our industries are steel, coal and handling of materials. From the electrical point of view there are no difficulties to be solved in connection with any of these problems. The tremendous activity in the steel trade will, we hope, be such as to make us something better than a discreditable third in the list. Engineers and coal owners no longer assert that "small coal is of no value and as such can beneconomically." The fact that there is useful work tene and few men to do it has directed attention to inl or modern methods of handling materials. Such lesearned with the enemy thundering at the gate, will norgotten in our time.

The engineering industry, tho its elasticity and adaptability, was never in a sounsition than it is to-day. In addition to supplying mun and building new works and modernising old ones, firrking in concert have found time to perfect their peganisation and programme. This applies to electrical ering as well as to the other branches. The effect of tbusinesslike methods of the Ministry of Munitions and alty in the placing of contracts has not tempted the laigineering firms to be unbusinesslike, and in many cases gements have been made so that the enormously increcapital may be used to good advantage when the wartracts come to an end.

With commendable shrewdness these busy nave allowed little or nothing to be published regardiheir plans. On this account many must have thought the engineers agreed with those who declared that "afhe war would look after itself."

It is probable that the policy to be pursued will eliate the cut-throat competition which characterised var trading, and will, at the same time, ensure a moyen distribution of work throughout the country. It is lly probable that account will be taken of the American iace as well as of the German. The former is of an ely different character to the latter, but the brains behian organisation that will keep the German trader out he market will be subtle enough to devise plans for countg the American and for securing for home firms all the ors they are likely to require to keep them fully occupied.

Many share our regret that the engineering institus have done so little during the war. There is an atmospe about the meetings of these institutions that leads ono believe they are losing their grip on the industry which y are supposed to represent. Some affirm that this is bece new blood is required. Others believe that the meetis should be conducted in a different manner. Beyond statg that many of the meetings remind us of anything and eve thing but real engineering, and that most discussions se to be forced and entirely artificial, we do not propose express any opinion. We would say, however, that son of the provincial engineering institutions appear to be doin very useful work; and, further, we would say that or criticism applies to no particular institution.

Even more regrettable is the fact that the State has faile to recognise the importance of technical education. Witl a criminal disregard of future requirements and with ai impotence surprising even in a State Department, the Boarc of Education has allowed the colleges to be emptied. It is said that the State is meting out generous treatment to the colleges. If by this is meant that large monetary grants are being made, then we state emphatically that in our opinion the money paid is the price of the Board's dishonour.

Although the colleges and schools are now practically empty we would still have the large employers of labour, and particularly the engineers, speak with no uncertain voice on this subject lest the politician, when called upon, should plead that what he did was done in ignorance of the country's requirements. Should they fail to do so it is not unlikely that in the future they will have to import their technologists either from America or the continent. It were better from every point of view that Britons should be employed in the workshops of Britain.

PRINCIPLES INVOLVED IN COMPUTING THE DEPRECIATION OF PLANT.*

BY F. GILL AND W. W. COOK.

[(*Concluded from page 476.*)

Alleged Objections to Sinking Fund for ascertaining the Value of Plant in place.—Those who advocate the straight-line method as against the sinking fund use arguments which group themselves somewhat in the following manner :—

1. The straight line method has always been adopted in valuations.
2. If half the life is gone, half the value is gone.
3. The sinking fund is a wrong method because if a person buys at depreciated value on the sinking fund basis, at the end of the life there is only in the fund the amount the buyer paid and not the cost which then has to be found for the new plant.
4. The depreciation to be paid to the sinking fund by successive owners is an increasing amount.
5. The sinking fund method is wrong because it locks up the money required for renewal of the short-lived plant.
6. The sinking fund method is wrong for plant because the life is uncertain. It is right for a lease or annuity where the life is known.
7. It cannot be that the rate of interest earned by a redemption fund can affect the value of plant.

Each of these arguments is discussed, and the authors continue : The straight line method appears to rest on two points : (*a*) it is so simple and avoids calculation ; and (*b*) the magic of the words, half time, half value !

The simplicity is useless if it is wrong ; and that half value is correct at half life has only been asserted and not demonstrated.

Equated Lives for Complex Plant.—In treating a case in which there are various lives, it does not appear to be well known that the average life obtained in the usual manner of getting a weighted average is an erroneous figure to use in calculations for redemption of money. The late Mr. Robert Hammond referred to this in his paper on "Depreciation."†

If we take a plant consisting of three classes of articles having different first costs and lives as shown below, we find that the average life is 7 years, obtained as follows :—

	Amount	Life in Years.	£×years.
Class A	£300	10	3,000
,, B	200	5	1,000
,, C	100	2	200
	600		4,200

$$\text{Total average life} \frac{4,200}{600} = 7 \text{ years.}$$

But in this calculation, £300 for Class A, £200 for Class B, and £100 for Class C, were employed, whereas in the complete cycle of 10 years the money actually involved will be £1,200, and therefore the figures should be, if interest be not added to the fund, and the

$$\text{equated life} = \frac{6,000}{1,200} = 5 \text{ years.}$$

One usual way of calculating this equated life, *i.e.* without interest, is to divide the first cost by the sum of the annual instalments. If, on the other hand, interest (say 5 per cent. per annum) is added to the renewals fund, the equated life will be 4·95 years.

Calculating for the sum of £600 on an equated life of 5 years without interest, or 4·95 years with 5 per cent. interest, will each give the money required to renew each part as its time comes to an end. To use an average life of 7 years by which to calculate the amount required to renew the plant would, however, result in a serious deficit.

Definition.—The equated life is purely a financial period, and has nothing directly to do with the life of the plant (though, of course, based upon this). It is the period in which the annual instalments would accumulate to the total required, and that being so, it is of course to some extent dependent upon whether interest is added to the fund or not, because it depends upon the rate of growth.

From this example it will be seen that there is a great danger if the difference between average and equated lives is not appreciated. For a complex plant, use of the average life will result in inadequate provision, because the equated life is always shorter than the average life. Provision for a complex plant can only be made either by providing separately for each part and summating the annual payments, or by using the correct equated life and treating the plant as a whole.

Lives for Non-complex Plant.—When, however, a subdivision of plant having the same general characteristics is considered, the average lives or ages may safely be used. The authors give an example which supports the general reasoning that provided plant is grouped in sub-classes having the same general characteristics the weighted average life of the individual items may safely be used, but groups not having the same general characteristics must be treated separately.

Where Life is Limited by Units of Work Performed Rather Than by Time.—In some cases the life of plant is limited by the units of work performed rather than by time. The question arises, how the proper charge per unit of work is to be arrived at, since in some cases there must be found the correct amount to be charged to each job for the use of the plant.

In such a case, time, *i.e.*, the physical and economic lives, must be brought into the calculation, and one is bound to estimate a period during which the units of work will be performed in order not to ignore the fact that the payment for depreciation is made in advance of the money being actually required, and therefore interest must accrue.

Example of Lives and Calculations for Renewals and Improvements Funds for Typical Plant Class.—The accompanying table gives a detailed example of depreciation charges and shows the provision for renewals fund based upon the physical lives and the provision for improvements fund based upon the difference between the economic and physical lives for each of the three sub-classes, A, B and C, of which the plant class is composed.

SUMMARY.

—	Equated life.	Residual value.	Depreciable amount	Annual percentage on first cost (5% sinking funds).		
				Renewals.	Improvements.	Total.
	Years.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Physical	43·9	13·1	86·9	0·5772	...	1·1711
Economic	28·3	30·2	69·8	...	0·5939	

Fig. 7 shows the funds of the three sub-classes together, and in this case the equated physical life is 43·9 years and the equated economic life 28·3 years. The residual value at the end of the economic life is 30·2 per cent., considerably higher than 13·1 per cent. at the end of the physical life. The annual contributions to the funds are : 1·1711 per cent. of first cost. The annual charges for capital are therefore : return on capital 5 per cent. plus depreciation 1·1711 per cent. = 6·1711 per cent.

Renewals and Improvements Funds for Complex Plant. 5 per cent. Sinking Funds.

Sub-class of plant.	For renewals fund.							For renewals and improvements funds.						For improvements fund.	
	Relative first cost.	Residual value at end of physical life.		Physical life depreciable amount $A-C$.	Physical life.	Provision for renewals		Residual value at end of economic life.		Economic life depreciable amount $A-J$.	Economic life.	Provision for renewals and improvements.		Provision for improvements.	
														$100P/K$	$N-G$
	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
	£	%	£	£	Years.	% p.a.	£	%	£	£	Years.	% p.a.	£	% p.a.	£
A	90	14	12·6	77·4	60	0·2828	0·2189	13	29·7	60·3	35	1·1072	0·6676	0·7441	0·4487
B	5	14	0·7	4·3	30	1·5051	0·0647	14	0·7	4·3	25	2·0952	0·0901	0·5907	0·0254
C	5	-3	-0·2	5·2	13	5·6456	0·2936	-3	-0·2	5·2	10	7·9505	0·4134	2·3038	0·1198
Total	100	13·1	13·1	86·9	43·9	0·6642	0·5772	30·2	30·2	69·8	28·3	1·6777	1·1711	0·8509	0·5939

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† "Journal" I. E. E., 1907, Vol. 39, p. 270.

The provision in these tables is sufficient for the renewal of each part as it becomes due, and nothing in the way of renewals is left to be provided out of maintenance.

Constant Maintenance Cost.—It was assumed above that the maintenance cost would be constant throughout the life of the plant, and it is necessary to return to this question.

It has been shown that the renewal of each part, as it is required in its turn, is provided for by the fund established on the basis of the equated physical life. It is clear that an equated life arranged for all the plant provides money for the renewal of every part. The cost of maintenance is the cost of looking after the plant, keeping it in running order, repairs, keeping records and inspections, but not of making renewals.

It seems clear from this reasoning that there is not much room for increasing maintenance cost. The general idea of increased maintenance cost with advancing age appears to have arisen out of the fact that provision has not been contemplated for all renewals in a depreciation scheme, in which case as the renewals come due, of course there will be the increased cost due to them. But as in the analysis set out herein all renewals are included under "renewals," it seems right to say that maintenance cost does not increase with age.

We believe that constant maintenance cost, if full provision is made for renewals, is a tenable assumption.

In the case of telephone plant, careful investigation failed altogether to detect any increase in the cost of maintenance with advancing age, and, so far as we know of, no data which has been put forward showing increasing cost apart from renewals.

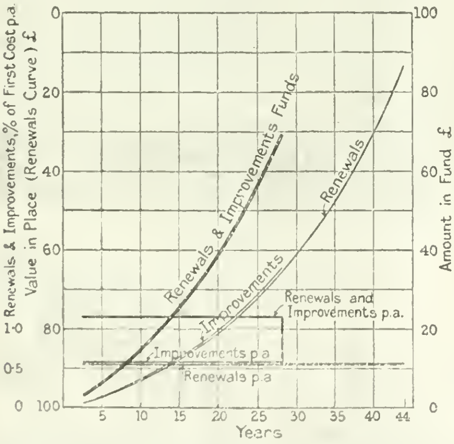

Fig. 7.

If one were trying to make plant last beyond the period during which it would give its service satisfactorily, there might be such a supervision and maintenance cost as would constitute an added burden, but that reason cannot be advanced because it would be a contradiction of the meaning of the term "physical life," which is limited to the period during which the plant can perform its service satisfactorily.

If there are cases of maintenance cost increasing with age, this increasing cost must of course be met, and any such cases will doubtless have well determined cost data, but the provision should be made directly and not indirectly. It would be curious if on all plant the increasing cost of maintenance were just the amount provided by interest at varying rates, compounded over various periods.

Assessment of Profits.—The amount to be charged to depreciation, or as we prefer to put it, to renewals fund and to improvements fund, before assessing the profits of an undertaking, is the total amount indicated by the portion of the annual charges alloted to those costs. When the annual charges have been settled, then the charge against the year's income for renewals and improvements must follow in principle that settlement, subject to any alteration of fact which later knowledge may have brought to light. But this does not permit of any change in the method. If the sinking fund method is correct for the annual charges it must also be correct for the year's accounts; otherwise, the annual charges are not true, and if they are not true, the primary object of ascertaining the annual charges —to select plant wisely—is vitiated.

In allowing for renewals and improvements when ascertaining the profits of a business, the accountant is likely to be met with the suggestion that if he puts away the depreciation funds on a straight line basis, investing them at interest and crediting the interest actually earned to the revenue, he will be using a method which gives credit for the interest which is in fact earned and will be charging a sum which represents the real cost over the whole period. This is the method shown in Fig. 3 and it is open to the criticisms which apply to that method.

If Depreciation Reserves are Invested in the Business.—Up to the present one assumption has been that the capital account was closed and therefore the reserve funds could only be lent outside. But there is no difference in principle whether the reserve be lent outside or invested in the business; in either case the money must earn interest and the interest must be credited to its real source.

Conclusions.—There is only one common method for the financier, the accountant and the engineer.

This common method is best studied in the annual charges for plant, determined in advance of construction.

To determine the amount in the annual charges for depreciation it is necessary to estimate the first cost, residual values, and the physical and economic lives of the various classes of plant.

It is also necessary to fix the treatment of the capital account and to estimate the charge for return on capital.

The interest to be earned by the reserve funds must be credited to its source.

The reserves are preferably handled by means of two funds as follows:—

(*a*) A renewals fund for providing the necessary money at the end of the physical life, that is, the end of the period during which the plant will give its service satisfactorily under all conditions *outside* the owner's control.

(*b*) An improvements fund for providing sufficient additional money to enable the plant to be taken out of commission for reasons *within* the owner's control and while it is still giving its service satisfactorily.

The calculation of the amounts to be contributed to these two funds must include the interest which should be earned by the money before it is required at the end of the life.

The amount, calculated as above, which should be in the renewals fund gives the correct diminution in value, when considering the value to the owner, of the plant in place and working, at any period in its history.

The amounts, calculated as above, which should annually be put to the two funds, renewals and improvements, determine the correct depreciation charge against the undertaking for the purpose of assessing profits, fixing rates and, under certain conditions, assessing the value of an undertaking as a going concern.

The sinking fund method fulfils all the requirements.

The straight line method does not.

All estimates, such as first cost, physical and economic lives, and interest earned by funds, will require revision from time to time either as a result of experience or of changes in conditions.

DISCUSSION.

Sir **Alexander B. W. Kennedy** said the Paper dealt with questions which would be more important in 1931 than they were at present. For undertakings already working and which had adopted some method for estimating depreciation there were two different questions: What provision for depreciation should be made annually so as to renew plant when worn out, without borrowing and what was the depreciated value of plant which had been used and was to be sold. What value should be put upon the plant when it came to be compulsorily purchased. Depreciation intended to save undertakers raising new capital when plant was disused was mostly based on the straight line method based on an estimated life and in some cases invested outside and in others invested in their own business. Some did not have a depreciation account but wrote down capital value every year. It was difficult to prove one method better than the other, provided the required financial result was achieved. With regard to the second question: the method of depreciation for an undertaking that was going to be sold could not be changed about. He believed the method advocated by the authors was the right one. Hitherto they had only examples of the sale of tramways in which the straight line method was practically universal. That was unfair to the seller in a forced sale after many years and within the physical life of the thing sold. The straight line method had no scientific basis. It enabled one to do without a table of logarithms and a slide rule and without financial valuations, but this was a financial question. The Paper referred to "half life and half value," but it might be only a quarter value. It was a thing to be proved. He trusted that there would be a general concensus of opinion among engineers that the sinking fund method was best and that it would be taken up and dealt with. If the sinking fund method was the best it was important to get that fixed in their minds and in the minds of the people who had to decide what they were to be paid. He had often heard the objection that the portion of the annual charge allocated to renewals became larger each year. The authors said that increase was exactly counterbalanced by the reduction of the charge in respect of the return of capital, so that that was not a serious objection. The authors raised the question as to what was meant by "life." The life had to be guessed or estimated at the beginning. The life of something not used might be unlimited. The life of plant with load factors of 25 and 60 or 65 would be very different.

Mr. J. S. Highfield said, assuming for every £100 of capital a revenue of £12, out of that £2 or £3 had to be provided for depreciation. The accountant thought more about the efficiency of the sovereign than the efficiency of the plant. The greater the security the smaller was the profit and the greater the risk the larger the profit under favourable circumstances. In an investment business the question was considered how long a profit was likely to be enjoyed and a reserve fund and sinking fund were provided. Most of the persons interested in investment businesses invested their money in businesses that might involve engineering skill, because the reserve put by in the business in which their money was invested was often not adequate. Dividing the two into (1) provision for diminution in the value of the plant, and (2) provision for improvement fund (the authors divided into two headings, renewals fund), the first related mainly to the preservation of the engineering assets, buildings, plant and so on—or in a manufacturing business, tools, &c. A sum was set aside to preserve these up to their full value, or if they lost value a sum was put by to make it up; the second amount was for improvements. He suggested sub-headings (1) for day to day repairs, (2) for extraordinary repairs such as replacement of boiler tubes, repainting of tramway poles, and so on, and (3) repairs that occurred at long intervals such as replacement of original boiler crowns and replacement of poles, occurring, say, after 20 or 25 years. Those three would come under renewals. The second item, "improvements," he divided into (1) the provision of better and more economical plant which was really in the nature of insurance, (2) a fund to enable larger plant to take the place of existing old plant; this led to many differences between accountants and engineers as the engineer knew he could replace the old plant by new plant which would perhaps take half the amount of steam which would enable the existing boilers to do double the work and make the existing buildings and land to be of twice their previous value, while the accountant regarded the old plant as an asset which would have no value if it were taken out; (3) competition might force on any trader the necessity of reducing costs, because competition reduced the price of the commodity supplied. This was depreciation of the profit earning capacity of the assets, but he thought it better to consider the fund which should be set aside out of profits to meet that as insurance. No business would continue satisfactorily unless it was growing. Apart from luck, the only way to make a business grow was to have money to take advantage of opportunities for extension. A considerable portion of the reserve should be invested outside the business so that cash could be available for extensions. The transfer of undertakings invariably resulted in loss to both sides, and he hoped in 1931 Sir Alexander would not have to consider how to get the best price, but how to enlarge the business and carry it on.

Mr. James Swinburne said in the National Telephone arbitration case he did not think any of the counsel understood the depreciation question except perhaps the junior counsel. The question of the straight line and the sinking fund seemed to be simply a theorem independent of the nature of the plant one was working on. If plant altered in value through being stored or becoming obsolete it had nothing to do with the principle of straight line and sinking fund as opposed to each other. Mr. Swinburne then drew a diagram to demonstrate that a man (A) who invested £1,000 in the lease of a building for 10 years and a man (B) who put £1,000 into a business which gave the same profit would make the same. B's sum carried interest, and at the end of 20 years he had, say, £2,000. A, who had invested in the lease, got profit out of it, and if he put the profit into his own business the same curve was obtained. If A disposed of his lease after five years the straight line man would say £500 was enough, but he had, say, £1,400, and he must pay something more. It was necessary to understand how the compound interest law came in.

Mr. J. E. Kingsbury thought that a method of providing for depreciation, without a scientific basis, had been blundered into, and if the method in common use was inaccurate and unscientific it was the business of engineers to reach some basis which was sound all round. Electrical enterprises were suffering from a lack of knowledge of the necessity of depreciation in a wider area. The consumer said the capitalist's money earned interest while he slept but did not recognise that the material bought by the capital was dying whilst he slept. The Paper contained a logical method of reasoning and conclusions which seemed to him to be sound. The question of depreciation should be dealt with as a whole and in all its details. He wished to impress upon engineers the importance of getting a scientific method in matters such as that and not relying on mere assertion or opinion.

Mr. E. S. Byng said apparently the "lives" of plant had a most important bearing on depreciation and annual charges. The authors showed how the physical life was obtained from averages of some 10,000 poles which had been recovered. How would a figure be arrived at where such records were not available? Mr. Byng then showed curves based on physical life of 25 years and economical life of 19 years. Curve No. 1 was based on the assumption that £2·05 was invested annually and accumulated at compound interest, so that the original value of the plant was attained at the end of its physical life: Curve No. 2 on £2·85 invested annually in order to reach a total of £87 in 19 years, and Curve No. 3 was an assumed value for the recoveries realised. At 10 years—assuming first cost to be £100, there was £25 in the renewals fund and the plant value was £75. If the plant were recovered at that date the value of recoveries would be £27, the net wastage being £48. The £10 accumulated in the improvements fund could not be taken into consideration, although it was for that purpose that the fund was created. At the end of the economic life the amounts in the renewals and improvements funds were £53 and £34, which, with the £13 for recoveries, made up the total capital, but a wastage of £34 must be taken into consideration. It would seem that the charge for improvements was not continued beyond the economic life of the plant, but it was submitted that if it was not necessary to recover the plant for causes within the owner's control before the termination of its physical life the same annual chrges fixed should be continued throughout, so that if the plant be recovered at 25 years the renewals fund would be £98 to which £2 was added for recoveries. The £38 in the improvements fund was therefore not required in that case and could be used to offset losses through recovering plant prior to the economic period. Mr. Byng then showed a table to give a general idea of the manner in which studies of the value of plant in place and the wastage due to recovery before the plant has served the life for which it was designed were scientifically tackled. The question was whether existing plant should be scrapped where it had only been in use a portion of its normal life in order to meet anticipated future developments. It was often more essential to compare the annual charges over some definite period than even the first costs, when it was desired to determine the relative economy of various types of plant. As depreciation affected annual charges to a large extent it was surprising that engineers had not been more concerned in the past as to whether correct figures and correct methods had been adopted.

Mr. A. T. Lawrence said he had been referred to as the only counsel who understood all the arguments in the National Telephone case. The lawyer's function was always to be logical. In the author's arguments it seemed to him there was only one side with any logic about it. If you put your depreciation fund in your stocking there might be something to be said for the straight line method, but common sense suggested that it should be used so as to get some return. That return was not taken into account in the straight line method. He had heard Sir John Simon's argument on the subject day after day, but he had heard no defence of the straight line method at that meeting, at which he was not surprised.

Mr. W. R. Cooper said he hoped the income tax authorities would listen to the authors and would in the near future allow depreciation and not insist upon taxing really non-existent profits. He was afraid some people might be inclined to run on too hard-and-fast lines on reading the Paper. The difficulty was that a curve had to be drawn between two points, one at the beginning and one at the end of the life of the plant. There was an infinite number of curves, but did the value of the plant follow any one of them? The sinking fund method gave one of those curves, but if the compound interest law had not been discovered the curve would be different, though the value of the plant would remain as before. The question was whether the asset was really there. That meant that to keep in a sound position, valuations must be made from time to time to check the curves. The question was receiving considerable attention in the United States. In Ohio there was a Committee of Public Utilities who came to the conclusion that the only sound method was to have a valuation from time to time. In conclusion, he suggested that by organisation it should be possible for the supply companies to train opinion so as to avoid the calamity in 1931, to which Sir Alexander Kennedy and Mr. Highfield had referred.

Mr. E. Kilburn Scott said he was called in in connection with a rating appeal relating to tramways and lighting in Bendigo. The municipality were dished, because the company brought exhibits—poles eaten by white ants and steel rails eaten by rust—into Court, to show how great was the depreciation. He hoped in 1931 exhibits would be ruled out and that the pros and cons would be weighed up as they had been at that meeting. The straight line man drew a curve between the curves put forward by the buyer and seller respectively, as the residual value at a given time, and this appealed to the average man. It would be an excellent thing to invest depreciation funds in concerns which the electric light undertaking was supplying with current—for instance, textile factories in Lancashire or collieries in Yorkshire—and so have some control over the people using the current. As an instance of the opposition by accountants to scrapping assets he might mention that some nine years ago he saw a large number of useless locomotives in a station yard and was informed that the accountants would not allow them to be scrapped. Similarly, in some electricity works there was plant, which was useless even as standby plant, occupying space which could be used for something else, but the accountants only took into account the depreciation of the plant itself.

Mr. Cook, in reply to the discussion, said they had been disappointed in not hearing anything in favour of the straight line. With regard to Mr. Highfield's remarks as to the accountants thinking of the sovereign, he thought the accountant thought more frequently of the interest it earned. He was not quite clear as to what Mr. Highfield meant by day to day repairs. He thought they were day to day renewals, and it depended to what extent those renewals were taken into account when the life was fixed. A fund invested in the business could be just as available as one invested outside, because if you spent that on new plant you were entitled to raise further capital. Mr. Cooper advocated valuations. If depended upon the system employed for the valuations. If done on the lines of Tables 8 and 9 the same results would be obtained.

DISCUSSION AT EDINBURGH.

Mr. F. A. Newington (Edinburgh) said that according to the Electric Lighting Acts it was illegal to provide for a renewal or depreciation fund. He had hoped the authors would have devised a scheme by which, instead of payments decreasing annually, the payments should be less in the early days of the undertaking when the capital was not earning full revenue, and the payments might be increased when the plant was in full operation. He could not agree that maintenance did not increase with the age of the plant.

Mr. McCallum (Greenock) said he did not think the straight line method of depreciation was the correct one. That proportion of capital expended on land and buildings should be repayable in 60 years instead of 30, which would halve certain of their statutory charges. The influence of capital charges was seen in the instances of undertakings finding it cheaper to put down steam plant in the neighbourhood of Niagara Falls and Victoria Falls.

Mr. Lackie, in the course of a communication, stated that depreciation of value was met by a sum set aside for sinking fund if such sum were properly calculated on the probable life of the plant. Decreased efficiency should be met by depreciation if the ordinary maintenance chargeable to revenue was not sufficient to keep the plant in its first state of efficiency. Obsolescence was not true depreciation; but it was quite possible that a spending authority owning works might look to the advantage which would be gained by installing present-day plant and so getting greater efficiency than could be obtained from antiquated plant. Such an authority would annually set aside a sum for this purpose, and might be found dispensing with old plant in favour of more up-to-date plant, even although the former might not have reached the end of its useful life. There was really no principle involved in computing the depreciation of plant. The examples worked out in the Paper were based on a 19 years' life. For the principal power station in Glasgow 10 years ago a 1,500 kw. generator and condensing plant were bought for £16,000. Depreciation had been written off this plant only, and it now stood in the books at £7,000. It was proposed to scrap this plant and put down a 6,000 kw. turbo-alternator costing £28,000. The new plant would save them £20,000 per annum in coal. So long as the plant was kept in first-rate condition out of revenue and one was prepared to write off the difference between what the plant stood at in their books and what it would fetch if sold, the rate of depreciation might be so small as to be met by sinking fund. No fixed rate of depreciation should be agreed upon over a period of 20 years in an engineering works. One might have a very slack year when the plant was only used for, say, the equivalent of 2,000 hours per annum, and in a subsequent year the same plant might be run for 6,000 hours per annum. The rate of depreciation in the two years would be quite different. In the early days of electricity supply for lighting purposes they thought that a depreciation of 5 per cent. was liberal, but to-day with new plant, which was run practically continuously, a depreciation of 10 per cent. was required.

Mr. R. B. Maccall stated that (1) he could not assent to the statement of the authors that a general agreement on this subject was possible, and (2) he did not believe that the straight line method condemned by the authors was so inequitable as alleged. Depreciation, he stated, was like incidence of taxation, a subject on which many divergent views were possible, even although it be agreed that depreciation and taxation are inevitable. Neither did he agree with the statement that the matter was largely one of fact. While it was true that depreciation of plant was a fact, the period of years in which total loss would occur was unknown, and therein lay the first difficulty in coming to a common agreement. Depreciation was a premium of insurance, and all that prudent people could do was to make a reasonable provision for the inevitable but undatable casualty by setting aside annually or otherwise a sum towards the probable day when new plant would have to be provided. He thought that the authors had wrongly obtruded certain factors into the question, such as the annual return of plant and maintenance, neither of which had to do with the question. If these were eliminated the subject became much simplified, and on the assumption that an annual instalment should be put aside for renewal of plant, all that remained was should this sum be on the straight line method or on the annuity or sinking fund methods, he came to the conclusion that the straight line method was as beneficial to the undertaking on the whole as any other method, because it called for an equal sum each year (not a decreasing sum as alleged by the authors), and that being so it was just as equitable as the sinking fund method, which required more bookkeeping, or the annuity method which required a certain amount of actuarial calculations. He also pointed out that there were other aspects of depreciation which the authors had not dealt with. He challenged the tables as being based on a wrong hypothesis, and that, therefore, the conclusions come to by the authors were wrong. With regard to the equating of depreciation on plant having different lives, he thought there was no difficulty either in the case where there were three units of plant each of the same value but all different lives, or where the items were of different values; it was only a matter of simple calculation. Where the physical and economical life (obsolescence) entered into the calculation the economic life, being the shorter of the two, was the life on which calculations for depreciation should be founded. He challenged the paragraph dealing with depreciation reserves invested in the business, and pointed out that the result to the undertaking was the same whether they borrowed £100 and continued to pay interest on it while receiving interest on £5 of a depreciation fund set aside, or repaying the loan to the extent of £5 and paying interest on £95. In both cases the interest was paid on a net sum of £95.

Mr. R. Robertson and Mr. J. M. M. Munro also made a few remarks, and Mr. Gillbey replied.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

It is gratifying to observe in your issue of the 12th inst. that one correspondent, Mr. C. Turnbull, has grasped every point in my recent article on the above subject. The correction he makes in my table for odd pence is mathematically correct, but of course I could only give the nearest coin which would meet the case. Mr. Turnbull's table of differences is invaluable and should give the quietus to every decimal scheme that would divide our present standard of value into less than 2,000 parts.

The letter from Mr. Allcock is merely a restatement of the case for the florin. In that respect, therefore, it requires no comment from me, for my views are already before your readers. But there are, however, certain statements made therein to which I should like to refer.

Mr. Allcock states that we could adopt our present florin as a standard coin. That cannot be. Our standard measure of value is gold. Silver and bronze coins can, therefore, only be tokens. The first duty of every reformer is to be explicit in his terms. He also tells us the chief argument against the florin scheme of decimals is that, since it divides the florin into 100 parts as against 96 it thereby operates to depreciate the present bronze coinage by 4 per cent. I would reply that such a statement is nonsense, for by the same line of reasoning, since the shilling scheme divides the shiling into 100 parts as against 48, it thereby depreciates the present bronze coinage by 52 per cent., which is absurd. The chief argument against any decimal system is that in the small purchases appertaining to everyday life it frequently gives remainders. The larger the unit the greater the injustice to the poor.

In my article I showed how the florin system met none of the requirements of everyday life. How it disregarded the welfare of the humbler classes and simply pandered to the unreasoned dictum of high finance. Based entirely upon theory and devoid of imagination there was not the slightest doubt but that if the florin scheme were adopted it would lead to disaster, and never again would any British statesman dare to mention "decimal coinage."

In spite of all this, Mr. Allcock actually says, "It will be noted that under the Decimal Association's proposals all objects desired by your contributor are attained, and a further advantage is secured in that the £ sterling is retained as an integral part of our coinage system."

After this it certainly would appear that, when once under the influence of high finance, ordinary language has no meaning, and that some men will only believe what high finance wants them to believe. My concluding remarks are therefore addressed to those business men whose judgment has not been unsettled by that mesmeric and dangerous persuasive influence.* In a matter of such grave national, and international, importance as the changing of our monetary system we want no speculative theories, but actual facts, based on the teachings of history and the lessons of experience. In that respect we are fortunately placed, since every country with a decimal monetary system provides us with ample precedents to be copied or avoided.

Among the many lessons we learn from other countries we realise that no nation can have two monetary units; that is to say, one for international computation and another for home use. If we adopt a token coin as a unit then for international exchange the sovereign measure of value is as dead as mutton. There is no international exchange of coins, but merely of credit, and therefore our sovereigns do not circulate abroad, as the innocent might think. If it is necessary to maintain the single sovereign as our measure of value we must make it the unit of our system. By no other means can it be made an integral part of any decimal system. I know of no country that refers to any of its dealings, either in the home or foreign market, in terms other than in multiples, or decimal fractions, of its units, nor can I by any amount of reasoning conceive how it can be, or why it should be, different with us. With the exception of Holland, I cannot think of any country that limits its principal gold coin to 10 times the measure of the token unit.

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* The latest instance of the extraordinary persuasive influence of high finance has been the issue by the present Chancellor of the Exchequer of a so-called "free of income tax" loan, which common sense would have rejected as unsound. But when high finance comes in common sense goes out.

In reply to Mr. Rogers I would remark that until we have an international coinage we cannot have the exact equivalent he mentions. Foreign exchange varies from day to day. His criticism of the half-farthing is answered by Mr. Turnbull's excellent table and by the lessons of experience. America furnishes a very good example of the results of a high unit. A coinage reformer should seek to promote economy, and not be innocently led to support waste and extravagance. The disdain of small coins matters nothing if it is confined to the rich, but if the working classes also regard them as "chicken food," then thrift among the working classes will be practically unknown.

London, Jan. 16. G. O. Parsons.

DUPLEXING THE SQUIRE SYSTEM OF TELEGRAPHY.

TO THE EDITORS OF THE ELECTRICIAN.

In the issue of The Electrician of November 17th, Mr. H. H. Harrison published a letter discussing briefly my article of above heading which appeared in a previous issue of The Electrician.

Mr. Harrison contends that the methods I have described are not new, and his reason for it, as far as I can see, is that the loop circuit I made use of was known and first introduced by Prof. Stone in wireless apparatus. Mr. Harrison seems to have lost sight of the principal idea of my Paper, which is the elimination of the artificial cable in duplexing. As far as I know, the idea of doing away with the artificial cable in duplexing was never suggested before, and the method I have marked out to accomplish this is certainly a new departure in the art.

I confess I am unable to follow the logic of Mr. Harrison's reasoning. It may just as well be argued that any electrical method, no matter what its character is, which involves the use of inductances or condensers, say, is not new because these elements were used before for other purposes.

In my Paper referred to, I have described a method which makes duplexing possible without the use of an artificial cable, and to accomplish this result I was perfectly justified in using any circuit arrangements suitable for the purpose. It is the combination of the various elements which constitutes the method.

Washington, D.C., U.S.A., Dec. 22. Louis Cohen.

THE PLIOTRON

TO THE EDITORS OF THE ELECTRICIAN.

In your columns of December 8 is an abstract of an article in the "General Electric Review" describing various phenomena obtained with the three-electrode audion, first as an amplifier of alternating currents from any source (*e.g.*, a small alternator); second, as a producer of sustained or slowly damped electrical oscillations of very low frequency; third, as a source of oscillations of very high frequencies. This is all exceedingly interesting to anyone interested in radio art or in general physics. We are ourselves glad to see these phenomena of the audion as amplifier and source of oscillating currents laid before the public. We do, however, think it only fair to point out that the novelty of the device as described, consists chiefly in its "Greeco-Schenectady" name, "Pliotron," an appelative with which the General Electric Co. has for some time seen fit to disguise their use of the audion.

The circuits and details of Fig. 2 of the article in question will be instantly recognised as those of the audion amplifier, first published by Dr. de Forest before the Institute of Radio Engineers in December, 1913. Those of Fig. 3 were first used by him in his investigations of the audion as telephone relay, early in 1912. At that time he observed that, if the grid-filament and plate-filament circuits of an audion amplifier were inductively associated and properly poled, sustained alternating currents of audio frequencies were generated. Developing this feature originally as an electric siren, or source of musical sounds, Dr. de Forest first applied the same circuit arrangement to high-frequency work, primarily for small power, for aid in increasing the sensitiveness of the audion as radio detector. Gradually the power of the high-frequency currents thereby obtained was increased, having in mind their application to radio-transmission.

The present oscillion or oscillating audion is the logical outgrowth of this early pioneer work of Dr. de Forest. Every phase of this work, as it developed, has been protected by patent applications, under none of which has the General Electric Co. as yet any rights.

De Forest Radio Tel. &
New York, Jan. 3. Tel. Co.

THE EFFECT OF TEMPERATURE ON THE LIGHT-SENSIBILITY CURVES OF DIFFERENT TYPES OF SELENIUM CELLS.[*]

BY E. O. DIETERICH.[*]

This Paper summarises a study of the wave-length-sensibility curves of three types of selenium cells at temperatures higher than room temperature.

Three types of cells were studied: type A, which shows no maximum in the red whatever; type C, in which the maximum in the red is lower than that in the blue; type D, in which the maximum in the red is higher than that in the blue. The permanence of the light-sensibility curves of the different types has been demonstrated previously; those obtained at this time were essentially the same, for the same conditios of temperature, as those obtained when the cell was first completed.

To determine the light-sensibility curves, the method outlined by Brown and Sieg [†] and previously used was followed. For obtaining the curves at temperatures higher than room temperature the cell was placed in a small oven which was about 1 in. square and 3 in. deep. This oven was constructed of plaster-of-paris, wound with Nichrome wire and insulated by means of asbestos packing. It was provided with a small mica window to admit the light. By connecting it to a battery of storage cells a very constant temperature could be maintained. Temperatures were measured by means of a thermometer placed directly behind the cell. At the higher temperatures the cell served as a very sensitive means of indicating variations too small to be detected on the thermometer, the resistance changing to such an extent that the galvanometer deflection amounted to several hundred centimetres. Whenever possible, exposures of 0·5 sec. were taken, for with short exposures the fatigue of the cell is much less than with long exposures. However, at the higher temperatures the sensitiveness of the cells became so low that the short exposures gave galvanometer deflections too small to be read with very great accuracy, so here the exposures were increased in length. For certain types of cells, namely, type A, this change of period of illumination has no effect on the shape of the light-sensibility curve, even if the time of illumination varies by a factor of 75. For those cells whose light-sensibility curve depends upon the period of illumination a constant period of exposure, 10 sec., was used at all temperatures. At the higher temperatures, to increase the sensibility, higher voltages were also found necessary. It has been shown repeatedly, however, that a change of voltage does not alter the light-sensibility curves of selenium.

In the case of the cell of type A, the sensibility in the blue end of the spectrum decreases markedly while in the red it is hardly affected. At the highest temperature reached, however, there is no indication of an appearance of a maximum in the red, as might be expected, perhaps, as a result of the depression in the blue.

From the behaviour of cells of type A, one would be led to expect that in the case of cells with a maximum in the red, this maximum should be displaced towards the longer wave-lengths. This was actually found to be the case. These results are in perfect agreement with those of Elliott [‡], who finds the maximum shifted towards the shorter wave-lengths at the temperature of liquid air.

The characteristic wave-length-sensibility curve at room temperature is not changed by the heat treatment; the maximum returns to the original place. The difference in resistance and sensitiveness encountered before and after heating may probably be due to slow changes taking place in the selenium similar to those exhibited by the freshly manufactured cells.

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[*] Abstract of an article in the "Physical Review."

[†] "Phys. Rev.," Series II., Vol. II., p. 487, 1913.

[‡] "Phys. Rev.," Series II., Vol. V., p. 53, 1915.

EDUCATIONAL.

University of London.—Notice is given that the Senate will elect external examiners, above matriculation for the year 1917-18, in mathematics, physics and electrical technology. Some further particulars are given in an advertisement.

Aberdeen University.—At a meeting of the University Court last week, the committee on the proposed Chair in Engineering to be established under the bequest of the late Mr. Wm. Jackson, reported that communication had been entered into with the governors of Robert Gordon's Technical College with a view to a joint scheme for the establishment of a department of engineering, and that a meeting had been arranged for an early date.

Public School Boys and Engineering.—Mr. W. L. Hichens, chairman of Messrs. Cammell, Laird & Co., who spoke at the annual conference of the Incorporated Association of Head Masters last week, said he often wondered why the number of public school boys who chose engineering as a profession was so small.

Mr. Hichens said we lived in a mechanical age, and our material progress was more closely bound up with engineering than with any other profession; yet boys preferred the counting-house, or the Army or the Civil Service. The reason was partly because few scholarships were offered to carry boys through their apprenticeship; but the main reason was that the engineering career did not offer the same certainty as the others, and during recent years boys had been taught to go for the safe thing. Yet there was nothing that sapped the moral fibre of any boy—or indeed any nation—more effectually than that he should embark on the journey of life with the motto "safety first" hung round his neck. He thought the tendency of modern education was often in the wrong direction—that too little attention was given to the foundations which lay buried out of sight below the ground, and too much to a showy superstructure. The pay of assistant masters was, on an average, less than that of his firm's workmen and considerably less than that of his skilled mechanics. Teaching was in fact a sweated trade as much as any in the East End of London, and for the same reason—owing to the working of unrestricted competition. The remedy was a "ring" to ensure that the rights of those engaged in the business were recognised. After the war there was a serious risk of higher education becoming sterilised because the best type of man did not join the teaching profession unless the problem was courageously tackled. For never had true education been more urgently needed than it was now. A nation could not last as a money-making mob.

In his presidential address, the Rev. J. R. Wynne-Edwards said that if we were to keep our place as a nation in the foremost ranks in the world of thought and of the industrial world also it was essential that the scientist's respect for truth, his determination to observe phenomena irrespective of preconceived ideas, and to reason on observed facts without being hampered by preconceived ideas, should be recognised as an essential part of the equipment of all educated men. He insisted on the necessity for a study of the classics, and entered the strongest protest against the modern fashion of deriding humanistic as compared with scientific studies. Both were equally necessary. The great native capacity of Englishmen for practical affairs was very elusive, but it was there. A number of firms were prepared to give a fair salary to a scientific adviser who had mastered all the details of their particular needs, but they had not all the foresight to secure good men and train them. A member of their Association wrote that after graduating B.Sc. (second-class honour in chemistry) and spending a year in research work in Germany and a further time at a local university he was offered a post at £100 as research chemist to a large firm. The works manager of the firm was killed a few days afterwards, and he was offered the post at the princely salary of £150, with no hope of a rise. Another member of the Association, a Scholar of Trinity, who obtained first-class in both parts of the Science Tripos in his three years at Cambridge, was recommended to a great armament firm, who offered him a post at exactly nothing a year for two years, with the prospect of being taken on at the end of that time at a [illegible]. If they had offered him 25s. or 30s. a week he would have risked it. A university student asked a possible employer if his B.Sc. would count, and was told that it would not invalidate his application. One still heard of graduates serving in Government munition works [illegible] £2 a week, which they were prepared to accept [illegible] for their country, while workmen in the [illegible] earning £5 or £6 a week. There were, however, signs of a change, and the great demand and very limited supply of expert science men [illegible] condition.

Training of Engineers.—The committee of the Manchester Association [illegible] the training of engineers have issued their report. [illegible] fronted with three great [illegible] of co-ordination among the existing [illegible] the defects of technical instruction [illegible] lack of continuity in the [illegible].

[illegible] reaching a [illegible] before becoming an apprentice, the [illegible] of 14. All engineering apprentices should be given an opportunity to attend a school for two half-days a week from the beginning of their apprenticeship to the age of 17, and during this period they should [illegible], but the employer should pay the boy's wages for the two half-days, and thus retain his influence over him, the fees being specially reduced to a figure the ordinary apprentice could afford.

At the age of 17 the half-day schooling must in most cases cease, and the youths should be encouraged by their employers to attend evening technical classes two or three nights a week. Those deriving most benefit from the part-time classes should have an opportunity of passing an examination admitting them to a day course of, say, one day a week, and in every case the employer should reward them according to their progress in the works and the school, by offering special prizes or grants for industry and ability.

The committee think that in a scheme for engineering apprentices the engineering employers should have properly elected representatives. They suggest, therefore, that an appropriate number of employers' representatives should be elected by each of the large technical societies, and that these, with an equal number of technical representatives of the local educational authorities should form an advisory body for dealing with all questions (other than finance) arising in connection with the education of engineering apprentices. In this way the co-ordination of the schools and the employers in each locality would be secured.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

14,423 Marconi's Wireless Telegraph Co. & Shoenberg. Transformers for increasing the frequency of alternating electric currents.

Relates to the production of currents of multiple frequency by producing by stationary means a rotating magnetic field in the saturated closed core of a transformer having a number of secondaries and suitably connecting these secondaries.

17,191 Heins. Magneto-electric ignition devices for internal-combustion engines (22/1/15.)

17,321 Roberts. Telegraphic and like receiving devices. (Cognate application, 5,090/16.)

17,325 St. John. Thermal electrical switching and/or actuating apparatus for the automatic control of temperature.

17,497 Pieper & Pieper. Electric and pneumatic control mechanism, particularly for use in dental surgery. (15/10/15.)

1916 Specifications.

723 Schiley. Electrically-operated portable vacuum cleaners. (17/1/16.) 102,521

948 Testor & Testors Fabriks Aktiebolag, F. Electric switches. (20/1/16.) 102,523.

1,502 Western Electric Co. (Western Electric Co.) Testing arrangements for machine telephone switching systems. (1/2/16.) 102,531.

5,596 Dungey & Kersting. Intercommunication telephone systems. (17/4/16.) 102,565.

7,252 Steiger. Electric devices for automatically turning lights on and off. (22/5/16.) 102,575.

9,249 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Means for controlling electric motors. (30/6/16.) 102,585.

10,335 Western Electric Co. (Western Electric Co.) Ionisation devices for amplifying electric currents and similar purposes. (22/7/16.) 102,589.

Relates to a thermionic device in which an input electrode and an output electrode are placed in operative relation to each other in an evacuated vessel, the output electrode being composed of a plurality of parallel strips serially connected.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 13, 1916.

17,916 B.T.-H. Co. (G.E. Co.) Producing alternating electric currents.

17,923 Pletscher. Electric pocket lamps. (18/11/16. Switzerland.)

17,929 British Electric Transformer Co. & Goodman. Electric apparatus having windings.

17,930 British Electric Transformer Co. & Goodman. Protective means for electric apparatus having windings.

17,934 Soc. Anon. pour l'Eclairage des Vehicules. Advancing ignition in engines. (20/12/15. France.)

17,936 Fabriques des Longines Francillon & Co. Energy meters for alternating currents. (22/4/16. Switzerland.)

17,937 Soc. Francaise Radio Electrique. High-frequency alternator. (16/9/15 France.)

December 14, 1916.

17,95[illegible] [illegible]. Galvanic batteries.

17,972 [illegible] Hutchinson & Hickman (Ltd.). Anodes for electrolysis of sulphate solutions.

17,983 B.T.-H. Co. (G.E. Co.) Methods of producing a high vacuum.

17,987 Mason. Ignition dynamos. (7/1/16. U.S.)

17,9[illegible]3 Zimmerman. Ignition systems. (12/5/16. U.S.)

17,993 Henkes. Collection of current from overhead conductor

17,996 [illegible]. [illegible].

17,998 & 17,999 Flaherty. Batteries.

18,0[illegible] [illegible]. [illegible] battery cups. (23/12/15. U.S.)

December 15, 1916.

18,019 [illegible]. [illegible] tram [illegible], &c.

18,020 [illegible]. Preparation of tungsten or tungsten oxides from tungsten ores, &c.

18,027 Evans. Portable [illegible] electric signalling lamp.

18,033 Maschinenfabrik Oerlikon. High-power turbine plant. (15/12/15. Switzerland.)

18,046 Automatic Telephone Mfg. Co. Automatic telephone systems. (14/2/16. U.S.)

18,049 [illegible] & Railing. Electric switches.

18,054 [illegible]. Railway signalling system. (23/12/15. Italy.)

December 16, 1916.

[illegible] [illegible] & [illegible]. Block signalling apparatus. (27/12/15. France.)

[illegible] B.T.-H. Co. (G.E. Co.) System of motor control.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Commercial Intelligence. A meeting of the Advisory Committee to the Board of Trade on Commercial Intelligence was held last week.

Sir Albert Stanley, President of the Board of Trade, presided, and there were also present Sir Alfred Bateman, Sir Henry Birchenough, Sir W. H. Clark, Capt. Muirhead Collins, Sir A. F. Firth, Bart., Mr. H. Fountain, Mr. C. A. Harris (Colonial Office), Mr. Louis J. Kershaw (India Office), Mr. E. H. Langdon, Mr. Stanley Machin, Sir Thomas Mackenzie, Mr. E. Parkes, M.P., Sir Hallowell Rogers, Sir H. Llewellyn Smith, Mr. G. J. Stanley and Mr. P. Ashley (secretary). Sir Albert Stanley addressed the Committee and emphasised the importance of its work. Among the matters considered by the Committee were proposals for a large extension of the Trade Commissioner service in the British Dominions, proposals for commercial missions and other matters relating to the organisation of British overseas trade, and questions arising out of the work of the Department of Commercial Intelligence.

We look to the new President of the Board to introduce modern business methods in the administration of the Commercial Intelligence Department. The appointment of more trade commissioners is a step in the right direction, provided the commissioners are qualified to deal with questions of trade and commerce, and their reports are readily made available to British manufacturers and exporters. The present method of publishing the reports of trade commissioners and consular officials is very unsatisfactory, and it is to be hoped that in future they will be promptly published and made available to trade and technical journals, so that they may get the wide publicity they deserve.

* * * *

Ministry of Commerce. We are pleased to see that the movement in favour of the creation of a Ministry of Commerce is being maintained, and we are hopeful that ere long the agitation will be crowned by success.

The London Chamber of Commerce has recently sent to the Prime Minister a memorial signed by nearly 700 of its leading members in London in favour of the establishment of a Ministry of Commerce and Industry. The memorial points out that present and future trade conditions, having regard to the lessons taught by the war, demand that the interests of commerce and industry shall be directly represented in the Cabinet by a specially appointed Minister, charged with the promotion of such interests, and expresses the view that the functions of the Board of Trade, as at present exercised, are so diverse as to preclude adequate attention being given to matters affecting the future commercial and industrial expansion of the country. Special stress is laid upon the necessity for the new Minister being a man of practical business experience, assisted by a permanent committee composed of practical business men in various trades and industries, apart from representatives of Government Departments and of the self-governing Dominions. The memorial also outlines what, in the opinion of its signatories, the principal functions of the Ministry of Commerce and Industry should be. The memorial is also supported by 38 mercantile and trading associations in the Metropolis.

The Employers' Parliamentary Association, the Federation of Industries and other influential organisations have already pronounced strongly in favour of the creation of a Ministry of Commerce.

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Gas Retort Carbon. The Minister of Munitions has issued an order that no person shall until further notice purchase or take delivery of any gasworks retort carbon except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions; and further, that no person shall until further notice sell, supply, or deliver any gasworks retort carbon to any person other than the holder of such a permit.

* * * *

Excess Profits Duty and After-War Trade. The Council of the London Chamber of Commerce have decided to make representations to the Chancellor of the Exchequer regarding the inequitable operation of the excess profits duty, and the need for amending the Finance Act in view of adequate provision for after-war developments of trade, commerce and industry. The Council will also urge upon the Government the desirability of proceeding with the reconsideration of the provisions of the Income-tax Acts without further delay.

London Electricity Supply Loans. During the year 1915-16 the London County Council sanctioned the raising of 23 loans, amounting to £172,636, by the Metropolitan Borough Councils for extensions of their electric supply undertakings, compared with 24 loans amounting to £212,673 in 1914-15, 26 loans aggregating £291,672 in 1913-14, and 19 loans of £238,163 in the year 1912-13.

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Enemy Trade With Australia. In a pamphlet recently compiled by the Imperial Trade Correspondent at Perth, Western Australia, it is stated that the value of imports from Germany, Austro-Hungary and Turkey was £480,801 per annum before the war, the share of each being: Germany, £460,008; Austria, £16,823; and Turkey, £3,970.

Among the chief items of imports were electric cables and wires, gelatine, glassware, cotton piece goods, gloves and hosiery, wire and zinc, cement, cyanide and pianos. The value of the exports to the three countries was comparatively small, amounting to only about £46,000 per annum.

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Trade After the War. The annual report of the Central Executive Committee of the Employers' Parliamentary Association makes reference to several important problems connected with the industrial reconstruction which must follow the war.

Holding that the first essential is harmonious working between capital and labour, the Committee suggest the appointment of an Industrial Advisory Council, equally representative of employers and workers, to whom disputes not settled by the parties immediately concerned should be referred. Compulsory arbitration is, however, condemned as impracticable. The Committee state that they have accepted an invitation by the Parliamentary Committee of the Trades Union Congress to discuss the resolution adopted by that body in September last, proposing that industrial peace should be agreed upon for a period of three years on certain conditions, including a compulsory 48 hour week in every occupation, and a compulsory minimum wage of 30s. for all adult workers. The Committee regard the resolution simply as a basis for discussion. They express the opinion that trade unionism has won an indisputable right to have its opinions heard in any industrial readjustment after the war, and that the principal menace to industrial peace is the unassociated employer and the non-unionist. They point out that very little statistical ability is needed to demonstrate that a general advance in wages of 5s. per week would result in most serious consequences. If labour is to receive an increased reward, this can only be provided by increased selling prices and increased efficiency. "Without State or Imperial interference there is no ground for anticipating a higher selling price. In any case, however, the most important question is that of increased efficiency, both on the part of employers and of the workers. The solution of this can only be found in co-operation among employers and close understanding and agreement with the workers, and every effort in future should be directed to that end."

The Committee approve of the proposal to establish a British Trade Bank, and endorse the recommendations of the Board of Trade Advisory Committee in regard to scientific industrial research, the patent laws and transport facilities. As to research, they particularly commend the proposal that the universities should be encouraged to assist neighbouring manufacturers, either through trade or other associations, in research work. "Manufacturers are apathetic with regard to this subject because they are unorganised, and although consultant scientists, chemists, physicists and engineers exist in this country in sufficient numbers, their talents are largely neglected. This country suffers, has suffered, and may in the future suffer, because of the lack of intimate intercommunication between science and industry. In the United States and in Germany science and industry are welded together to form a mighty weapon for the advancement of commerce. That the United Kingdom lacks this weapon is due, perhaps, in the main to the unassociated employer."

The Committee think the National Insurance scheme requires remodelling, and as to the important movement for the formation of a Central Association of Employers' Organisations, the Committee invite the members to confirm the arrangement under which it is proposed that the association shall affiliate with the Federation of British Industries.

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America and Electrical Exports. Already the United States is displaying some concern regarding the immediate future of her own industries. A bid is likely to be made for foreign trade and upon a scale which will compare with that of the Germanic Powers previous to the war. The tendency in this direction is indicated in the following, which appeared in a prominent position in the "Electrical World."

W. C. Redfield, secretary of the Department of Commerce, states to the "Electrical World": –

Our experience in the Department of Commerce shows us that the electrical manufacturer has a vital interest in the development of export trade.

We must have foreign trade if we are to maintain our domestic business. To-day we hold the world's greatest reserve of gold. This reserve forms the basis for all our credits, domestic and foreign, those we grant at home and those we grant abroad. Unless we have a great gold reserve we cannot grant credits largely. It will not, in other words, be as easy, perhaps not easy at all, to get sufficient credit to keep our domestic industries moving as we wish.

There are several ways to protect this gold reserve: loans abroad, investments abroad, sales abroad. These are three most effective. Probably all of them will be needed. Certainly all of them should be encouraged by every far-seeing American business man. The manufacturer who says he does not care for foreign trade is following false lights. If all did that our domestic trade would soon shrink. We must keep out in the big world whether we will or no in order to keep on good terms with ourselves in our domestic world. Foreign trade is not a luxury but a necessity. Our plants are too big to run full time continuously on our domestic markets. We may not offset the foreign trade against the domestic. We must rather remember that one should be done and the other should not be left undone.

Appreciating these facts, the Department of Commerce aims to help the foreign trade in every practicable way. It has a double staff of trained commercial men, ten commercial attachés who hold fixed posts, and twenty or more commercial agents, who are travelling men. The results of their work and that of our fine consular service are made known to the business world through eight branch offices and eight co-operating offices and by constant publications, including a daily paper, "Commerce Reports," and through the correspondence and circular letters of the main office in Washington. Our commercial staff, both foreign and domestic, is kept in constant personal touch also with manufacturers and commercial bodies throughout the country. The service is flexible, effective, productive. It has the enthusiastic support of the business men who have tried it. It produces in actual orders many-fold its annual cost each year. We think it to-day the most effective official apparatus in aid of industry that there is anywhere. Still, it may be improved, and if business men will use it and will constructively criticise it they will help both themselves and us.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 6, 1917, *to* Jan. 12, 1917.

IMPORTS.

LONDON.—*U.S.A.:* Elec. lamps, £20; elec. machinery, £1,384; unenumerated, £7,210. *Japan:* Elec. glow lamps, £45; telephone material, £72; unenumerated, £6,554. *France:* Unenumerated, £606. *Switzerland:* Unenumerated, £1,914. *Canada:* Unenumerated, £575. *Holland:* Wire and cable, £870; glow lamps, £2,044; unenumerated, £2,761.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £40. *Melbourne:* Wire and cable, £8,163, unenumerated, £975. *Sydney:* Elec. machinery, £84; wire and cable, £3,692; unenumerated, £673. *Wellington:* Elec. machinery, £30; unenumerated, £56. *Lyttelton:* Elec. machinery, £116; unenumerated, £120. *Adelaide:* Elec. lamp., 536 n.o.; unenumerated, £167. *Brisbane:* Elec. machinery, £28, unenumerated, £31. *Perth:* Elec. machinery, £706 unenumerated, £198. *Dunedin:* Elec. machinery, £115. *Fremantle:* Unenumerated, £24. *Newcastle:* Elec. machinery £667. *New Plymouth:* Elec. machinery, £31.

AFRICA.—*Cape Town:* Elec. machinery, £30; wire and cable, £310; unenumerated, £52. *Port Elizabeth:* Unenumerated, £16. *East London:* Unenumerated, £70. *Beira:* Unenumerated, £65. *Delagoa Bay:* Unenumerated, £38. *Mauritius:* Wire and cable, £66.

EGYPT.—*Alexandria:* Elec. machinery, £39; unenumerated, £752. *Port Sudan:* Unenumerated, £26. *Suez:* Elec. machinery, £72.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £939, elec. glow lamps, 900 n.o., unenumerated, £1,379. *Calcutta:* Elec. glow lamps, [illegible]420 n.o., elec. lamps, 4,000 n.o., unenumerated, £626. *Madras:* Unenumerated, £250. *Ceylon:* Unenumerated, £26. *Singapore:* Wire and cable, £1,309; elec. machinery, £118; unenumerated, £735. *Penang:* Wire and cable, £33, unenumerated, £16. *Bangkok:* Unenumerated, £80. *Shanghai:* Telephone material, £180. *Kilindini:* Unenumerated, £183. *Rangoon:* Wire and cable, £18. *Karachi:* Unenumerated, £164.

CHINA.—*Hongkong:* Unenumerated, £70.

U.S.A.—*New York:* Unenumerated, £438.

SOUTH AND CENTRAL AMERICA.—*Buenos Aires:* Elec. machinery, £106, unenumerated, £[illegible]8. *Tal[illegible]:* Unenumerated, £65. *Valparaiso:* Unenumerated, £121.

HOLLAND.—*Amsterdam:* Wire and cable, £1,8[illegible]0; unenumerated, £71. *Rotterdam:* Wire and cable, £171, elec. machinery, £1[illegible]2, unenumerated, £525.

FRANCE.—*Paris:* Elec. machinery, £167; wire and cable, £2,730; unenumerated, £2,147. *Dieppe:* Elec. machinery, £[illegible]2; unenumerated, £2,[illegible]. *Calais:* Unenumerated, £[illegible]. *Dunkirk:* Elec. machinery, £70[illegible]. *Havre:* Elec. machinery, £1,342. *Boulogne:* Unenumerated, £25.

CANADA.—*Montreal:* Elec. machinery, £1[illegible]3. *Toronto:* Unenumerated, £137.

MALTA.—[illegible]

NORWAY.—[illegible] *Ch[illegible]:* Wire and cable, £325.

FOREIGN GOODS (duty paid and free).

[illegible] *Adelaide:* Elec. lamps, [illegible] Elec. lamps, 300 n.o. *Melbourne:* [illegible] Unenumerated, £17. *Singapore:* [illegible]

IN TRANSIT.

[illegible] *Cape Town:* Elec. [illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICE.

Shares for Sale by Tender. The Public Trustee (Kingsway, London, W.C.) invites tenders by noon Feb. 5 for the purchase of the whole or any part of 3,[illegible]79 £10 fully paid A and 1,200 £10 fully-paid B shares of the Tudor Accumulator Co. (Ltd.), vested in him as custodian by an order of the Board of Trade. Forms of tender from the Public Trustee or from Messrs. Knox, Cropper & Co., Spencer House, South-place, London, E.C. *Further particulars are given in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of Chas. Benjamin Ogilvie, electrical engineer, 43, Dudley-street, Whalley Range, will take place on Jan. 24 at the O.R.'s, Byrom-street, Manchester, and the public examination on Feb. 6 at the Court House, Encombe-place, Salford.

The liquidator (Mr. H. E. Burgess) of the Stolz Electrophone Co. (1913) (Ltd.), 85, Fleet-street, London, E.C., has been released.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bedford.—Terms have been agreed for the supply of electricity to a large consumer outside the Borough boundary, necessitating capital outlay of £3,476.

The customer will pay the whole cost of the mains outside and £1,319 being 25 per cent. of the cost of the mains inside the Borough and the transformers. The customer will pay the ordinary rates for combined power and lighting charged to the town, and guarantees £3,250 for 7 years, with an undertaking to take current if required from the Corporation for the whole period fixed for the repayment of the loan, and after the expiration of the agreement not to take current from any other source or to put down their own plant.

Bradford.—The Corporation propose to extend the supply mains to the works of the Phœnix Dynamo Mfg. Co., and to install additional plant at a cost of £5,200.

Carlisle.—Owing to the increasing demand for electrical energy for power, application has been made for permission to order an additional generating set for the electricity station, at an estimated cost of £9,000.

Cheltenham.—It has been decided to give a supply of electrical energy to premises outside the borough boundary.

The cost of the supply cable will be about £750. The consumers agree to take a supply of energy for three years and to guarantee a minimum payment of £350 per annum, and also to pay £120 in consideration of a large-sized cable being laid.

Sheffield.—As stated in our last issue, the Corporation Bill for the acquisition of a site for the erection of new electricity works has been approved at a public meeting of electors.

The Lord Mayor (Councillor W. Appleyard) presided, and said it was to a large extent the war which had created the necessity for the Bill. There was an enormous demand upon the electricity works, and as they could not meet that demand the erection of a new power station was imperative. The station would be erected upon the Corporation's own property, but as some of that property extended into Rotherham, they were seeking power to include it in the city. During the last 40 or 50 years the Corporation had promoted a number of Bills, all of which had justified themselves as being for the benefit of the city, and he felt perfectly satisfied that the present Bill would abundantly justify itself. They were trying to look forward, with a large vision, into the future of that important centre of industry, and they were assured by the leading manufacturers that they had work on hand, and work before them, that would certainly last 10 or 12 years, and that they would be able to take all the current that the municipality could supply. In order to induce other industries to come into the city, the Corporation wanted to be prepared to meet the demands of everyone.

Ald. STYRING, chairman of the Parliamentary Committee, proposed a resolution in favour of the promotion of the Bill. He said the area of the proposed site was 35 acres. Their object was to have the generating station within their own control, so that they might police it and exercise over it all the power which it was desirable they should have. The Neepsend station was completely full. They had applicants clamouring for more and more power, faster than they could supply it. They had latterly had large demands made upon them for the supply of electricity in connection with the steel industry, and he thought it was no secret that the demand from that industry bade fair to be much more important than those for either power or light. The steel furnaces that were already connected with the supply mains, and those on order, were equal to an output of 100,000 tons of steel per annum, and from all they could gather the demand for that purpose was likely to increase very rapidly indeed. In the minds of some people there was an idea that when the war was over the demand for electricity would to some extent subside. The Electric Supply Committee had given very careful attention to that view, as they did not want to embark upon a large scheme which, in the course of a few years, might prove in the nature of a white elephant. But from the best information they could obtain they were perfectly well assured that, war or no war, the demand for electric current in connection with the manufacturing industries of the city would very rapidly increase, and that in those circumstances it was incumbent upon them to proceed with the new station, so that they might be able to deal with the demand as it arose.

The resolution was seconded and carried unanimously.

Southend-on-Sea.—It is suggested that it will be necessary to increase the capacity of the existing plant at the generating station by two 750 kw. steam generators at the termination of the war, and the electrical engineer (Mr. R. Birkett) has been instructed to make inquiries as to the probable cost, &c.

Mr. Birkett is also to report on the possibility of the condenser being extended by erecting additional pipes over the existing structure.

Stafford.—The L.G. Board have sanctioned a loan of £1,000 for laying additional electric cables.

Swansea.—The electrical engineer (Mr. J. W. Burr), who has reported that a water-tube boiler with auxiliaries, an induced draught fan and a feed pump are urgently required, has been instructed to obtain quotations from manufacturers.

With reference to a recent report of the Borough Treasurer and the Borough Electrical Engineer as to the best means of encouraging the supply of electricity to premises where the occupiers are unable or unwilling to bear the initial cost of installation, Mr. Burr has suggested that certain of the Corporation houses on the Trewyddfa Common might be dealt with under the scheme of free wiring as set out in the report. The Electric Lighting Committee and the Housing Committee have approved of this suggestion, and the rent collector has been deputed to collect the weekly payments for light and also control the issue of lamps, &c.

GENERAL.

Accrington.—Major Harold Gray, the Borough electrical engineer, who has been identified with Accrington's electricity undertaking since its inaugeration, has resigned. Arrangements have been made by which Major Gray will continue in touch with the department and will receive £140 a year until the end of the war.

Barnes.—Upon the recommendation of the Electrical Engineer, Mr. Law and Mr. Cornet are to be granted, as recognition of special services rendered during the past year, honoraria of £30 and £20 respectively.

Barrow-in-Furness.—The salary of the borough electrical engineer (Mr. H. R. Burnett) has been increased to £600 per annum.

Blackpool.—At a special meeting of the Council last week the Improvement Bill of the Corporation, which confers additional powers upon the tramways and electricity supply department, was approved.

Bradninch.—As stated in our last issue, the Bradninch & District Electric Supply Co. has a lady in charge of their electric plant.

It is necessary, however, to say that the running of the company's electric station is a matter of some simplicity, as current is generated by water power only. There are two turbines of 40 H.P. and 27 H.P. respectively. The lady's name is Mrs. Rowe. She looks after the station by day and her husband takes on the work in the evening until the station is shut down at about 10.30 p.m. The training necessary for the position was undertaken by one of the company's former electricians, but, as will be seen, the duties are not particularly onerous.

Dundee.—The Electricity Committee has conceded the demand of the sub-station attendants for an increase of 10s. a week in their wages.

The men start at £1, and after learning the duties the wages are raised to £1. 5s. Lately the seniors had been getting 33s. and the juniors 30s., and the convener (Mr. J. M. Naim) moved that the seniors be increased to 34s. and the juniors to 32s.

The motion was agreed to.

Featherstone.—The Urban Council will not oppose the application of the Electrical Distribution of Yorkshire (Ltd.) for a provisional electric lighting order for the district.

Hull.—Sculcoates Rural Council will not oppose the proposal of Hull Corporation to give a supply of electric current to Willerby Asylum.

Liverpool.—The Mersey Dock and Harbour Board have acquired land adjacent to the wool warehouses for use either for letting purposes or the erection of electricity works in connection with the docks, when such a scheme can be undertaken after the war. The Board have also decided to provide an electric discharging elevator with internal band elevators, automatic weighing machines, &c., at the Waterloo grain warehouse, and an automatic weighing machine at the Birkenhead grain warehouse.

Manchester.—At last week's meeting of the Corporation Mr. Kendall called attention to the restricted lighting at night.

He said accidents were becoming a serious matter. Burnley had made representations to the Home Office, with the result that the streets were now not only lit properly at night, but when the people went to work in the morning. At Manchester the electric light should temporarily take the place of gas lamps, and tramcars should have improved lighting. They were not under martial law, and they ought to take the necessary steps to safeguard the public.

After discussion, it was resolved that the chairmen of the Gas, Electricity, Watch and Tramways Committees, with Mr. Kendall, should wait upon the chief constable to discuss the matter.

Richmond.—Messrs. Price, Waterhouse & Co. have been re-appointed auditors of the accounts of the Richmond (Surrey) Electric Light & Power Co. for the year 1915.

Stretford.—The Council were informed last week that owing to the exceptionally heavy demand for current, the coal consumption had gone up to 280 tons per week, necessitating taking coal out of stock, as the deliveries only averaged 220 tons per week.

The colliery contractors had notified that it was hardly possible to meet the extra demand. At present it was possible to deal satisfactorily with the load, but consideration would have to be given before granting increased supplies.

Surrey Provisional Orders.—The Parliamentary Committee of Surrey County Council has reported on the electric lighting orders promoted for certain districts in the county.

The Committee proposed to make representations to the Board of Trade that, in view of the general questions relating to the supply of electrical energy raised by the two London Electrical Supply Bills of 1915, which will be revived after the war, it is not expedient that any new powers should be granted or vested interests acquired until such questions are settled; also that the time is inopportune for the consideration by Parliament of proposals which must involve the raising of new or additional capital.

TRACTION NOTES.

Ashton-under-Lyne.—At a public meeting of the electors last week the Corporation Bill to acquire the local tramways, &c., was approved.

Edinburgh.—On Tuesday the Council decided to purchase the cable tramcars of the local tramway company at the end of the present lease, for £50,000.

Glasgow.—The Tramways Committee have instructed the general manager (Mr. J. Dalrymple) to communicate with the large employers of labour in the city to ascertain if some arrangement could be come to with regard to adjusting the meal-hours and stopping-times at public works so that the great mass of workpeople should not be released at the same hour.

The congestion of the tramway traffic at present is due chiefly to the great rush of passengers from the public works at practically uniform hours, and it is believed that the excessive pressure could be materially relieved by a slight variation of the starting and stopping times. The Committee also appeal to ladies who may be shopping in the city in the afternoon to make the homeward journey not later than four o'clock, as a heavy pressure on the service begins shortly after that hour.

Hull.—The Corporation have adopted recommendations of the Tramways Committee regarding the abolition of halfpenny stages on the principal routes, the substitution of a penny flat rate, with a halfpenny flat rate for non-commissioned officers and men of the Army and Navy (who, at present, on week days are having the free use of the cars), and also making the Old Town route a halfpenny stage.

Ilford.—The Urban Council are again recommended to abolish halfpenny fares on the local tramways.

Manchester Corporation Tramways.—The Board of Trade have extended for one year from Aug. 18, 1917, the time limited by the Manchester Corporation Act, 1911, for the completion of tramways and the purchase of lands for street widenings, except a portion of tramway No. 2 authorised by the Manchester Southern Tramways Act, 1903, in Cheadle and Gatley.

Southend.—In connection with the proposal to convert certain of the tramcars into double-decked cars, the Board of Trade suggest that the conversion should in the first place be carried out on large bogey cars.

Mr. Birkett has been instructed to make inquiries from other towns where a similar gauge of light railways is in use as to their experience of the running of double-decked cars, and he has also been directed to report as to the aporoximate cost of converting certain of the existing cars.

Surbiton.—A deputation recently waited on the L.G. Board and urged the necessity of the Council being permitted to purchase two electrically propelled vehicles for the collection of house refuse, and to pay for them by instalments spread over three years.

It appeared that the sanction of the Ministry of Munitions would also be required for the manufacture of the vehicles. At the interview the question was raised as to whether the purchase money would find its way out of the country, but the Board were assured that the manufacturers were an English firm.

The Council have informed the Edison Accumulators (Ltd.) that if the L.G. Board do not permit the Council to purchase the two vehicles by instalments they will purchase one vehicle for cash and take another for hire for 12 months from April 1 next, upon the understanding that the Council will purchase the vehicle for the sum named in their specification at the expiration of 12 months. The makers of the vehicles have accepted this arrangement. The hire for one year (£60, or 6 per cent. on the outlay) will not be deducted from the purchase price.

Walsall.—The tramway service was suspended between 9 a.m. and 8 p.m. on Monday, Tuesday and Wednesday of this week in order to enable necessary repairs to the plant at the electricity station to be carried out.

TELEGRAPH AND TELEPHONE NOTES.

Burnley.—The Corporation have entered into an agreement with the Postmaster-General for the installation of a private telephone exchange at the Town Hall with 12 exchange lines and 50 external and 18 internal lines.

The annual rental is £380. 1s., and the agreement is for a period of five years from the completion of the installation, and the work to be carried out as early as possible after the termination of the present war.

Telephony in India.—The Committee of the Indian Mining Association had before them at a recent meeting information regarding a proposed telephone trunk line from the coalfields to Calcutta.

After discussion, it was arranged that a deputation from the Committee should call on the Director-General of Posts and Telegraphs to ascertain whether the proposal was likely to materialise in the near future.

EMPIRE NOTES.

Australasia.—The "Victoria Government Gazette" contains a notice to the effect that the Council of the City of Brunswick (Victoria) intends to borrow £7,500 for extending the electric lighting and power system of the city.

The hydro-electric plant in Tasmania is to be duplicated shortly. Mr. Milne, H.M. Trade Commissioner, says everything seems to point to important industrial developemnts in Tasmania in connection with the hydro-electric scheme, and to indicate that the market there for electrical appliances will be considerably increased.

The Tasmanian Government has received a report from engineers on the utilisation of the Franklin River for the production of electricity. It is considered practically certain that power from this source will be available for the new company which is to operate the Hercules-Mt. Read ores. The main power station will probably be about 8 miles from the nearest point on the North Mount Lyell line from Kelly Basin to Linda, and if the electrolytic plant is established at Zeehan the transmission line will be between 30 and 40 miles long, or about half that from the Great Lake to Hobart.

Richmond (Victoria) Council has for a long time been endeavouring to secure the co-operation of the Collingwood and Prahran Councils in a scheme for constructing an electric tramway from Clifton Hill to Prahran, to connect with the existing cable trams through Prahran to St. Kilda. On a previous occasion Collingwood Council refused to take part. Richmond, however, instructed Messrs. McCarty, Underwood & Co., to furnish a report on the proposal, and this having been supplied Collingwood will be again invited to take up the scheme. The firm state that a double track is necessary. The length would be 3·9 miles and the cost of construction, including overhead equipment, rolling stock and a new bridge over the Yarra, is estimated at £173,367, of which Collingwood would provide £65,924; Richmond, £65,820; and Prahran, £41,623. The revenue (calculated on a basis of 18s. per head of population served within half a mile of the route) is estimated at £42,030, and the annual expenditure, including interest on capital cost at 5 per cent., and allowance of 2½ per cent. for renewals reserve fund is put at £37,887, leaving a surplus of £4,143.

Canada.—At the recent municipal elections in Ontario the question of the extension of the Government hydro-electric works and the construction of an electric radial railway system to connect up various towns and villages in the province was voted upon. Eighty municipalities voted favourably and only two (Hamilton and Goderich) against the proposal.

New Zealand Trade.—In a supplementary report on the trade of New Zealand in 1915 H.M. Trade Commissioner for New Zealand says it is desirable for United Kingdom manufacturers to appoint agents in New Zealand at once and not to defer until more normal times the first steps towards the preparation of a selling organisation.

Manufacturers should explain to customers what they are doing for the war and how the war is interfering with their ordinary trade. The main part of the supplementary report is taken up with a detailed examination of the statistics of imports of the various classes of goods from the chief competing countries. The United Kingdom's share of the total trade of New Zealand in competitive merchandise is highest in paints and [illegible], metals and metal manufactures amongst other classes. The most important class in which the trade of the United Kingdom is deficient is machinery and [illegible], and there does not appear to be any valid reason why in normal times the United Kingdom's share of this trade should not be greater. With regard to machinery, what is lacking is a sufficiently close [illegible] with the special needs of the market in [illegible] lines different from those in use in the United Kingdom, and a more active selling campaign. There are classes of imports in which countries closer to the Dominion are in a better position to secure trade and the other classes in which the share of the United Kingdom falls short of the average mostly cover industries of secondary importance in the United Kingdom, such as earthenware, china and glassware, optical, surgical and scientific instruments, and miscellaneous classes of smallwares. Other countries are aware that these were lines in which Germany held a good deal of trade, and they have taken the opportunity of the disappearance of that country from the field to endeavour to establish themselves in these trades. In spite of the great difficulties under which manufacturers in the United Kingdom have been working, they have been able to maintain their poistion in New Zealand and to some extent to develop it. In most of these lines price is the great factor and the cost of distribution should be kept as low as possible. It would also appear that firms in the United Kingdom are not sufficiently represented in the New Zealand market for the sale of many kinds of goods.

FOREIGN NOTES.

Chili.—A "Times" correspondent sends the following notes from Valparaiso:—

The pre-war condition in this market, in which the principal lines are electric lighting materials and electric motors, was that from Valparaiso to the north the American-British manufactured article held the market, while from and including Valparaiso to the south German goods prevailed. In the principal southern towns the Germans own the power and light companies, and make their specifications so as to exclude British goods. In northern Chili, in the nitrate works and in the mines, there is a considerable field for electric lighting material and electric motors. In the nitrate works alone there are about 140 distinct small independent power and lighting installations.

Recently an American mining company contracted with a German firm for an electrical power plant. The plant has been completed, but owing to inferior material they cannot get the power required.

The manufacturer should work the market with expert salesmen and demonstrators, and use Spanish and metric system catalogues.

China.—The British Consul-General at Hankow has extracted the following information from the Customs statistics on the trade of Hankow in 1915:—

There was a general decline in imports from foreign countries, and many of the commodities which showed a decline, including machinery, are those in which United Kingdom manufacturers are specially interested. The total net imports were valued at 43,310,000 Haikwan taels (average exchange rate 2s. 7⅛d.), a decrease of 7,710,000 tales, compared with 1914 (when the exchange rate was 2s. 8¾d.). The value of imports of electrical materials and fittings declined by 97,000 taels. This was not due to a falling-off in the demand for up-to-date lighting, but to the difficulty in getting orders filled, as well as to the increased cost. When conditions return to normal there is expected to be a great expansion in the demand for all kinds of electrical materials from all over China. A decline in the importation of machinery to the value of nearly 700,000 taels was also due to abnormal conditions and not to a lack of demand. Many new enterprises in Hankow are contemplated in the near future, but the present time is not considered propitious for making purchases. There are many commodities for which a good demand exists locally, but importers find it difficult, if not impossible, to procure these at a marketable price. Amongst the principal goods in demand are engineering sundries, screws, bolts and nuts, builders' hardware, glass and electrical and other machinery, but the high prices ruling, and the impossibility of guaranteeing early delivery prevent much business being done in machinery. Before the war a large proportion of the goods mentioned were imported from Germany or Austria. Supplies are at present being obtained mainly from Japan and the United States.

Italy.—Permission has been granted to Don Martin Pizarro to instal an electric lighting system by means of aerial lines in the town of Pozo de Almonte.

Swedish Engineering Combine.—The Swedish General Electric Co. (Almänna Svenska Elektriska Aktiebolaget) has acquired a controlling interest in the Ljungström Turbine Co. and the Surahammar works. The Surahammar works supply railway material and plant.

The Ljungström Company controls the Ljungström patents for Sweden, Norway, Denmark, Finland and Russia. A branch factory will be erected in Russia, in order to meet the anticipated demand in that country. The Swedish General Electric Co. is increasing its capital from £1,170,000 to £1,500,000.

MISCELLANEOUS NOTES.

Blackmail Case.—On Monday the Court of Criminal Appeal (Justices Bray, Low and McCardie) dismissed the appeal of Thomas Absolam Jackson, sentenced to three years' penal servitude at the Central Criminal Court for demanding money with menaces from Mr. Godfrey Isaacs,

Control of Metals.—At a meeting of the brass trade of Birmingham and district the following resolution was passed unanimously:

That this meeting of brassfounders of Birmingham and district, comprising manufacturers or representatives, earnestly request the Ministry of Munitions to grant permission to continue the use of commercial scrap brass, or such brass as may be unfit for munitions, in their foundries and workshops. This, while not interfering with the manufacture of Government work, will enable them to give restricted supplies of essential articles to their home customers and to retain a proportion of the foreign trade of the country, which is of the utmost national importance.

Enemy Firms Wound Up.—The Controller of the business of C. F. H. Muller, X-ray tube manufacturer, 47, Red Lion-street, London, W.C., has applied for a release. Objections to the Board of Trade by Jan. 20.

The controllers of Schoen Bros., electrical accessories manufacturers, 29 & 30, Cock-lane, London, E.C., and of Hoppe & Co., cutlers, &c., 6, Westmoreland-buildings, London, E.C., have applied for release. Objections to the Board of Trade by Jan. 23.

The controller of Lobenthal & Co., bronze power manufacturers, 17, Carthusian-street, London, E.C., has applied for a release. Objections by Jan. 24.

Fire.—A fire which broke out on the 17th inst. at the battery house of the Merthyr Electric Traction and Lighting Co. caused damage which is estimated at £2,000. The supply of electric current was not interrupted.

Prohibition and Restriction of Exports.—On Jan. 15 the Privy Council made the following amendments in the schedule to the Proclamation of May 10, 1916, regarding the prohibition and restriction of exports:—

The following heading is deleted: (c) Telegraphs (except wireless), instruments and material for (not including insulated wires and cables, the exportation of which to all destinations abroad other than in British possessions and protectorates, is prohibited).

The following headings are added: (B) Telegraphs, instruments and material for, the following: Wheatstone automatic transmitters and Wheatstone transmitters; parts of Creed apparatus (Creed engines, relays and pneumatic valves) and auxiliaries of Creed apparatus (h.t. keys operated by pneumatic pressure or magnetically, dictaphones and dictaphone cylinders, Einthoven galvanometers, paper tape photographically sensitised); (C) telegraphs (except wireless) instruments and material for, not otherwise prohibited; (A) boiler tubes.

Trade With China.—It is announced that Mr. Archibald Rose, H.M. Assistant Commercial Attaché at Shanghai, is now in this country, and is prepared to arrange interviews with representatives of British firms on the subject of the development of their trade with China.

Mr. Rose will visit Glasgow, Leeds, Bradford, Sheffield, Manchester, Liverpool, Birmingham, Leicester and Nottingham.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during December, 1916, and (*b*) the aggregate figures from Jan. 1 to Dec. 31, with increase or decrease compared with 1915:—

Electrical machinery, (*a*) £53,496 (decrease £73,182), (*b*) £1,083,424 (decrease £438,125); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £17,083 (increase £6,033), (*b*) £211,818 (decrease £39,869); and electrical machinery unenumerated, (*a*) £36,413 (decrease £79,225), (*b*) £871,606 (decrease £398,256); telegraph and telephone cables: submarine (*a*) nil (decrease £2,778), (*b*) £7 (decrease £3,082); other than submarine, (*a*) £53,246 (increase £52,708), (*b*) £128,850 (increase £100,027); telegraph and telephone apparatus (*a*) £3,387 (decrease £10,100), (*b*) £231,302 (increase £108,821); other electrical wires and cables, rubber insulated, (*a*) £15,183 (increase £5,355), (*b*) £133,728 (increase £37,380); with other insulations, (*a*) £407 (decrease £2,285), (*b*) £15,173 (decrease £31,381); carbons, (*a*) £4,041 (decrease £2,432), (*b*) £82,027 (decrease £59,143); glow lamps, (*a*) £19,212 (decrease £1,251), (*b*) £278,296 (increase £124,683); arc lamps and electric searchlights, (*a*) nil (decrease £39), (*b*) nil (decrease £2,839); parts of arc lamps and searchlights (other than carbons), (*a*) £24,378 (increase £18,860), (*b*) £128,681 (increase £44,036); primary and secondary batteries, (*a*) £32,109 (increase £10,927), (*b*) £224,315 (increase £51,119); meters and measuring instruments, (*a*) £2,721 (decrease £2,875), (*b*) £51,173 (increase £16,897); switchboards, (*a*) £110 (decrease £80), (*b*) £377 (decrease £5,262); electrical goods and apparatus unenumerated, (*a*) £37,962 (increase £14,743), (*b*) £377 (increase £5,262). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £192,756 (increase £80,753), (*b*) £1,652,763 (increase £556,540).

Exports.—The exports of electrical machinery material, &c., (*a*) during December, 1916, and (*b*) from Jan. 1 to Dec. 31, with increase or decrease compared with 1915, were as follows:—

Electrical machinery, (*a*) £165,613 (increase £68,282), (*b*) £1,551,904 (increase £160,553): including railway and tramway motors, (*a*) £4,477 (decrease £2,613), (*b*) £38,725 (decrease £75,458); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £99,395 (increase £40,399), (*b*) £858,195 (increase £159,025); and electrical machinery unenumerated, (*a*) £61,741 (increase £30,496), (*b*) £654,984 (increase £76,986); telegraph and telephone cables, submarine, (*a*) £26,375 (increase £20,505), (*b*) £449,863 (increase £95,081); other than submarine, (*a*) £20,355 (decrease £20,730), (*b*) £496,262 (increase £52,810); telegraph and telephone apparatus, (*a*) £19,034 (increase £3,458), (*b*) £254,549 (increase £36,703): other electrical wires and cables, rubber insulated, (*a*) £30,096 (decrease £2,954), (*b*) £546,373 (increase £183,390): with other insulation, (*a*) £39,789 (decrease £11,135), (*b*) £761,221 (increase £242,653); carbons, (*a*) £882 (increase £508), (*b*) £10,672 (increase £2,240): glow lamps, (*a*) £11,476 (increase £808), (*b*) £192,258 (increase £35,235); arc lamps and searchlights, (*a*) £187 (decrease £2,497), (*b*) £9,636 (increase £126); parts of arc lamps and searchlights (other than carbons), (*a*) £778 (decrease £678), (*b*) £22,488 (increase £368); primary and secondary batteries, (*a*) £17,516 (decrease £2,450), (*b*) £264,385 (increase £68,337); meters and measuring implements, (*a*) £15,011 (increase £2,115), (*b*) £209,663 (increase £57,113): transformers, (*a*) £5,688 (decrease £7,044), (*b*) £105,857 (increase £31,412); switchboards, (*a*) £1,675 (decrease £2,636), (*b*) £56,483 (decrease £2,628); electrical goods and apparatus unenumerated, (*a*) £48,933 (decrease £3,067), (*b*) £727,522 (increase £13,750). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £237,795 (decrease £20,997), (*b*) £4,107,232 (increase £938,590).

TENDERS INVITED.

Turbo-Generator, Boiler House Plant, Switchgear, Transformers and Cables.

Bedford Corporation is about to carry out extensions at the electricity works, comprising buildings, boiler-house plant, turbo-generator plant, steam and water auxiliaries, h.t. and e.h.t. switchgear, transformers and cables. In consequence of the present conditions and the urgency with which the works must be executed no detailed specification will be issued, but British manufacturers in a position to contract for any part of the works may obtain particulars by writing to the borough electrical engineer, Mr. R. W. L. Phillips, A.M.I.E.E. *See also an advertisement.*

Automatic Telephone Exchange.

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Copies of specification and conditions of contract may be obtained at the offices of the High Commissioner, 32, Victoria-street, Westminster, S.W., where tenders must be lodged by noon March 8. *See advertisement.*

Steel Air Ducts.

Manchester Corporation want tenders by 10 a.m. Jan. 22 for supply and erection of Steel Air-ducts for turbo-alternator at Bloom-street station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Turbo-Alternators, Dynamos, Switchboards, Motors, &c.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of Melbourne electricity works. Tender forms from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Agents for the City Council, Billiter-square-buildings, London, E.C.; tenders to Chairman, Electric Supply Committee, Town Hall, Melbourne, by noon March 5.

The Australian Commomwealth Navy Department, Melbourne (Victoria), require tenders by noon Jan. 31 for supply of Dynamos, Switchboards, Motors, Balancers and Control Gear for Flinders Naval Base. Specifications from Director of Navy Contracts, Melbourne, and the Naval Staff Offices, Brisbane, Sydney, Birkenhead (S. Australia), Fremantle and Hobart.

Meters, M. D. Indicators, &c.

Sydney (N.S.W.) Council require tenders by 3 p.m. Feb. 19 for supply of meters, m.d. indicators and feeder regulators. Specifications from Electric Lighting Dept., Town Hall, Sydney.

Public Lighting.

Banbridge Urban Council want tenders by 7.30 p.m. Feb. 3 for Public Lighting (gas or electric).

Electric Light Wire.

The Victorian Railway Commissioners, Melbourne, require tenders by 11 a.m., Feb. 7, for supply of v. r. Electric Light Wire (p. d. ½ per cent.). Particulars from the Contractors' Room, Railway Commissioners' Offices, Spencer-st., Melbourne.

Electrically Controlled Clocks.

The Deputy Postmaster-General, Sydney, will receive tenders until Jan. 22 for supply and installation at Newtown (N.S.W.) Post Office of 9 Electrically-Controlled Clocks (Schedule 599 N.S.W.), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmaster-General.

Electric Cranes.

Tenders are required until Feb. 12 for the supply of six 4-ton Electric Travelling Portal Jib Cranes for DURBAN Harbour. Specifications from Secretary to Tender Board, S. African Railways Headquarter's Offices, Johannesburg, or from the High Commissioner for South Africa, 32, Victoria-street, London, S.W., at which addresses tenders will be received.

Electrical and General Stores.

MIDDLESBROUGH Corporation require tenders by first post Feb. 1 for 12 months' supply of Electric Lamps, Rubber Goods and General Stores. Specification, &c., from the Borough Engineer.

Tramway Stores.

HALIFAX tramways department require tenders by Feb. 12 for 12 months' supply of lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor-Bronze Wire, Brake Blocks, Trolley and Overhead Line Materials, Castings, Oils, &c.

MANCHESTER Tramways Department require tenders by Feb. 12 for 12 months' supply of Stores and Materials. Forms of tender, &c., from the Engineer.

YARMOUTH Council want tenders by noon Feb. 6 for supply of various Stores to the Tramway Department. Forms of tender, &c., from the Manager.

TENDERS RECEIVED AND ACCEPTED

AYLESBURY.—The Town Council has accepted the tender of the Bowring Petroleum Co. for paraffin oil, and that of the Vacuum Oil Co. for lubricating oil.

STRETFORD.—The Urban Council has accepted the tender of Veritys Ltd. (at £84) for a 15 b.h.p. electric motor.

GLASGOW.—The Corporation have accepted the tenders of the British Westinghouse Co. for a turbo-alternator £20,500, and Mirrlees-Watson condensing plant £8,945.

BRADFORD.—The Corporation have accepted the tenders of the British Elec. Engineering Co. for supply of three 600 k.v.a. transformers.

LEIGH.—The Council have accepted the tender of Bruce Peebles & Co. for supply of 250 kw. La Cour motor converter, £1,225.

SOUTHEND-ON-SEA.—The Council has placed orders for the following :—

John Brown & Co., tyres, £373 ; P. R. Jackson & Co., armature coils, &c., £303 ; S. Stone & Co., bar steel, iron, &c., £190 ; Hider Dempster, springs, white metal, &c., £219 ; British Thomson-Houston Co., field coils £162, gear cases, &c., £68.

Chamberlain & Hookham, contractors for meters, have given notice of intention to terminate their contract on Jan. 21, and quoted amended terms for the continued supply of meters. Mr. Birkett has been directed to report thereon.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Halifax.—The gross capital expenditure of the tramways department at March 31 was £421,890 (increase £1,605), of which £142,140 has been redeemed.

Revenue was £113,602 (compared with £113,170 in previous year), working expenses were £72,246 (£73,504), interest required £9,832 (£10,124), and sinking fund £12,469 (£12,106), leaving net profit £19,055 (£16,214). Total revenue per car mile was 12·41d. (11·66d.) and working expenses (including power) were 7·90d. (7·57d.). Passengers carried were 21,021,003 (20,707,071) and car miles run 2,195,980 (2,330,104).

Huddersfield.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £177,919, and total sinking fund £170,472.

Revenue was £143,210, working expenses were £79,981, and net profit after providing for capital charges and £4,451 for war service allowances, was £28,352. Average total revenue per car-mile was 12·30d., and working expenses were 5·79d. plus 1·46d. for power. Passengers carried were 26,941,112, and car-miles run 2,792,960, exclusive of non revenue running and coal trucks.

Southport.—The accounts of the tramways department for the last financial year show a net profit of £909 after meeting all charges.

Total revenue was £20,405 (against £20,420 in previous year), but the traffic receipts created a record and amounted to £20,005, although 12,244 car-miles less were run. Last year's traffic receipts were £19,970. Deducting war allowances (£1,051), working expenses were reduced from £12,813 to £11,565, and gross profit was £7,788 (increase £178.) Car miles run were 463,136 (compared with 465,686), and passengers carried were 4,870,581 (against 4,772,478). Up to the end of the year 14 women conductors had been employed, and six of them had been permitted to learn driving, but so far no woman driver has been allowed to undertake public driving.

NEW COMPANIES, &c.

CLEMENT CASTING METAL CO. (LTD.) (145,753.)—Private company. Reg. Jan. 12, capital £1,000 in £1 shares, to carry on the business of manufacturers and founders of copper, copper alloy, brass, gunmetal, nickel, spelter, lead, iron, steel and other metal castings and goods, manufacturers of manganese bronze ingots, &c. Reg. office: 11, New-street, Birmingham.

PRESSPARTS (LTD.) (145,747.)—Private company. Reg. Jan. 11, capital £3,000 in £1 shares, to take over the business of an electrical and mechanical appliance manufacturer, sheet metal worker, stamper, piercer, &c., carried on by Henry Justin Eck at Darwin works, Birmingham, as "Pressparts." First directors are Edwin B. Alldridge, Henry Justin Eck and Alfred C. Lee. Reg. office: 8, [illegible]-street, Birmingham.

RIDOUT & RATCLIFF (LTD.) (145,740.)—Private company. Reg. Jan. 10 with a capital of £2,000 in £1 shares, to take over the business of an electrical contractor formerly carried on by G. F. Ratcliff, and the business of an electrical engineer carried on by L. Ridout. First directors are to be appointed by L. Ridout and G. F. Ratcliff. Solicitors: Turner & Co., 89, Chancery-lane, W.C. Reg. office: 42, Upper Baker-street, W.

SCOTTISH TUBE CO. (SOUTH AFRICA) (LTD.) (9,729.)—Reg. in Edinburgh on Dec. 27, capital £20,000 in £1 shares, to take over the business of dealers in tubes and fittings carried on in the Transvaal Province of South Africa by the Scottish Tube Co. Reg. office, 34, Robertson-street, Glasgow.

WILLIAM TAYLOR (ELECTRIC LAMP) CO. (LTD.) (145,750.)—Reg. Jan. 11, capital £300 in £1 shares, to carry on the business indicated by the title. Private company. W. Taylor is the first permanent director. Reg. office, 8, India-street, E.C.

CITY NOTES.

MEMORANDA (Jan. 17).—Bank rate 6 per cent. (since July 13, 1916), Consols, $53\frac{3}{16}$. Stocks and Shares Ticket Days, Jan. 25 and Feb. 8. Pay Days Jan. 26 and Feb. 9. Price of Silver, 36⅝d.

EDMUNDSONS' ELECTRICITY CORPN. (LTD.)—The directors have decided to withhold payment of the six months' dividend on the cumulative preference shares payable Jan. 15 until the accounts for the financial year ending March 31 are prepared.

IMPERIAL TRAMWAYS CO. (LTD.)—Mr. Samuel White has been elected chairman of this company, Sir G. Stanley White has been elected a director, and Mr. W. G. Verdon Smith (secretary of the company for the past 15 years) has been appointed managing director. Mr. F. H. Withers becomes secretary.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO., (LTD.)—A quarterly dividend of 1¼ per cent. has been declared.

SAO PAULO TRAMWAY LIGHT & POWER CO. (LTD.)—A dividend of 2½ per cent. has been declared on the common stock.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO. (LTD.)—After meeting all expenses, the net income for the year 1916 was £26,188. Adding £15,045 brought forward the available balance is £41,233. A dividend of 6 per cent. per annum (less tax) on the cumulative preference shares has been paid, £12,525 placed to reserve and £17,952 carried forward. The number of passengers carried during the year was 12,888,271, and the car miles run 1,768,007, against 11,602,483 and 1,763,702 respectively in 1915. It is proposed that the preference dividend arrears shall be funded and transferred to a separate register, so as to be capable of being transferred and dealt with as a funded dividend, apart from the shares themselves.

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NOTES.

The Development of the Power Load.

THE writer of "Electricity Supply Memoranda" in the "Gas Journal" observes that we had a rare good opportunity, in commenting on the above, of "slating" those electricity concerns, which, through prior negligence, entered into the war period with plants demanding several pounds of coal per kilowatt-hour generated. Will such concerns kindly note that, for the hundredth time, we "slate" them? The Memorandist states that our thoughts were on the sinners outside the bounds of the electricity industry, and not on those within it. This we most emphatically deny. Our thoughts were on all the sinners, including those in the gas industry, who think they have the right to use extravagantly every ton of coal they purchase, and to destroy everything in the coal except its calorific value. It is unnecessary (and such being the case, we suppose we must again miss a "rare good opportunity") to remind our esteemed contemporary that for many years the gas engineers of the country destroyed most things that were worth anything in the coal, and that they also used coal extravagantly. Nor need we remind our contemporary that after experience extending over a century there is still much to be done concerning the recovery of the valuable by-products, and the utilisation of the calorific value of the fuel. Now that the gas engine is outclassed by the electric motor our friends are turning their attention to the by-products. We sincerely hope that in this direction at least the limits of the gas industry will be expanded, the more so since their disappointment in connection with the decay of their power load seems to have made them irritable.

Third-Rail Difficulties in Winter.

THERE was an unusual occurrence last Monday when the sleet and frost resulted in the third rail of the London suburban electric railways being coated with ice. If the running of the trains had been continuous no difficulty would have resulted, but owing to the cessation of the service during the usual night interval the ice formed sufficiently to prevent contact with the rail. Consequently, most of the services on the Metropolitan and District system, and on the London & South-Western Co.'s system, were unworkable for some time. In due course the temperature rose and the services were resumed. This sort of thing does not occur very frequently, and perhaps there may not be a similar occurrence for many years. At the same time, it draws attention to a distinct weakness of the over-running third rail, and, considering the extreme inconvenience and loss of money resulting from a dislocation of this sort, it is a question whether the railways would not have been well advised to have adopted some form of under running or side-running rail. The latter type is in use on a section of the Lancashire & Yorkshire Railway, though for a different reason, and appears to have given satisfaction. The objection, of course, is that the cost is somewhat higher. In this instance, at least, the overhead conductor has shown to advantage, though such would not necessarily be the case under all conditions.

Rating Lamps in Lumens.

DURING recent years the view has frequently been advanced that the best method of rating illuminants is in terms of the total flux of light in lumens. The lumen, originally proposed as a unit of flux by Prof. A. BLONDEL, of Paris, has been widely used in the United States, and the lamp makers in that country have now determined that lamps shall in future be rated in terms of lumens. This decision has also been endorsed by the American Illuminating Engineering Society. The question was discussed at the last meeting of the Illuminating Engineering Society in this country on January 16th, when Prof. J. T. MORRIS and Mr. F. W. WILLCOX pointed out the very marked variations in distribution of light from modern illuminants. By the use of suitable reflectors one can now modify the distribution within wide limits, and a statement of candle-power in any one direction is misleading, and has long been recognised as unsatisfactory. There is, in fact, general agreement that such sources should be rated on this total light output, either in mean spherical candle-power or in lumens.

* * *

FROM the purely scientific standpoint, there is little doubt that the latter basis is preferable. The mean spherical candle-power is an imaginary quantity, somewhat difficult to conceive, and, in the case of sources which depart widely from the ideal "point source," of doubtful significance. "Candle-power," however, is so deep rooted as a conception in this country that it is naturally difficult to make a change, though expert opinion has been steadily moving in favour of the lumen for some years. The announcement by Mr. WILLCOX that the leading makers of incandescent lamps and lighting appliances in this country have also decided to adopt the lumen rating, therefore, marks a courageous departure. At the present moment it may be possible to make changes which would hardly have been practicable before the war. Two important precautions seem necessary: (1) To publish both candle-power and lumen values during the transition period, and (2) to prepare literature explaining in popular terms the new method of rating. We note that the Illuminating Engineering Society is taking this last matter in hand, and no doubt the change will be made gradually, so that the conception of flux of light can be properly understood before lumen rating becomes general. The proposed departure is an interesting step which is surely significant of the changing attitude of manufacturers towards scientific methods since the war began.

Teachers and Organised Labour.

OF late a good deal of attention has been directed to the conditions under which the ordinary teacher follows his employment. For a long time we have been endeavouring to improve the lot of the technical teacher and more particularly of the engineering teacher. Although the salary paid to the latter is, in many cases, below the wage paid to the engineering artisan, the engineering teacher has nevertheless to work very long hours and his employers have seldom the same breadth of view as that of the principals of a large engineering works. In addition to the beggarly wage, engineering teachers are generally unable to pick up any outside work because education committees put obstacles in the way. For example, one of the conditions of employment under an enlightened body like the London County Council is that all employees, including teachers, who engage in outside work shall hand over to the Council all moneys received. But, entirely apart from the small stipend and the impossibility of increasing it, the technical teacher has a certain position to keep up. There is no need to enlarge on these subjects. The sorry position of the technical teacher in this country is, to some extent, due to the fact that the Principals of our schools and colleges are not loyal to their staffs. In order to keep on good terms with his Committee and to make the latter think that the institution under his charge is being run (on the whisky money) on strictly business lines, the Principal is apt to grind all he can out of his staff. Anyone who has been connected with a technical institution knows how true this is, and it is fairly well known that when Principals make a serious effort to increase salaries they are generally reprimanded by the tradesmen in a small way of business who form the Education Committee in most of our provincial towns. On account of his prestige (which, in our opinion, is imaginary) the technical teacher has a little society of his own which carries no weight with anybody who is anybody. It is on account of this imaginary prestige, we suppose, that makes it impossible for the technical teacher to combine with the "ordinary" teacher. We notice with a great deal of pleasure that the ordinary teacher proposes to throw in his lot with organised labour. Although on many subjects we hold very different views to those held by the National Union of Teachers, we do at least recognise that but for this Union the lot of the ordinary teacher would be intolerable to most men and women. In order to improve the position of the technical teacher we urge the Technical Teachers' Association to throw in its lot with the other associations and with organised labour. To put it bluntly under present conditions the technical teacher has no position. He need not fear, therefore, that by amalgamating with anybody his position will be worse than it is.

High-Speed Telegraphy.—The report of the committee appointed by the Postmaster-General to consider the subject of high-speed telegraphy has just been issued, and an abstract will appear in our next issue.

The Railway Clearing House.—We have received an interesting pamphlet issued by the "Railway News" (price 6d.), dealing with Mr. Gattie's proposed Goods Clearing House for London, the pamphlet being entitled "Some Railway Myths and Fallacies." The pamphlet deals with such subjects as "Mobility Versus Users of Railway Wagons," the various classes of traffic that have to be handled, the traffic which is suitable for Mr. Gattie's scheme and traffic which is not suitable. Various adverse conclusions are reached. We do not doubt that Mr. Gattie will in due course provide a suitable reply.

Lighting Economies in Paris.—Londoners have by now become familiar with lighting restrictions and the advice not to waste electricity widely advertised on hoardings. They have not, however, yet had to suffer the restrictions now being imposed in Paris. According to the "Yorkshire Post," the stopping of electric elevators and the rationing of light in apartments are now under consideration in that city.

Public School Reform.—A report has been issued of the proceedings at the reception of a deputation by a committee of the headmasters of the public schools held in London on July 6th of last year. Besides giving an account of the proceedings, there are several pages devoted to replies received from parents dealing with the question of reform. The number of replies received was 536, of which 512 were in favour and 12 against and 12 neutral. The extracts afford very interesting reading and form a damning indictment of the education given in our chief public schools at the present day. It might be thought that the remainder of Europe was of no interest to us.

The "Growth" of Iron.—In the course of a recent address before the South Staffordshire Iron and Steel Institute, Prof. H. C. H. Carpenter gave some interesting examples of the growth of cast-iron. A cast-iron steam turbine case has been known to grow 7 per cent., which naturally had a most prejudicial effect on its efficiency; and other troubles, such as the seizing of piston heads have been attributed to the same cause. The phenomena of growth appears to be due to the action of silicon, present as silicide, at the same time as free graphite. When iron containing these ingredients is heated, oxidising gases penetrate into and gradually attack the metal chemically, causing it to swell. For many purposes such as for steam valves and turbines, it is, therefore, desirable to avoid the use of cast-iron, cast-steel being now substituted.

Steel for Electrical Transmission.—In a recent Paper, read at a joint meeting of the American Institute of Electrical Engineers and the Association of Iron and Steel Engineers, Mr. H. B. Dwight emphasises the utility of steel cables for transmission purposes on branch lines, especially in cases where the size of copper strictly required to meet the load would be too small for use in practice. For alternating currents the resistance of a steel cable is considerably greater than for direct-current, owing to the skin effect. In copper or aluminium conductors the latter is negligible, increasing the resistance by at most 1 to 2 per cent., but at high frequencies the apparent resistance of steel conductors may be increased by 100 per cent. or more. The losses may be kept within moderate limits by using fine strands to act as laminations, and by winding the spirals of alternate layers of wire in reverse directions.

An Electrically-Heated Mine Ambulance.—The "Colliery Guardian" gives an account of a useful form of ambulance being introduced in one of the mines of the Union Pacific Coal Co., at Wyoming. Formerly it was usual, when an accident occurred in the mine, to place the injured man on a stretcher, transporting him to the surface in a mine car. As the distance to be travelled might be from three to four miles and against the high velocity intake current of air, the injured men often became chilled and this retarded recovery. The difficulty has now been overcome by the use of a specially-designed ambulance, which is electrically-heated and lighted, and is equipped with a cot suspended on springs to obviate any jarring. The ambulance can accommodate both the patient and an attendant, and is equipped with receptacles on either side in which first-aid supplies, hot-water bottles, blankets, &c., can be stored.

Electro-Metallurgy of Steel.—Reference has recently been made to the growing use of electric furnaces for steel production. According to a Paper by Mr. J. Gray in the "Canadian Mining Journal," the electric furnace provides exactly the instrument required to free the steel from objectionable ingredients such as oxygen and sulphur. The passage of the electric current, unlike the flame, can in no way add oxygen to the material, but the iron ore introduced into the furnace supplies just the oxygen required to burn out the undesired elements, which pass out as gases. The electric furnace is thus not only a non-oxidising, but a reducing element, and furnishes a very high quality of steel. It seems probable that in course of time its use will become general.

OBITUARY.

W. T. Le Feuvre.—We regret to record the death of Capt. Walter T. Le Feuvre, R.E., borough electrical engineer of Bexhill.

The death took place at Bangor Hospital on the 8th inst., as the result of pneumonia. Deceased, who was in his 43rd year, had been acting as an instructor at a depot in Wales and he had seen a good deal of military service both before and during the war, having been for nine years in the Queen's Westminsters and subsequently he took a commission in the Home Counties Royal Engineers at St. Leonards. Capt. Le Feuvre joined H.M. Forces soon after the outbreak of war and he went to the Front in June, 1915, but he returned in September. He had been resident electrical engineer at Bexhill from the establishment of the municipal electricity department in 1900.

PERSONAL.

Mr. John H. Bunting, who has been joint manager of Bruce Peebles & Co. (Ltd.) for the last four years, has been appointed general manager of the company, and Mr. S. E. Bastow, who has been joint manager with Mr. Bunting for the same period, has accepted the position of chief engineer to British Dyes (Ltd.). His headquarters will be at Huddersfield.

Mr. J. B. Hamilton commercial manager for Leeds Corporation, has been released in order to take up the post of Director of Trades Regulations in the department of the Admiralty which is being formed by Mr. Lynden Macassey, K.C., for organising labour in shipbuilding and repair yards and marine boiler and engine works.

Bradford Corporation has been asked by the Government, and has agreed, to lend the services of its tramways general manager (Mr. C. J. Spencer) for some special work.

Mr. Chas. Haswell, Sherbrooke-chambers, 8, Norfolk-row, Sheffield, has been appointed the agent of Messrs, Crompton & Co. (Ltd.) for Sheffield and the surrounding district.

Mr. F. A. B. Lord, senior partner in W. F. Dennis & Co., is to be nominated for a vacancy in the Common Council of the City of London.

The New Peers.—The following titles have been taken by recently created peers :—

Mr. Stuart Wortley.—Baron Stuart of Wortley of the City of Sheffield.

Sir William Max Aitken.—Baron Beaverbrook of Beaverbrook, New Brunswick, and of Cherkley, Surrey.

Mr. J. A. Pease.—Baron Gainford of Headlam, Durham.

Roll of Honour.—We have received lists of 22 members of the staff of Carlisle municipal electricity department who are serving with H.M. Forces, and 24 serving in the Volunteers.

The former include Compy. Sergt.-Maj. H. P. Baynham, R.M. (station supt.), and Bomb. J. H. Hay, R.F.A. (chief clerk), while the latter comprise Capt. F. W. Purse (city electrical engineer), Corp. J. H. Thompson (chief assistant), L.-Sergt. P. Wardle (mains supt.), L.-Corp. R. M. Maxwell (chief clerk), Pte. C. C. Fairweather, Pte. M. Cubby and Pte. R. Wright (charge engineers). We congratulate the staff on their patriotism and we regret that we are unable to publish the full list.

War Honours.—Mr. A. H. Adamson (formerly sub-station attendant in the Poplar electricity department) has been awarded the Military Gold Medal for the part he took in destroying a Zeppelin on March 31 last.

APPOINTMENTS VACANT.

A temporary assistant is required to engineer-in-charge of h.t. electric sub-station in London district. *See advertisement.*

An engineer is wanted by a Midland firm, to design a complete line of d.c. motors up to 50 h.p. *See advertisement.*

An electrician is wanted for a private house. Applications to Mrs. Pitt, Pett Place, Charing, Kent. *See advertisement.*

A large electric power company in the Midlands advertises for a meter and instrument tester.

A temporary charge engineer is wanted for the Borough of Southwark electricity department. Salary £3, rising to £3.10s., with bonus. Applications to Mr. D. M. Kinghorn, Electricity Works, Penrose-street, Walworth, London, S.E. *See advertisement.*

A firm of consulting engineers require an assistant electrical engineer to undertake the lay-out of electrical power stations, &c. *See also an advertisement.*

A lecturer on chemistry is required for the South African School of Mines and Technology, Johannesburg. Salary £450, rising to £600. Applications to Messrs. Chalmers, Guthrie & Co. (Ltd.), 9, Idol-lane, E.C.

INSTITUTIONS AND SOCIETIES.

The Royal Society.—At the meeting held yesterday the following Papers, among others, were read : "Spectroscopic Observations on the Active Modification of Nitrogen (V.)," by the Hon. R. J. Strutt, F.R.S., and "Magnetic Induction and its Reversal in Spherical Iron Shells," by Prof. J. W. Nicholson and Prof. E. Wilson.

Metropolitan Association of Electric Tramways Managers.—A meeting of the members of this Association was held at the Municipal and County Club, Whitehall Court, Whitehall, S.W., on Friday, the 19th inst., when there were present : Messrs. Ullmann (East Ham), Chairman, Hammond (M.E.T.), Vice-Chairman, Bruce (L.C.C.), Schofield (Leyton), Harvey (Ilford), Slattery (West Ham), Mason (South Met.), Mackinnon (London United), and Goodyer (Croydon), hon. sec. Various matters of interest were discussed.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Jan. 26th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Papers on "A Clock of Precision," by Mr. C. O. Bartrum, B.Sc. ; and "The Effect of the Water Vapour in the Atmosphere on the Propagation of Electromagnetic Waves," by Dr. F. Schwers.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At Bolbec Hall, Newcastle-on-Tyne. General Meeting.

TUESDAY, Jan. 30th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, W.C. (Colonial Section). Paper on "Imperial Industries After the War," by Mr. O. C. Beale.

Manchester Local Section, Institution of Electrical Engineers.

7.30 p.m. At the Engineers' Club, Manchester. Paper on "Fuel Economy," by Messrs. J. D. Paton and J. Frith.

THURSDAY, Feb. 1st.

Royal Institution.

3 p.m. At Albemarle-street, W. Paper on "The Mechanism of Chemical Change," by Prof. F. G. Donnan, F.R.S.

FRIDAY, Feb. 2nd.

Royal Institution.

5.30 p.m. At Albemarle-street, W. Discourse on "The Supply of Gaseous Energy," by Dr. C. Carpenter.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week.

Officer for the Week.—Platoon Commander G. H. Parker.

Next for Duty.—Platoon Commander C. H. C. Bond.

Monday, Jan. 29.—Technical for Platoon No. 9 at Regency-street ; Squad and Platoon Drill, Platoon No. 10 ; Signalling Class ; Recruits' Drill, 6.30 to 8.

Tuesday, Jan. 30.—A volunteer fatigue party is required to assist the Quartermaster.

Wednesday, Jan. 31.—Instructional Class, 6.15 ; Platoon Drill, Platoon No. 1.

Thursday, Feb. 1.—Platoon Drill, Platoon Nos. 5 and 6 ; Ambulance Class by M.O., 6.30.

Friday, Feb. 2.—Technical for Platoon No. 10, Regency-street ; Squad and Platoon Drill, No. 9 ; Signalling Class ; Recruits' Drill, 6.25 to 8.25.

Saturday, Feb. 3.—Commanding Officer's Parade, 2.15, uniform.

Sunday, Feb. 4.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday rations to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

MODERN TYPES OF DIRECT-CURRENT MACHINES.*

BY D. HALL

A direct-current machine may be considered as a certain mass of steel to provide a path for magnetic flux, and a mass of copper to provide a path for electric currents. In this conception, there are the two main elements—*flux* capacity and *current* capacity. Further deductions as to what can be obtained from a given machine will all revert to these two factors.

Flux Capacity.—In rotating electrical machines, the primary interest centres in the total flux which passes through the air-gap between the stator and the rotor, and which is cut during rotation by the belt of copper conductors, distributed on the armature. The *gap area* is a measure of this flux capacity.

While the flux capacity for a unit area of gap is not the same for all machines, yet for a given class of machine the air-gap area can be considered a fairly accurate measure of the flux capacity, and it is, therefore, evident that the flux capacity of any machine increases directly as the diameter of the rotor increases, and directly as the length of the rotor increases. Thus, flux capacity may be looked upon as air-gap area, and any changes which increase or decrease the air-gap area would cause a corresponding increase or decrease in flux capacity. The steel above and below the air-gap may be looked upon as a necessary evil—simply a carrier to make possible the air-gap flux, as also may the field copper be looked upon as a necessary evil—simply a means of producing the air-gap flux.

Current Capacity.—The conductors adjacent to the air-gap may be considered as a belt, having a definite area of cross-section; that is, the total copper section is equal to the cross-section of the copper in one slot, multiplied by the number of slots. If we look upon this total cross-section as the area of one wire we have a measure of the ampere-wire capacity—that is, the current which all these conductors would be capable of carrying when connected in parallel. If this cylindrical belt of conductors be considered as one large wire, then the total current which is carried represents the ampere-wire capacity of the winding. The ampere-wire capacity is entirely dependent on this section of the copper, hence, other things being equal, the section will increase directly as the diameter D of the armature increases, and it is independent of the length of the armatures. While the ampere capacity for a unit area of copper is not the same for all machines, yet for a given class of machines the copper section may be considered a fairly accurate measure of the ampere-wire capacity.

With flux capacity proportional to gap area, and ampere-wire capacity proportional to copper section, a measure of a given machine is available, whether it be a motor or a generator, alternating or direct current, and whether it stands still or rotates. The windings may be considered as a cylindrical copper cage; the total cross-section of all of the bars of this cage is a measure of the ampere-wire capacity, and increasing the length of the cage does not change the ampere-wire capacity. It is evident that the ampere capacity of these wires will depend on how well they are ventilated; consequently for the same temperature rise, the better the ventilation, the more current can be carried by a given section of copper. Hence, the necessity of well-ventilated armatures. With a given ventilation a given diameter of armature and a given section of armature winding, the ampere-wire capacity is fixed; that is, if all the conductors surrounding the armature are considered as a single wire, there is sufficient copper section for a definite current. However, if these armature conductors are so connected as to use one half of them to carry current from the front of the armature to the back, and the other half to carry the current from the back of the armature to the front, the number of conductors will be doubled and the number of amperes halved, but the product of the amperes and the conductors—that is, the ampere-wire capacity—will remain constant.

So far, output or speed have not been mentioned. It is evident that at zero speed the output is zero. If the armature is rotated, the voltage generated will be dependent on the flux, the speed, and the number of wires in series, and as the output is dependent on the product of voltage and amperes, it must be proportional to flux, speed, amperes and wires. It is the variation of these four factors which enter into the many designs which are obtainable from a given mass of steel and copper.

Output = Flux × Speed × Amperes × Wires × Constant.—From this simple formula a number of facts are easily observed. If a maximum output is to be obtained from an armature of given dimensions, the flux must be made a maximum, and the ampere wires must be made maximum. On a given armature there is only a certain space available for flux and wires. It is not essential that an armature of given dimensions and for a given rating be worked always at the same flux, but when the flux is fixed the wires will also become fixed; either of these may be changed, but they must change together. Hence, it is that from the same diameter and length of armature a machine of a given rating may be designed with a relatively large amount of flux and a small number of ampere wires or, on the other hand, the machine may be made with relatively small amount of flux and a large number of ampere wires. The former machine will require a large amount of steel and a small amount of copper; the latter machine the reverse. These different relative proportions of steel and copper constitute different performances and cost and it is around these factors that designs may be said to revolve.

In observing the above formula and considering that the flux, as it enters the air gap is perpendicular to the wires on the armature, one might suggest that the output could easily be increased by making the armature slots narrow and deep instead of wide and shallow. This is true, and the slots are made as deep as can be permitted, taking all other factors into consideration. As deep slots increase the self induction due to current reversal and as deep conductors may introduce other losses at high speeds, slow speed machines contain deep slots while high speed machines contain relatively shallow slots. The high speed machine ventilates better than the low speed machine, and consequently the copper can be worked at a higher density. As a rule, the high-speed machine will have a higher self induction, and in order to obtain good inherent commutation it generally becomes advisable to use relatively shallow slots. From the standpoint of efficiency, these relative proportions are also desirable; that is, slow speed machines require a large amount of copper, and high speed machines can be made with relatively less copper.

From the same frame of a machine there may be obtained many outputs, depending on the speed. For example, from the same frame

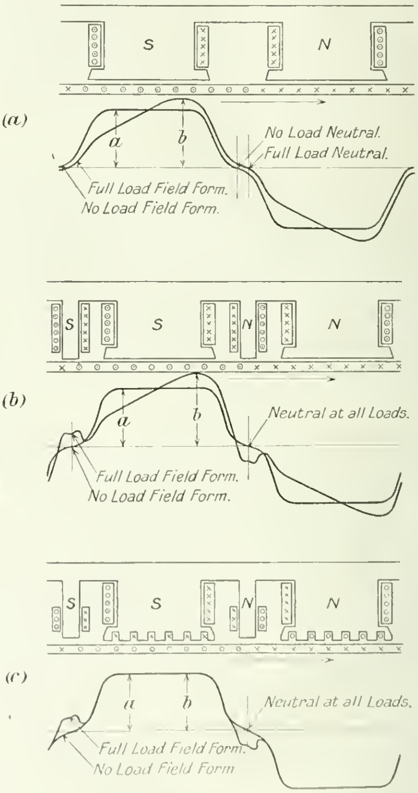

FIG. 1.—FIELD FORM CURVES.

(*a*) Of a non-commutating-pole generator.
(*b*) Of a commutating-pole generator.
(*c*) Of a compensated generator.

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* Paper read before the Association of Iron and Steel Electrical Engineers. Abstracted from the "Electric Journal."

there can be obtained 100 kw. at 100 revs. per min., 200 kw. at 200 revs. per min. and 1,000 kw. at 1,000 revs. per min., speaking generally, as regards the flux and ampere wires. For changes in voltage, changes in the number of poles will become necessary. If a machine is properly constructed to give 100 kw. at 100 volts, when running at 100 revs. per min., this same machine would give 200 kw. at 200 volts when running at 200 revs. per min., and 1,000 kw. at 1,000 volts when running at 1,000 revs. per min., if there were not other limitations, both mechanical and electrical, which prevent this simple procedure being applied over a very wide range of ratings and speeds. As the voltage obtained from a given frame is dependent on the flux, speed and wires, if the speed is set, the wires will have to be increased in order to increase the voltage; and as the product of amperes and wires is a constant, the wires can only be increased by reducing the ampere capacity; hence, it is that the same frame of a machine may be used to give 100 kw., 100 volts, 1,000 amperes at 100 revs. per min., and also 100 kw., 200 volts, 500 amperes at 100 revs. per min. The latter machine has twice the number of wires and twice the voltage, but one-half the ampere capacity. In other words, the capacity of a given frame is proportional to its speed, and the voltage at a given speed is proportional to the wires connected in series on the armature.

If the total current is large, it is, in general, desirable to have a relatively large number of paths in the armature. Hence, on large-current machines a large number of poles are used, and on small current high-voltage machines a small number of poles constitute the best design. Increasing the length of a given armature increases the flux capacity, but it does not increase the ampere-wire capacity; hence, the output of the armature will increase directly with its length. Increasing the diameter of an armature increases both the flux capacity and the ampere-wire capacity; hence the output of an armature increases directly with the square of the diameter. Thus, output is proportional to D^2L, and kw. $= D^2 \times L \times$ revs. per min. $\times$ output factor.

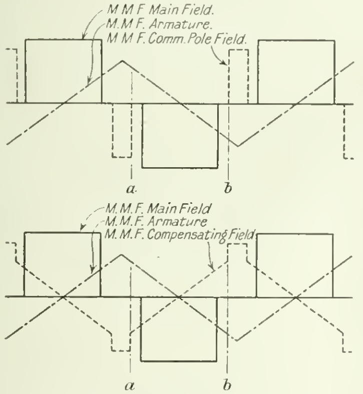

FIG. 2.

(*a*) Magnotomotivo Force in a Commutating-pole Generator. and (*b*) Magnotomotive Force in a Componsated Generator.

The aim of the designer is to obtain a high output factor, that is, to obtain a large output for a given armature diameter and given ength of armature; in other words, he endeavours to proportion the nachine so as to get maximum output at minimum cost. One way f accomplishing this is to ventilate the various parts so as to enable he maximum watts to be dissipated with least amount of heating. For example, the armature core may have a liberal number of air lucts, and the armature spider may be designed easily to admit air nto the core. This output factor represents what may be called the oading factor of the armature, or, in other words, the magnetic flux er inch of length, and the armature ampere wires per inch of armaure diameter. Let $F =$ number of lines of flux per inch of diameter er inch of length of armature, and $A =$ armature ampere wires per nch of armature diameter, then total flux $= F \times D \times L$, and the xpression for the voltage generated is

$$\text{Volts} = \frac{F \times D \times L}{10^8} \times \frac{\text{Revs. per min.}}{60} \times \frac{\text{Wires}}{\text{Circuits}}.$$

In this formula wires/circuits represents the number of wires in ries on the armature. For example, a six-pole machine may have the winding so connected to the commutator bars as to give six paths in the armature. This forms what is generally called a multiple armature winding, and the ends of an armature coil connect to adjacent commutator bars. A winding of this kind is used in practically all large machines, that is, the number of circuits in the armature is the same as the number of poles. The armature winding may be so connected to the commutator as to give only two paths in the armature. The latter winding would be called a two-circuit winding. With the same number of commutator bars and the same number of turns per coil, the six-circuit winding will give one-third as many volts as the two-circuit winding, but it would have three times the current capacity. It will be observed that the ampere-wire capacity is the same in both windings. If the six-circuit winding gives 100 volts and 3,000 amperes, the two-circuit winding would give 300 volts and 1,000 amperes.

Multiplying both sides of the above equation by amperes, and simplifying, we obtain

$$\text{Volts} \times \text{amperes} = D^2 \times L \times \text{revs. per min.} \times \frac{(F \times A)}{60 \times 10^8}.$$

This equation provides an expression for the total watts of the machine. The term in the parentheses is the output factor. The output which is obtainable from a given size armature at a given speed depends upon the flux per inch and the ampere wires per inch. The higher these two factors are worked the more will be the output from a given armature. These two factors have their limits. If the flux is too high a large amount of field copper is required, at a consequent increase in cost. Also, if the flux density in the armature teeth and core is made high the iron loss will be high. The actual loss in the iron will increase much faster than the density increases. In slow-speed machines the iron loss is usually very small because of the low frequency; consequently, this does not become the limiting factor, but in high-speed machines, that is, machines of 30 cycles or more, the iron loss begins to be a considerable factor in the total losses, and must be kept down in order to make high efficiencies possible.

The ampere-wire loading of the machine, as has been observed, is a direct factor in the output; hence the desirability of making this high. The current density which can be used in the armature conductor will depend on the ventilation, the permissible heating and the efficiency which must be obtained. The section of copper which can be put on a given armature will depend on the size and shape of the slots. As flux capacity and ampere-wire capacity are equally important in obtaining output, and as the increase of one means the decrease of the other, the design becomes a compromise. If the armature slots are made narrow and deep they interfere the least with the available section of iron for the flux. As has long been known, armatures with narrow deep slots have more self-induction due to current reversal than armatures with wide shallow slots, and while the capacity of such armatures from the heating standpoint, as shown by our formulæ, may be very large, the commutation limit might be much lower. The above formulæ have in no way taken commutation into consideration, and if there is any one element in a direct-current machine which is more important than all other elements it is commutation.

For many years, previous to their general use, commutating poles were well known, but the requirements imposed by the users of electrical machines were being met in a reasonably satisfactory manner with the old non-commutating-pole designs. Necessity for machines with greater overload capacity, for machines of high-speed, for wide range variable speed motors, for generators capable of operating over a wide range of voltage, for machines which would stand reversal either mechanically or electrically or both, has led to the general introduction of special means for ensuring good commutation. This has not come without the addition of some new parts, and without a certain relative degree of complication, but the general improvement in operation since the introduction of commutating-pole and compensated machines has been so marked as to render the old type of machines non-competitive for most purposes.

The old non-commutating-pole machine had no fixed neutral position for the brushes. The generator required that the brushes be moved forward; the motor required that the brushes be moved backward. The amount of brush shift was dependent on the load; consequently, many non-commutating-pole machines cannot be satisfactorily operated through a wide range of load without changing the brush position. The commutating conditions often depend on the field strength, and many pole-tip constructions were devised to assist in producing a suitable magnetic field for commutation. Armatures were designed with wide shallow slots, thus reducing the output in other directions, all for the sake of improving the commutation. That is not all, for, with special pole-tip construction, the relative strength of armature flux in the main field was of great importance if good commutating conditions were to be maintained. This restriction prevented good commutation over either a wide range of load or over a wide range of voltage, and motors could not be made to operate well over a wide range of speed.

In order to meet these inherent characteristics of non-commutating-pole motors and generators, there appeared on the market various well-meaning designs, whereby the neutral zone of commutation was supposed to be more or less fixed. All of this goes to show to what a great extent the designer of direct-current machines has been concerned with commutation, and even with the best type of construction it was impossible to make machines of such ratings as are commonplace to-day. This is the fact which is of interest to the consumer, for, as has been previously pointed out, the output from a given size armature is proportional to the speed and, with the commutation provided for, the speed has been increased, and the cost and the weight per kilowatt has been correspondingly reduced.

Reversing motors for large blooming mills, some of which to-day carry swings of more than 10,000 amperes at 1,200 volts, would be impossible without special provisions for commutation. High-speed generators supplying energy to such reversing motors would not have been considered under the old type of design. The motors for speed variations of 4 to 1 and generators which will commutate throughout the entire range of voltage have widened the field of application of electrical machinery. These are not all the advantages, for, with good inherent commutation, graphite brushes can be used, as a high brush contact resistance is not necessary. Such brushes have a low coefficient of friction, and they do not wear the commutators as the old carbon brushes did. Both the life of the commutator and the life of the brushes are greatly lengthened. Hence, it is that operating troubles and maintenance expense have been greatly reduced by improved commutation.

Types of Construction.—There are two general types of field construction—one type using commutating poles only, Fig. 1 (*b*), and the other type, which is a variation of the commutating-pole type, being called a compensated machine, Fig. 1 (*c*). The commutating-pole machine is made by introducing additional small poles between the main poles. The small poles are magnetised by a winding in series with the armature, and the brushes are so placed that the coil during commutation comes under the influence of the flux from the commutating poles, which flux is of such value and direction that cutting it produces in the coil undergoing commutation a voltage which neutralises the voltage of self-induction. In a generator the flux from the commutating pole must be in the same direction as the flux from the main pole immediately ahead, and in a motor the flux from the commutating pole must be in the same direction as the flux from the main pole immediately behind. An easy way of remembering this relation is to consider that in a generator a piece of the main pole is moved *backward*, instead of the brushes being shifted *forward*, and in a motor a piece of the main pole is moved *forward*, instead of shifting the brushes *backward*.

This brings the neutral position midway between the main pole pieces for either a motor or a generator, and by connecting the commutating-pole winding in series with the armature a change from generating load to motor load automatically changes the polarity of the commutating poles. Thus, such a machine is suitable for either motor or generator operation without any movement of the brushes. This characteristic is very important, and it has opened a wide field of application which could not be covered by the older type of machines.

The next principal variation from the commutating-pole machine is the compensated machine, which may be looked upon as a modified commutating-pole machine. This has the exciting winding concentrated about the commutating pole, while the compensated machine has a part of the exciting winding distributed in the main pole face. The total excitation is the same in both cases.

As the commutating-pole machine is simpler in mechanical construction than the compensated machine, the question naturally arises as to why the latter construction is used. In order to explain this it is necessary to consider the function of the commutating-pole winding. Fig. 2 shows the magnetomotive forces which are present in both type of machines. The essential difference, as will be noticed from an inspection of the diagram, is that in the commutating pole machine the armature reaction is not neutralised in the zone *a-b*, while on the compensated pole machine the armature reaction is completely neutralised under the main pole. In order to maintain the best commutating condition the flux from the commutating pole must change in exact proportion to the change of load. As soon as there is any saturation in the commutating pole this exact relation is destroyed and the commutation limit is soon reached. It is, therefore, undesirable to use shunts around either the commutating pole winding or the compensating winding, as the presence of shunts may destroy the straight line relations between the armature current and the exciting current which produces the commutating flux.

As the commutating pole must carry both the useful flux for commutation and also any leakage flux which may be produced by its winding, it is evident that reducing the leakage flux will increase the commutation limit of the machine. The most effective way of reducing this leakage flux is to distribute the commutating-pole exciting field winding in the main pole faces and thereby increase the length of the path of leakage flux. This construction produces what is called a compensated machine, and it possesses two distinct advantages over the plain commutating-pole machine. It has a greater maximum commutating capacity and, as the armature cross-magnetisation is neutralised under the main poles, the maximum voltage between adjacent commutator bars is correspondingly less. By taking advantage of these points it becomes possible, by the aid of compensation, to increase the speed of generators and to make motors which will meet more difficult cycles of operation. Within the commutating limits the commutating-pole machine commutates just as well as the compensated machine, but the limiting factor in commutation is the saturation of the commutating-pole magnetic circuit. The main factor in saturating this circuit is the leakage flux and, as there is less leakage in this part of the compensated machine, the overload limit is correspondingly increased.

As the number of commutator bars per pole decreases with an increase of speed, a high average voltage between adjacent commutator bars is the result, and if the number of commutator bars is arbitrarily increased in order to obtain low average voltage between bars the armature reaction is correspondingly increased, and the distortion of the main flux becomes greater, resulting in a high peak voltage between adjacent commutator bars. As has been shown in the compensated machine, there is no distortion of the main pole flux ; consequently, with the same degree of safety, a higher average voltage between commutator bars is permissible ; that is, with the same peak voltage between commutator bars, the compensated machine can have a higher average voltage between bars than the commutating-pole machine. Hence, for very high speeds, the compensated machine makes higher ratings possible. For the same reason, the compensated machines makes possible higher voltage machines for a given speed.

The pole-face windings and their necessary connections introduce a certain amount of complication which is inherent to the compensating windings. It is a fact that the compensated machine is not as easily dismantled and not as easily repaired as the commutating-pole machine and, for pure simplicity of construction and minimum number of parts, we must admit that the old non-commutating-pole machine is superior to either of the later types. Hence the better performance is obtained at a sacrifice of simplicity, and a universa application of compensated machines would be as much of an erro as would be an attempt to apply non-commutating-pole machine to all classes of service.

Voltage Regulation of Generators.—It is generally known that th voltage points on the regulation curve of a compound generator a different loads do not lie in a straight line, but they lie on a curve the half-load voltage being higher than either the no-load or the full load voltage when the compounding is adjusted for the same voltag at both no-load and full load. This characteristic is due to the cross magnetising effect of the armature winding, and it is present in bot non-commutating-pole and commutating-pole machines. Th magnitude of this effect depends upon the relative strength armature to main field flux and to the degree of saturation in certai parts of the magnetic circuit. The chief difference between th compounding of non-commutating-pole machines and commutatin pole machines is that in the latter type less series turns are require to give a certain compounding, because in a commutating-po machine the brushes are placed in the neutral position and there no *demagnetising* effect from the armature. In practice the seri coils of a commutating-pole machine will have less resistance th the series coils of a corresponding non-commutating-pole machi and, to parallel two such machines, it is often necessary to conne a resistance in series with the series winding of the commutating-po machine. The compensated generator has a straight-line volta regulation. This is because the cross-magnetising effect of th armature is neutralised by the pole face winding. No troub however, is experienced in operating all three types in parallel. I parallel connection of commutating-pole or compensated machin the commutating-pole winding and the compensating winding treated as a part of the armature circuit ; that is, the equalisers brought out where the inside end of the series winding connects the outside end of the commutating pole or compensating windi

The question of generator voltage regulation is often confu with the change in voltage, which occurs with a sudden change load. The two characteristics are entirely different and no atte should ever be made to apply the same limitations to them Volt regulation, as generally referred to, applies to a change in voltage to a gradual change of load, the voltage being read by an ordinary voltmeter, as distinguished from an instantaneous change of load. Such change of load extends over a period of at least a few seconds, and is of sufficient time to permit of a settling of the voltage to the usual condition of operation. In certain classes of service the load changes very suddenly over a very wide range. These changes, if momentary, produce variations in voltage which are of very short duration, but of large magnitude. For example, suddenly throwing full load on a generator may reduce its voltage almost to zero, and suddenly throwing off full load may increase the voltage 25 per cent. These changes, which are of very short duration, can only be measured by an oscillograph and, except for circuits used for lighting, they are of no consequence.

Efficiency.—In efficiency there has been no particular gain made in changing from the non-commutating-pole construction; in fact, it is evident that the introduction of additional windings has occasioned additional losses. To counteract this effect, which would in itself have meant a reduction in efficiency, it can be said that less total losses in the main field are necessary, and one very important fact in this connection is that, with a special means of taking care of commutation, deeper slots are permissible and, consequently, a more liberal section of armature copper can be used, thus reducing the losses. As the maximum point on an efficiency curve is where the variable losses are equal to the constant losses, it might be noted that in either low-voltage or low-speed machines the constant losses are generally low as compared to the variable losses, and the maximum efficiency occurs at less than full load. In high-voltage or high-speed machines the constant losses are generally higher as compared to the variable losses, and the maximum efficiency occurs beyond the full load.

Hand in hand with the improvement in commutation there have been many improvements along other lines, both electrical and mechanical. Armature coils, formerly made of wire, are now made of strap wherever possible. In many cases cotton insulation has been replaced by mica and asbestos. Cast-steel and rolled steel have taken the place of cast-iron, thus improving the magnetic quality, increasing the strength, reducing the weight and the size. Better brushes are contributing to long life of commutators, and better commutation has made possible the use of softer grades of brushes—brushes which contain graphite, and which have no abrasive quality, and which possess the desirable quality of a low friction coefficient.

Various lines of direct-current machines have been designed embodying special means such as described for ensuring good commutation. Some of these lines have been made especially for steel mill application, such as the steel-mill motor. Motors for a reversing blooming mill have a special rotor construction, which is made to withstand the shocks which are characteristic of this application. The armature windings are braced at both ends outside of the armature core, and all parts are more rugged than is necessary for ordinary classes of service.

Altogether, the direct-current machine has been greatly improved by the introduction of special means of securing good commutation. Its field of application and its flexibility have been greatly widened, and at the same time the cost and the weight have been materially reduced. As an exceptional illustration of the satisfactory service of modern motors, the writer has in mind a particular steelworks where some 175 motors, aggregating 5,000 H.P., are in use, and in the last $2\frac{1}{2}$ years the only repairs necessary to these 175 motors have been the re-winding of two armatures.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(*Continued from page* 497.)

ROTARY BALANCERS.

XI. General Theory of Rotary Balancers.

The general theory of the rotary balancer will now be considered. A charged battery is an independent source of energy, and would continue to supply current to R_3 even if the main dynamo were cut off. A rotary balancer has not this property, but would stop altogether if $2V$ were cut off. There must be in use along with it, therefore, some permanent source of supply, which might be a battery coupled right across the outer wires only, or some running machinery. The rotary balancer, as is well known, consists of two machines, duplicates of each other, having their armatures mechanically coupled together so as to run at the same speed, and electrically coupled together so as to be in series across $2V$ volts. The middle wire is connected to the armatures by joining it to the wire which couples them in series. Figs. 11 and 12 apply to a rotary balancer, and at present it is assumed merely that e_0, e_3 and e_4 exist; how they are produced will be considered later. The important new point to remember is that in a rotary balancer, as illustrated in Fig. 12, say, the two armatures running at the same speed will have e_4/e_3 necessarily in the same ratio as the magnetic fluxes in the two field circuits at any moment. These fields are indicated as carrying shunt currents C_{S0}, C_{S0}, C_{S1} and C_{S2} respectively in their windings, but these are only diagrammatic, and do not necessarily represent actual conditions. Let the fluxes φ_4 and φ_3 respectively produce e_4 and e_3, and let the two fluxes which produce e_0 and e_0 in Fig. 11 be each φ_0. These are necessarily equal to each other, though not necessarily equal to φ_3 or φ_4.

Fluxes will be called positive when they produce E.M.F.s opposing $2V$, such as are shown in Figs. 9 and 10. In a previous section, the case of two motors in series electrically, but not mechanically coupled, was considered, and it was shown that such a combination is quite unstable. If, however, the armatures are mechanically coupled so that they are not independent of each other as regards their load, then any change in the load will affect both alike, and, as far as external load is concerned, they will act just like one armature, each absorbing half the volts of the system as long as the two back E.M.F.s are equal. The external load may consist only of those losses inherent in the balancer which require a torque to be developed to balance them—namely, the iron and friction and windage losses—in which case C will be the light load running current of the armatures; or the balancer may also, as frequently happens, be driving a booster at some load independent of its function as a balancer altogether, in which case C will be the current required both to make up the losses referred to above and to supply torque sufficient to keep the booster going. It is assumed that this current C does not change, whatever happens in regard to the unbalancing of the system. This is not strictly true, because the inherent losses of the machine may change when φ_3 and φ_4 change, and may, therefore, require C to change to balance them; and, further, as the booster load is independent of the balancing conditions, it also may cause C to change considerably. But if the set be used mainly or solely as a balancer, the change in C may be neglected as a rule, without vitiating the conclusions to be drawn except, in a small degree, quantitatively. In other cases it may be necessary to correct for a change in C, but these cannot be brought simply within the scope of a general treatment. It is necessary, however, to bear in mind, for the purpose of correcting special cases, that two assumptions have been made: first, that C does not change, and, second, that R does not change. R now contains a brush contact resistance, which is not constant under all circumstances, and allowance may have to be made for this in certain cases, when final and exact calculations are being made.

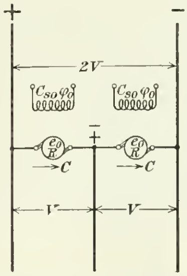

Fig. 11.—Diagram of Rotary Balancer without Load.

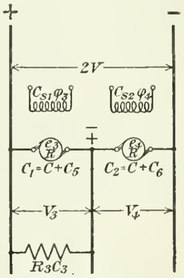

Fig. 12.—Diagram of Rotary Balancer with Load.

The equations for the rotary balancer are the same as those given at the beginning of section IX. There is one additional equation which gives the key to the whole theory of the rotary balancer, because it gives a connection between C_5 and C_6, and so allows relations between the other variables to be determined. C_5 and C_6 are currents superposed on an existing system of currents, and the latter is assumed not to be altered by the setting up of C_5 and C_6. Now the set as a whole cannot permanently take in energy from the system more quickly than is required for the driving of the external load, nor can it give out energy permanently to the system, as there is no external driving source to maintain such a process. If the setting up of C_3, therefore, result in any immediate change in the total power of the set, this change will at once set about wiping itself out, and will continue so to act until the total power absorbed by the balancer is again just what will drive the external load. The exact way in which this takes place depends on other processes going on in the system as a secondary result of setting up C_3; but the general statement is true, that the net power added by C_5 and C_6 is zero when the stable state is reached. Now the power added by C_5 is e_3C_5, and that added by C_6 is e_4C_6. The relation $e_3C_5+e_4C_6=0$ must therefore be true, and hence

$$C_5/C_6=-e_4/e_3,$$

which is true under all possible circumstances so long as the set is stable. This is the same as $C_5/C_6=-\varphi_4/\varphi_3$, since $e_4/e_3=\varphi_4/\varphi_3$. That is to say, the torques added by C_5 and C_6 to the system of torques already existing are also balanced when stability is reached, as the torques are proportional to $C_5\varphi_3$ and $C_6\varphi_4$. This clearly must be true, as any unbalanced torque added to a system of balanced torques produces changes in speed which go on acting until something happens to restore balance again. The relation between C_5 and C_6 is such that when one acts in the same direction as the E.M.F. of its armature, the other acts in the opposite direction to that of its armature, so that one acts in the motoring sense and the other in the generating sense; that this must be so is the corollary of what has been said about the balance of power and torque, but additional evidence of it emerges frequently as the theory is developed. In order to have numerical values as a basis for plotting results in typical curves, and for other purposes, choose those shown in Fig. 13, where the total voltage of the system is 500 volts $=2V$, and each armature has a resistance of 1 ohm $=R$, and a light load current of 5 amperes $=C$ so that e_0 is 245 volts $=V-CR$.

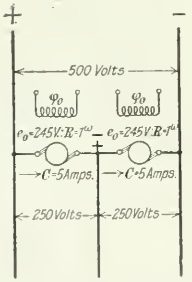

FIG. 13.—DIAGRAM OF ROTARY BALANCER SHOWING CHOSEN NUMERICAL VALUES.

XII. FURTHER THEORY OF ROTARY BALANCERS.

The relation $C_5/C_6=-e_4/e_3$ may now be developed further. From section IX,

$$\frac{e_4}{e_3}=-\frac{C_5}{C_6}=\frac{R(2V-e_3-e_4)-(R+2R_3)(2e_0-e_3-e_4)}{R(2V-e_3-e_4)-(R+2R_3)(2e_0-e_3-e_4)},$$

$$=\frac{VR-e_0(R+2R_3)+e_3(R+R_3)+e_4R_3}{VR+e_0(R+2R_3)-e_3R_3-e_4(R+R}$$

Multiplying across, and simplifying, this becomes

$$2V\{e_4/(e_3+e_4)+R_3/R\}-(e_3+e_4)R_3/R-(e_3^2+e_4^2)/(e_3+e_4)$$
$$-CR(1+2R_3/R)=0.$$

Now

$$e_3=V_3-C_1R=V_3-CR-C_5R;\ \ e_4=V_4-C_2R=V_4-CR$$
$$-C_6R;\ \ V_3+V_4=2V;\ \ C_3=C_6-C_5=V_3/R_3$$
$$=-(e_3/e_4+1)C_5;\ \ e_0=V-CR;$$
$$-C_5=\frac{V_3}{R_3}\left(\frac{e_4}{e_3+e_4}\right);\ \ C_6=-\frac{e_3}{e_4}C_5=\frac{V_3}{R_3}\left(\frac{e_3}{e_3+e_4}\right);$$

hence

$$e_3=V_3-CR+\frac{V_3R}{R_3}\left(\frac{e_4}{e_3+e_4}\right);\ \ e_4=V_4-CR-\frac{V_3R}{R_3}\left(\frac{e_3}{e_3+e_4}\right);$$

therefore $$e_3+e_4=2V-2CR-V_3\frac{R}{R_3}\cdot\frac{e_3-e_4}{e_3+e_4}.$$

Inserting this value for e_3+e_4 in the expression derived above gives

$$2V\{e_4/(e_3+e_4)+R_3/R\}$$
$$-\{2V-2CR-V_3R(e_3-e_4)/R_3(e_3+e_4)\}R_3/R$$
$$-(e_3^2+e_4^2)/(e_3+e_4)-CR(1+2R_3/R)=0,$$

which simplifies into $2Ve_4/(e_3+e_4)+V_3(e_3-e_4)/(e_3+e_4)$ $-(e_3^2+e_4^2)/(e_3+e_4)-CR=0,$

and finally becomes

$$V_3/2V=\{-e_4+(e_3+e_4)CR/2V+(e_3^2+e_4^2)/2V\}/(e_3-e_4).$$

Then, since $V_4=2V-V_3$, $V_4/2V=1-V_3/2V$;

hence $V_4/2V=\{e_3-(e_3+e_4)CR/2V-(e_3^2+e_4^2)/2V\}/(e_3-e_4),$

and

$$\frac{V_3}{V_4}=\frac{-e_4+(e_3+e_4)CR/2V+(e_3^2+e_4^2)/2V}{e_3-(e_3+e_4)CR/2V-(e_3^2+e_4^2)/2V}.$$

This can also be expressed in terms of fluxes. For the above equation, obtained by inserting for e_3+e_4, can be written in terms of φ_3 and φ_4, because $e_4/(e_3+e_4)=\varphi_4/(\varphi_3+\varphi_4)$, $(e_3-e_4)/(e_3+e_4)=(\varphi_3+\varphi_4)/(\varphi_3+\varphi_4)$, and $(e_3^2+e_4^2)/(e_3+e_4)$ can be manipulated into an expression containing only φ_3 and φ_4, and quantities other than e_3 and e_4,

for $$\frac{e_3^2+e_4^2}{e_3+e_4}=\frac{e_3^2+e_4^2}{e_3(e_3+e_4)}\times e_3=\frac{\varphi_3^2+\varphi_4^2}{\varphi_3(\varphi_3+\varphi_4)}\times e_3=\frac{\varphi_3^2+\varphi_4^2}{\varphi_3(\varphi_3+\varphi_4)}\times$$

$$\left\{V_3-CR+\frac{V_3R}{R_3}\cdot\frac{e_4}{e_3+e_4}\right\}=\frac{\varphi_3^2+\varphi_4^2}{\varphi_3(\varphi_3+\varphi_4)}\left\{V_3\left(1+\frac{R}{R_3}\cdot\frac{\varphi_4}{\varphi_3+\varphi_4}\right)-CR\right\}.$$

Inserting all these, and simplifying, gives

$$2V\frac{\varphi_4}{\varphi_3+\varphi_4}-CR\frac{\varphi_4(\varphi_3-\varphi_4)}{\varphi_3(\varphi_3+\varphi_4)}-V_3\left(\frac{\varphi_4}{\varphi_3}+\frac{R}{R_3}\cdot\frac{\varphi_4}{\varphi_3}\cdot\frac{\varphi_3^2+\varphi_4^2}{(\varphi_3+\varphi_1)^2}\right)=0,$$

hence

$$2V\varphi_3-CR(\varphi_3-\varphi_4)-V_3\{(\varphi_3+\varphi_4)+R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)\}=0,$$

and

$$V_3/2V=\{\varphi_3-(\varphi_3-\varphi_4)CR/2V\}/\{(\varphi_3+\varphi_4)+R(\varphi_3^2+\varphi_4^2)/$$
$$R_3(\varphi_3+\varphi_4)\}.$$

Hence also

$$V_4/2V=\{\varphi_4+R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)+(\varphi_3-\varphi_4)CR/2V\}/$$
$$\{(\varphi_3+\varphi_4)+R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)\},$$

and

$$\frac{V_3}{V_4}=\frac{\varphi_3-(\varphi_3-\varphi_4)CR/2V}{\varphi_4+R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)+(\varphi_3-\varphi_4)CR/2V}.$$

V_3 is greater than, equal to, or less than, V_4, according as the numerator of the above expression is greater than, equal to, or less than, the denominator; that is, $V_3 > = < V_4$ according as

$$\varphi_3-(\varphi_3-\varphi_4)CR/2V \text{ is } > = < \varphi_4+R(\varphi_3^2+\varphi_4^2)/$$
$$R_3(\varphi_3+\varphi_4)+(\varphi_3-\varphi_4)CR/2V,$$

that is, as

$$(\varphi_3-\varphi_4)(1-CR/V) \text{ is } > = < R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4),$$

or as

$$(1-CR/V)R_3/R \text{ is } > = < (\varphi_3^2+\varphi_4^2)/(\varphi_3^2-\varphi_4^2),$$

which, by the usual rules for ratios, may be written as

$$\frac{(V-CR)R_3/VR+1}{(V-CR)R_3/VR-1} \text{ is } > = < \frac{\varphi_3^2}{\varphi_4^2},$$

or, as $\frac{\varphi_4}{\varphi_3}$ is $<=>\left(\frac{\frac{V-CR}{V}\cdot\frac{R_3}{R}-1}{\frac{V-CR}{V}\cdot\frac{R_3}{R}+1}\right)^{\frac{1}{2}}$ or $\left(\frac{\frac{e_0}{V}\cdot\frac{R_3}{R}-1}{\frac{e_0}{V}\cdot\frac{R_3}{R}+1}\right)^{\frac{1}{2}}$.

For φ_4/φ_3, e_4/e_3 may be written, if desired. This is an important general statement, as it forms the first indication yet reached of a means of knowing whether the more heavily loaded side of the system will have its volts greater than, equal to, or less than, those of the other side, for any given out of balance condition. e_0 is a known characteristic of the set; R is also known. The variable is R_3, and hence an equation is given showing how φ_4/φ_3 must vary with R_3. Calling a system where V_3 is $>=<V_4$ over compounded, level compounded and under compounded respectively, and supposing level compounding to be required in the balancer in Fig. 13, it will be necessary that φ_4/φ_3 be equal to

$$[\{245R_3/250-1\}/\{245R_3/250+1\}]^{\frac{1}{2}}$$
$$=\{(0{\cdot}98R_3-1)/(0{\cdot}98R_3+1)\}^{\frac{1}{2}}.$$

This use of the term compounding as applied to the distributing system is analogous to its use in connection with dynamos, but does not imply anything directly connected with the field windings on the machines, as is evident from its definition, which concerns only the relation of V_3 to V_4.

If R_3 be 10, say, then $\varphi_4/\varphi_3=\sqrt{(8{\cdot}8/10{\cdot}8)}=\sqrt{(0{\cdot}815)}=0{\cdot}9$ very nearly, and if the fluxes be brought to have this relation to each other, so that e_4/e_3 also is equal to 0·9, the system will be level compounded, and $V_3=V_4=250$. Whether $\varphi_4/\varphi_3=0{\cdot}9$ is obtained by hand regulation or otherwise does not matter; the only thing that matters is that the ratio be somehow produced. Once this is so, the speed of the set will go on adjusting itself, and altering the actual values of e_3 and e_4, while keeping e_4/e_3 constant, until e_3 and e_4 become such that the superposed currents C_5 and C_6 are in the correct ratio to give superposed torques which exactly balance. Then the set has reached its new stage, and is once more stable. If φ_4/φ_3 have some other value than 0·9, a similar process goes on, and the set settles at some other speed, with a different ratio between V_3 and V_4, becoming over or under compounded as the case may be. An examination of the expressions for C_5 and C_6 shows why there is a tendency for the set to adjust itself at all. For

$$C_5=-\frac{2V+e_3-e_4}{2(R+2R_3)}+\frac{2e_0-e_3-e_4}{2R},$$

and

$$C_6=+\frac{2V+e_3-e_4}{2(R+2R_3)}+\frac{2e_0-e_3-e_4}{2R}.$$

Thus at the very moment of switching on R_3, while e_0 and e_0 have not yet begun to change, $-C_5=+V(R+2R_3)=C_6$. Now, if e_3 and e_4 are not adjusted in any way, but remain equal to e_0, that is, if the fluxes are not altered, and armature reaction be negligible, $-C_5=C_6$ will remain true always, which means that the torques are already balanced, since $\varphi_3=\varphi_4=\varphi_0$; there is, therefore, no tendency in this special case for the speed to change. This gives the interesting result that if the fields are shunt wound, and connected in series across the outers without any connection to the middle wire, so that $\varphi_3=\varphi_4=\varphi_0$, again neglecting the possible effect of armature reaction, the balancer will run at an absolutely constant speed, no matter what the out of balance current be. If, however, φ_4/φ_3 be not unity, but something less, say, then at the initial moment $-C_5$ will be equal to C_6, but these will not produce balanced torques as the flux ratio ceases to be unity. The generating torque of $-C_5$ will be greater than the motoring torques of C_6, and, unless the change from e_0 and e_0 to e_3 and e_4 due to the change from φ_0 and φ_0 to φ_3 and φ_4 is just of the right amount to alter C_5 and C_6 to values giving balanced torques, the speed of the set, under the influence of the unbalanced torque, will change, accelerating if the nett torque be a motoring one, so reducing C_6 and increasing C_5, and diminishing in the contrary case.

Another means of ascertaining the compounding of the system is furnished by the following relation:—

$$e_3-e_4=V_3-C_1R-V_4+C_2R=V_3-V_4+C_3R,$$

or

$$V_3-V_4=e_3-e_4-C_3R.$$

Hence $V_3>=<V_4$ according as $e_3-e_4>=<C_3R$.

Now if $e_3-e_4=C_3R$ means $V_3=V_4$, V_3 also $=V$, so that e_3-e_4, which is V_3R/R_3, since $C_3=V_3/R_3$, is also, in this case, VR/R_3; and if $e_3-e_4>C_3R$ means $V_3>V_4$, V_3 must be $>V$, so that e_3-e_4, which is now $>V_3R/R_3$, is all the more $>VR/R_3$; and if $e_3-e_4<C_3R$ means $V_3<V_4$, V_3 must be $<V$, so that e_3-e_4, which is now $<V_3R/R_3$, is all the more $<VR/R_3$. Hence another form of $e_3-e_1>=<C_3R$, is $e_3-e_4>=<VR/R_3$.

Another criterion for level compounding only is as follows. It has been shown that

$$\frac{V_3}{V_4}=\frac{-e_4+(e_3+e_4)CR/2V+(e_3^2+e_4^2)/2V}{e_3-(e_3+e_4)CR/2V-(e_3^2+e_4^2)/2V}.$$

Therefore $V_3=V_4$ if

$$-e_4+(e_3+e_4)CR/2V+(e_3^2+e_4^2)/2V=e_3-(e_3+e_4)CR/2V-(e_3^2+e_4^2)/2V,$$

that is, if $\quad -(e_3+e_4)(1-CR/V)=-(e_3^2+e_4^2)/V,$

or, if $\quad (1-CR/V)=(e_3^2+e_4^2)/V(e_3+e_4),$

or, if $\quad (e_3^2+e_4^2)/(e_3+e_4)=V-CR=e_0.$

Inequality of the two sides will show that there is not level compounding, but whether it is over or under compounding is uncertain, because by changing the sign of both numerator and denominator in the expression for V_3/V_4 the correctness of the ratio is not altered, but the subsequent process could thus be made uncertain as regards sign, and this would make it possible to interchange $>$ and $<$ by the introduction of this false relation. The same objection may apply in some cases to the use of the other two criteria already given, but all three will be shown later to be only partial statements of complete equations dealing exactly with all kinds of compounding of the system. Hence, in doubtful cases, there is a complete means of checking the result, but all the criteria are certainly valid for level compounding.

XIII.—VOLTAGE VARIATION WITH CHANGE OF LOAD WITH ROTARY BALANCERS.

The percentage change in voltage between outer and middle wires on the loaded side of the system in Fig. 12 is denoted by q, so that $V_3=V(1+q/100)$.

Hence

$$V_4=2V-V_3=V(1-q/100);\ V_3/V_4=(100+q)/(100-q);$$
$$V_3-V_4=V(2q/100)\ \text{or}\ (V_3-V_4)/V=2q/100,$$

whereas $(V_3-V)/V=q/100$, which shows that the difference between the voltages on the two sides is twice the difference between the voltage on one side and the mean voltage of the two sides.

V_3/V_4 has been expressed in Section XII. in terms of fluxes and other quantities; hence $(100+q)/(100-q)=V_3/V_4=$

$$\frac{\varphi_3-(\varphi_3-\varphi_4)CR/2V}{\varphi_4+R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)+(\varphi_3-\varphi_4)CR/2V}.$$

Hence, by ordinary rules of ratios,

$$q/100=\frac{(\varphi_3-\varphi_4)(1-CR/V)-R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)}{(\varphi_3+\varphi_4)+R(\varphi_3^2+\varphi_4^2)/R_3(\varphi_3+\varphi_4)}$$
$$=\frac{(\varphi_3^2-\varphi_4^2)(1-CR/V)-(\varphi_3^2+\varphi_4^2)R/R_3}{(\varphi_3+\varphi_4)^2+(\varphi_3^2+\varphi_4^2)R/R_3}.$$

Now $1-CR/V=(V-CR)/V=e_0/V$, so that this statement may be put into the form

$$\frac{q}{100}=\frac{(e_0/V-R/R_3)\varphi_3^2-(e_0/V+R/R_3)\varphi_4^2}{(1+R/R_3)\varphi_3^2+2\varphi_3\varphi_4+(1+R/R_3)\varphi_4^2}.$$

Hence, by multiplying across,

$$(e_0/V-R/R_3)\varphi_3^2-(e_0/V+R/R_3)\varphi_4^2$$
$$=(q/100+qR/100R_3)\varphi_3^2+2q\varphi_3\varphi_4/100+(q/100+qR/100R_3)\varphi_4^2,$$

which eventually becomes a quadratic in φ_4/φ_3,

$$\left(\frac{100+q}{100}\cdot\frac{R}{R_3}+\frac{q}{100}+\frac{e_0}{V}\right)\left(\frac{\varphi_4}{\varphi_3}\right)^2+\frac{2q}{100}\cdot\frac{\varphi_4}{\varphi_3}+\left(\frac{100+q}{100}\cdot\frac{R}{R_3}+\frac{q}{100}-\frac{e_0}{V}\right)=0.$$

Hence

$$\frac{\varphi_4}{\varphi_3}=\frac{-\frac{2q}{100}\pm\left\{\frac{4q^2}{100^2}-4\left(\frac{100+q}{100}\cdot\frac{R}{R_3}\right)^2-8\frac{100+q}{100}\cdot\frac{R}{R_3}\cdot\frac{q}{100}-\frac{4q^2}{100^2}+\frac{4e_0^2}{V^2}\right\}^{\frac{1}{2}}}{2\left(\frac{100+q}{100}\cdot\frac{R}{R_3}+\frac{q}{100}+\frac{e_0}{V}\right)}$$

This gives φ_4/φ_3, and hence also e_4/e_3, in terms of known or specified quantities. The expression can be simplified, and for convenience the ratio $\varphi_4/\varphi_3=e_4/e_3$ will be denoted by A.

$$A=\frac{-q\pm[(100e_0/V)^2-2q(100+q)R/R_3-\{(100+q)R/R_3\}^2]^{\frac{1}{2}}}{100e_0/V+q+(100+q)R/R_3}.$$

Now $R_3=V_3/C_3=(100+q)V/100C_3$, hence $(100+q)R/R_3=100C_3R/V$. Inserting this gives

$$A=\frac{-q\pm\{(100e_0/V)^2-2q(100C_3R)/V-(100C_3R/V)^2\}^{\frac{1}{2}}}{+q+100e_0/V+100C_3R/V}.$$

The value of R used must correspond to C_3, and must, therefore, include the value of the brush contact resistance corresponding to C_3. This expression for A gives, in its full form, the criterion for compounding already given in section XII., namely, $V_3>=<V_4$, if φ_4/φ_3, which is A, $<=>$ an expression which is simply the above in an incomplete form. This is evident from an examination of the two formulæ, V_3 being $>=<V_4$ according as q is positive, zero, or negative.

When $V_3=V_4=V$, and thus $q=0$, the two expressions for A become $A=\pm\{(e_0/V-R/R_3)/(e_0/V+R/R_3)\}^{\frac{1}{2}}$, which is the incomplete form previously given, and

$$A=\pm\{(e_0-C_3R)/(e_0+C_3R)\}^{\frac{1}{2}},$$

which is the other form, and is even simpler. Except in the very smallest sets, e_0 is so nearly equal to V that it is often sufficiently correct to calculate from $\pm\{(V-C_3R)/(V+C_3R)\}^{\frac{1}{2}}$ to get A, which saves even the small amount of work involved in finding e_0 from $V-CR$. Thus, the determination of A for level compounding is very simple indeed.

What is given in a specification as regards the compounding of the system is usually the percentage, if any, of over or under compounding at some given value of C_3 in the middle wire, say 5 per cent. at full load, or the like. As the ideal arrangement is straight line compounding, whether level or otherwise, q may be taken as proportional to C_3 directly, for other values than the specified amount, so that q/C_3 is a constant, say, $q=BC_3$. If, say, q is $+4$ per cent. at 40 amperes out of balance, then $B=+1/10$; for level compounding, $B=0$, and so on.

Inserting BC_3 for q gives

$$A=\frac{-BC_3\pm[(100e_0/V)^2-\{2B\,.\,100R/V+(100R/V)^2\}C_3^2]^{\frac{1}{2}}}{+BC_3+100e_0/V+100C_3R/V}.$$

This expression, in its various forms, is one of the most important and comprehensive in the whole theory of the rotary balancer.

In the numerical example, inserting the values gives

$$A=\frac{-BC_3\pm[98^2-\{B\,.\,200/250+(100/250)^2\}C_3^2]^{\frac{1}{2}}}{+BC_3+98+100C_3/250}$$
$$=\frac{-BC_3\pm[9601-\{0{\cdot}8B+0{\cdot}16\}C_3^2]^{\frac{1}{2}}}{+BC_3+98+0{\cdot}4C_3},$$

which shows how to get the ratio of φ_4/φ_3, or e_4/e_3, for any given value of B, as C_3 changes. For level compounding

$$A=\pm[9601-0{\cdot}16C_3^2]^{\frac{1}{2}}/[98+0{\cdot}4C_3]$$
$$=\pm[\{98-0{\cdot}4C_3\}/\{98+0{\cdot}4C_3\}]^{\frac{1}{2}}$$
$$=\pm[\{215-C_3\}/\{215+C_3\}]^{\frac{1}{2}},$$

which is the same as the second form derived above from the expression with q in it; and this simply means that to keep level compounding, the ratio of fluxes must change in the above way as C_3 changes; if this relation be maintained, then φ_4/φ_3 is correct, therefore e_4/e_3 is correct, and speed adjustment as necessary will automatically take place until e_4 and e_3 individually are of the correct values to make $C_5/C_6=-e_4/e_3$, that is, to make the total superposed torque have zero value. The meaning of the $\pm$ sign in A will be examined later.

From previous statements

$C_3=(2V+e_3-e_4)/(R+2R_3)$,

hence $C_3R=-2V_3+2V+e_3-e_4$,

or $e_4=e_3-C_3R-2V_3+2V$,

or $Ae_3=e_3-C_3R-2V_3+2V$.

Hence $e_3=(C_3R+2qV/100)/(1-A)$,

and $e_4=(C_3R+2qV/100)A/(1-A)$,

therefore $e_3-e_4=C_3R+2qV/100$,

which is the full form of another compounding criterion previously given. These expressions, in terms of B, are—

$e_3=C_3(R+2BV/100)/(1-A)$,

$e_4=C_3(R+2BV/100)A/(1-A)$,

and $(e_3-e_4)=C_3(R+2BV/100)$.

The complete form of the third criterion for compounding can be derived as follows :—

$$V_3=\{-2Ve_4+CR(e_3+e_4)+(e_3^2+e_4^2)\}/(e_3-e_4).$$

Hence, $e_3^2+e_4^2=2Ve_4+V_3(e_3-e_4)-CR(e_3+e_4)$,

which, simplified by putting V_3+V_4 for $2V$, and then expressing V_3 and V_4 in terms of V and q, becomes

$e_3^2+e_4^2=(V-CR)(e_3+e_4)+qV(e_3-e_4)/100$,

or $(e_3^2+e_4^2)/(e_3+e_4)=e_0+qV(e_3-e_4)/100(e_3+e_4)$.

It is also possible to relate C_5 and C_6 to C_3 in terms of A, for $A=e_4/e_3=-C_5/C_6$, hence $C_6=-C_5/A$. Now,

$C_3=C_6-C_5=-C_5(1/A+1)$,

hence $C_5=-C_3A/(1+A)$,

and $C_6=+C_3/(1+A)$.

If, then, A is settled in terms of the compounding required, C_5 and C_6 are known, as are also e_3 and e_4, in terms of C_3 and other known or sepcified quantities.

V_3 and V_4 can also be related to A and the other quantities thus :—

$$V_3=e_3+CR+C_5R\,;\quad V_4=e_4+CR+C_6R.$$
$$V_3=C_3(R+2BV/100)/(1-A)+CR-C_3RA/(1+A)$$
$$=C_3\{R(1+A^2)+2BV(1+A)/100\}/(1-A^2)+CR,$$

and
$$V_4=C_3(R+2BV/100)A/(1-A)+CR+C_3R/(1+A)$$
$$=C_3\{R(1+A^2)+2BVA(1+A)/100\}/(1-A^2)+CR.$$

Using the expression just found for V_3, gives

$$V(1+q/100)=C_3R(1+A^2)/(1-A^2)+2qV/100(1+A)+CR.$$

Thus

$$V\{1-q(1+A)/100(1-A)\}-CR=C_3R(1+A^2)/(1-A^2),$$

or
$$e_0=C_3R(1+A^2)/(1-A^2)+qV(1+A)/100(1-A),$$
$$=C_3R(e_3^2+e_4^2)/(e_3^2-e_4^2)+qV(e_3+e_4)/100(e_3-e_4),$$

whence
$$q=\frac{100}{V}\left\{\frac{(e_3^2-e_4^2)e_0-(e_3^2+e_4^2)C_3R}{(e_3+e_4)^2}\right\},$$
$$=\frac{100}{V}\left\{\frac{(1-A^2)e_0-(1+A^2)C_3R}{(1+A)^2}\right\}.$$

A variant of this is derivable from the relation already stated,

$$e_0=(e_3^2+e_4^2)/(e_3+e_4)-qV(e_3-e_4)/100(e_3+e_4),$$

which gives
$$q=\frac{100}{V}\left\{\frac{e_3^2+e_4^2)-(e_3+e_4)e_0}{e_3-e_4}\right\},$$

and still another form is derivable from

$$e_0=C_3R(e_3^2+e_4^2)/(e_3^2-e_4^2)+qV(e_3+e_4)/100(e_3-e_4).$$

Inserting $V(1+q/100)/R_3$ for C_3, and multiplying up, gives
$e_0(e_3^2-e_4^2)R_3=(e_3^2+e_4^2)VR+qV\{(e_3^2+e_4^2)R+(e_3+e_4)^2R_3\}/100$,
whence

$$q=\frac{100}{V}\left\{\frac{(e_3^2-e_4^2)e_0R_3-(e_3^2+e_4^2)VR}{(e_3^2+e_4^2)R+(e_3+e_4)^2R_3}\right\}$$
$$=\frac{100}{V}\left\{\frac{(1-A^2)e_0R_3-(1+A^2)VR}{(1+A^2)R+(1+A)^2R_3}\right\}.$$

Hence, for any given relation of e_3 and e_4, q is determinable in terms of these and other known or specified quantities.

(To be continued.)

THE ORGANISATION OF TRADES.*

BY E. J. P. BENN.

My mission to-night is a very simple one. It can be expressed in a sentence. It is to plead for the organisation of the trades of this country in such a way that the three parties interested—(1) the State, (2) the workman, (3) the capitalist—may be able together to develop them to their fullest extent.

The first question which arises is this: Why bother to organise trade at all? We have done very well in the past, and why not leave things alone?

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* Abstract of a lecture to the London School of Economics, delivered January 18th.

Among the many reasons why improvements must be made are such matters as: Raising revenue, repairing the wastage of war, providing work for all upon demobilisation, and foreign competition.

But among the fundamental and more important reasons are these: The increasing needs of the population demand more goods, and the march of civilisation demands less work, and the two can only be secured by better arrangements.

It is one of our elementary duties to see that in our industrial scheme there is as little as possible of waste of material or effort.

The Interests of the State in Trade.—Before considering the relations of the Government to trade and industry it may be convenient to inquire what is it that the nation wants from trade. We have got into the habit of giving the whole of our mind to side issues like Free Trade and Protection, or work and wages, and it seems to me that we have now to go back a little and consider the primary interests of the nation in industry.

If we take as an example the boot trade—I select boots because I know nothing about them—if we look at the boot trade from a national point of view we find:—

> A few hundred so-called masters, representing a few millions of capital, at present in control of the trade.
>
> Next, there is a much larger body of managers, salesmen, accountants, travellers, shippers, and wholesale and retail shopkeepers.
>
> And last and most important, an army of operatives engaged in the actual work of manufacturing boots.

Looking at the matter from the national point of view only, the best things that can happen are:—

> That the maximum quantity of boots should be produced.
>
> That the proportion of boots to population should be high.
>
> That the largest possible number of pairs of boots should be sent abroad.

That, it seems to me, is the national point of view.

Next, we arrive at a number of secondary considerations, such as foreign competition, involving questions like tariffs, and wages and profits, which are domestic questions as between the different persons in the trade. But the first essential is the production of the maximum quantity.

A further study of the boot industry will show that the small body of masters are able to withdraw their capital and stop production altogether if it suits them to do so. On the other hand, the operatives can call a strike with the same result. Either of these parties may so act as to send the industry, lock, stock and barrel, to Germany or America.

This sort of thing has happened many times. There is no authority which can watch the national interests in these matters. The British boot trade to-day depends upon the accident that a number of capitalists, managers and workpeople will, in their own discretion, think it worth while to engage in the manufacture of boots. I suggest that it is the duty of the Government to make such arrangements that this nation shall occupy a proper place in the boot world. I submit that the maintenance of output in boots, as in everything else, is a proper matter for the consideration of the Government.

The work of the Government in assisting trade and industry should take the form of organisation, direction, or control, rather than of direct intervention in actual trading transactions. The Government should encourage the activities of traders and not attempt to compete with them.

Our trade and commerce is the only part of our national life which is not organised upon a representative basis. The Government should not dabble in trade any more than it dabbles in local affairs. In trading matters the Government ought to prescribe and not dispense. In considering the possibilities of a connection between the State and trade the question of initiative arises. I am frequently told that the first step should come from the trades themselves, and that there ought to be a general demand on the part of trade unions and associations for Government recognition and help. I believe that the initiative must come from the Government. Manufacturers are interested in prices, workpeople are interested in wages, and both have done a great deal to promote their respective objects. I suggest that there is a more important interest in trade than either of these two, the interest of the nation, and that the nation, through the Government, should take active steps to promote that interest.

Trade associations can be divided into two chief classes. First, there are those like the Chamber of Commerce, which is concerned with all trades; and, secondly, the particular trade association which deals with the interests of one particular industry.

Chambers of commerce, federations of industry and other similar bodies are not included in my present argument. When we come to study the trade associations proper we find some thousands of bodies with very varying objects. At the head of the list should be placed a group of strong societies which I class together as price associations, existing admittedly for the simple purpose of the regulation of prices.

Some of these have the most interesting arrangements with labour. The Bedstead Federation is notable in this respect. Not only have they succeeded in satisfying labour with a sliding scale based upon the market price of bedsteads, but they admit the labour leaders to a small share of the control of the industry, and in that way arrange a complete boycott of non-associated firms so far as labour is concerned.

The next most important series consists of associations which have their being simply for the purpose of fighting labour. After these come a variety of bodies, some of them local, some of them national in their activities, and most of them having special objects arising out of the peculiar needs of their particular industries. But the latest and the most interesting trade association is to be found in connection with building. There has within the last few months been established a National Industrial Parliament for the building industry. This body is to have the support of most of the trade unions connected with building, as well as of the masters' associations. It is the most serious and the most promising effort that I have come across for the settlement of outstanding differences between capital and labour. It falls, however, far short of the ideal Trade Council as I conceive that body, in that it appears to have nothing to do with production, with science, with education, with the elimination of waste or the control of competition.

What is Wanted.—It may be convenient at this stage to state exactly my conception of the National Trading Organisation which, in my judgment, the Government ought to bring into being without delay. The basis upon which I build is the trade association and the trade union.

> I would have every manufacturer in a given trade a member of the trade association.
>
> I would require that every workman and workwoman in that trade become a member of the trade union.
>
> And from the two bodies I would construct a Trade Council to which the Government would give a status and responsibility, placing it in much the same position as a local governing body.
>
> Out of these numerous Trade Councils I would elect a National Trades Council, and, presiding over this, I would place a member of the Government specially responsible for the promotion of the trading interests of the country.

Having established Government control of associations, unions, and councils, it then becomes necessary to formulate a scheme of work for the development of each industry. The principal work which lies before these bodies divides itself naturally into six or seven heads: (1) Industrial and scientific research, (2) education, (3) export, (4) statistics and finance, (5) wages and profits, (6) exhibitions and advertising, (7) welfare.

The Government department charged with the control of these Trade Councils would divide itself into six sub-departments, dealing with these six subjects. It would then be necessary for each trade to set up committees and officers to handle each of these same subjects.

As an example, in this way the boot trade would, for the first time in its history, have the advantage of a body of men, paid officials, concerned with the problems of the trade as a whole—not interested in the propserity of any particular firm:—

> Interested only in the production of boots.
>
> Interested to see that British boots were better than any other boots.
>
> Responsible for making certain that the boot industry had the advantage of every fact that was known to science in connection with the manufacture of boots.
>
> Responsible to the nation for the securing of this country's proper proportion of the world's trade in boots.
>
> Responsible to the nation and the trade for the education of the young people who are later to form the masters and the men of the boot trade.
>
> Responsible for the absolute elimination of any waste, overlapping, or inadequate procedure within the industry—

and so on. *In fact, for the first time there would be scope for really great brains in the boot trade.*

The essential element in all these arrangements is the representative principle. The Boot Trade Council or the Boot Parliament would be a properly representative body, always under the necessity of keeping the confidence of its constituents. With the trade on the one hand and the Government on the other it ought to be able to combine the interests of the industry with the interests of the nation.

Some of the writers on this subject consider that the salvation of British trade will come from the amalgamation of businesses. The advantage of the association method over the trust method is that it keeps the little man in being. The little man in trade is a tremendous asset. He is essentially British. His only trouble is that he *will* devote his energies to fighting other little men instead of joining with them in an effort to fight the battles of the nation and to improve himself and his industry. If we can get the advantages of amalgamation or united action without destroying the little man I contend that we shall be all the better. If the little man is organised, if his work is arranged for him, if he is forced to specialise on some one little part of the trade, in which he is engaged, we can, I think, secure the advantages of economical production, which is the main asset of the trust or combine.

In suggesting that the Government should recognise and control trade unions and trade associations I am not overlooking the fact that both of these bodies will probably object to the process. As the price of recognition, and in return for the assistance which it is able to give to an industry, the Government will demand, on the one hand, the abandoning of the independent and irresponsible attitude of the trade union, and, on the other hand, the giving up of those elements in the masters' associations which are contrary to the public interest.

Labour.—Any settlement of the trading problem is out of the question unless the co-operation of labour can be secured. Satisfactory working arrangements with labour can never be made until bodies representing capital and management of equal standing with the trade unions have been brought into existence. The establishment of thoroughly representative trade associations, together with the existing trade unions, would make possible the creation in each industry of governing or controlling bodies composed half of masters and half of men, who could be responsible to the Government for the welfare of each particular trade.

The demands of labour are generally erroneously expressed as demands for money—wages. The workman gets an exaggerated idea of the importance of money, because in his case the bulk of his turnover actually passes through his fingers in the shape of coinage. But the demand of labour is not really for money; it is for boots, beef, bicycles, omnibuses, or any other form of goods or services. These things all necessitate production.

The great brains that are directing the labour movement understand this point, and some interesting changes are noticeable. The claim of labour used to be for money. It then became a demand for a bigger share in the proceeds of industry; and latterly a more advanced plea is put forward for a share in the control of industry.

If we put the problems of production in their order they are, roughly, as follows: (1) Education, (2) the application of science to industry, (3) the elimination of waste, (4) the disposal of the product, (5) wages, (6) profits.

Now, the whole nation is interested in problems (1), (2), (3) and (4). Labour and capital are equally dependent upon their successful solution. Labour and capital are equally entitled to express an opinion with regard to them, and it is not until they are solved that any question of wages or profits can arise.

My demand is on behalf of the nation for the fullest possible development of each industry. My argument is that everyone engaged in that industry ought to be given the opportunity to take a hand in that development. My theory is that this can only be done by the introduction of the representative principle into each trade, and the setting up of authorities for the study and control of the whole trade. On these bodies labour should have an equal voice with capital.

Output.—A comparison of the census of production in this country and America gives some very startling and unpleasant facts. The American produces three times as much as the Englishman. The value produced in the United Kingdom by each worker in the boot and shoe industry per year was £171, in America £516. In cardboard boxes, £106 here and £275 in America. In butter and cheese, here £1,310 and £2,979 in America. In cement, £192 in England and £472 in the States. In clothing the figures are £158 and £481. These startling differences are the direct result of the better organisation of trade in the United States. This is not a matter of tariffs; it is not a matter of wages or profits; it is solely and simply a question of organisation. But in securing maximum output it is not only necessary to employ the best machines and to see that the energies of every worker are utilised to the best advantage; it is also necessary to see that every factory in an industry is employed upon the particular class of work which it can best perform. In the past, so far from studying the possibilities of increasing output, the tendency has been deliberately to restrict output. We have heard a great deal in the last few years about the limitation of output on the part of the trade unions. The iniquities of this system are, in my mind, no worse than the iniquities of the stupid competitive system which forces every manufacturer to attempt to cover the whole of his trade and thus waste half of his energy.

Coming to the question of export, although we have, per head (I am speaking now of pre-war times), the largest export business in the world, the full possibilities of exportation have not yet been realised. It is the greatest folly to rest content with the fact that we happen to be doing more business in this way than others. We have been at it for centuries, others have only just begun; and it would, indeed, be a marvel if after a mere 30 or 40 years either Germany or America were able to show an export position which would compare with ours.

But it is necessary to realise that we are in danger of losing our lead in export matters unless we improve our methods.

The position in regard to any particular industry in a particular foreign market is, roughly, this: The German trade, through its cartel, has a perfect system of representation in that market. There is no competition as between Germans. America is in almost the same position. But Great Britain has nothing but a personal connection between a number of individual manufacturers and a number of individual buyers. Those individual manufacturers are in most cases in direct competition with each other. There is no attempt on the part of that British trade as a whole to study or to capture that market. My contention is that every trade must present a united front to foreign competition.

Another weak spot in English arrangements for foreign representation is that the men who travel for us are not always experts in the goods which they have to sell. If instead of different trades clubbing together to meet the expenses of a foreign representative the custom were for men in the same trade to join hands it would be possible to send to each market an expert in each industry.

To sum up this question of export, the position is that American trusts have done extremely well, that German cartels have done better, and that British co-operation, if it can be brought about, will do best.

I have left until the last the greatest question of all—scientific research. The most important work that will fall to the lot of these Trade Councils will be in connection with the application of science to trade. The arrangements which the Advisory Council have recently made are an exact model of the arrangements which I hope may be made in other departments.

In conclusion, I ask:—

1. That the State shall recognise its duty in connection with the promotion of trade.
2. That duly elected public bodies shall be created, charged with the responsibility of caring for each trade.
3. That both employers and employed shall be represented on those bodies.

Only by some such means as this can the gigantic problem of our trade, with all its details, all its complications, and all the vast national and international interests involved, find a satisfactory and a lasting solution.

DISCUSSION.

The chair was taken by Dr. H. F. Heath, C.B., Secretary of the Committee of the Privy Council for Scientific and Industrial Research, in the absence through indisposition of Sir William McCormick.

Dr. HEATH, in proposing a vote of thanks to Mr. Benn, which was carried by acclamation, congratulated the lecturer on giving a perfectly clear statement in concrete terms of what he believed to be the right steps to be taken towards the organisation of trade. If all public speakers and professors followed that practice our advance in knowledge would be more rapid. In regard to the activities of his (Dr. Heath's) Department, the Advisory Council was an expert body set up by the Government to advise them in connection with the organisation and development of research as a whole. Very early they were impressed with the necessity for some form of co-operation so far as industrial research was concerned. They found a great number of most valuable "engines" for the production of new knowledge in the universities and university institutions, of which that was one, and also a considerable number of distinguished scientific and professional societies also engaged in encouraging research; but neither was able to deal with the largest problems of industrial research, as they had no means of knowing what the trades wanted, and there was no machinery by which the trades could express their desires or even discover them. So, on lines parallel to those of Mr. Benn, the Council came to the conclusion that there was no means of dealing with the needs of the great industries unless they could be induced to come together in co-operation, with the co-operation and good-will of the Government. That conclusion led to Lord Crewe's announcement* and to the decision of the Administration that the plan must be devised for a longer period than 12 months—that annual votes by Parliament would be insufficient and unsuitable for the purpose. The Government placed at the disposal of the Department a large fund to be expended over not less than five years in agreement and consultation with the industries of the country for their benefit, either in the form of capital or maintenance or both, this money to be available for the assistance of associations. There would be other funds for universities, research students and workers, and professional and scientific societies. All those could be dealt with by the ordinary annual vote. The Council was clear that associations must be associations, not of a whole industry, but of particular trades. For instance, the makers of all types of internal combustion engines might form one association. The associations must include the employer, the employé and the man of science (who might be either an employer or employé). The actual guiding body that would spend the money put up by the Government and the associations jointly should include men who understood what research meant and the principles upon which it should be adopted. Provided the associations conformed with the general principles which the Department must stand for, they might also undertake other functions, the scope of which must be decided after experience. A surprising number of such associations were coming into existence. If an association did more than deal with research, the new Government Department would only ask that the funds for research be kept separate.

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* *See* THE ELECTRICIAN, December 8, 1916.

Mr. Benn, in acknowledging the vote of thanks, said he was much indebted to Dr. Heath for coming there at an hour or two's notice, and so kindly giving up his time to taking the chair at that meeting.

THE HIGH-VOLTAGE POTENTIOMETER.*

BY HARRIS J. RYAN.

The potentiometer method for the measurement of alternating voltage duties requires: (1) A distributor of alternating potential, identical in phase and wave form with the alternating potential to be determined; (2) a satisfactory potential difference detector to determine when the known potential from the distributor matches the unknown potential to be measured. For a high-voltage potentiometer at reasonable expense the following types are feasible:—

A source of synchronous variable voltage that matches the voltage to be measured in phase and wave form; requires a phase-shifting transformer and an induction regulator or a suitable multiple-tap transformer.

A condenser connected to the high-voltage source having a variable potential feature as follows: A fluid dielectric and a potential tapping plate electrode that may be moved to any position between the main electrodes of the condenser, or a series of electrode potential plates mounted in the dielectric between the main electrodes at uniform intervals.

A chain of equal water resistances connected across the same high-voltage source as the test specimen from which any required potential may be tapped.

There are two types of detector available: the sparking probe; the Bennet small current oscillograph.†

In the sparking probe detector advantage is taken of the fact that a spark occurs at a pointed electrode when used to connect two condensers charged to different potentials (even when the capacitances and differences of potentials are small). In the Bennet detector an oscillograph with suitable auxiliary equipment is used to observe the charging current taken by the insulator system under observation, and to note when the potential applied to a conductor is such that it may be brought in contact with a metal part of the insulator system without disturbing the normal value of such charging current.

It has been found that the water resistance distributor and the probe detector constitute a convenient and reliable high-voltage potentiometer that may be constructed of common materials with ordinarily skilled labour at small cost. A column of water moving slowly through an ample length of garden hose constitutes the resistance. The author has used 1 ft. of hose per 1,000 maximum range effective volts. Tapping-in points from which to connect the cable leading to the probe are provided by breaking the hose at regular intervals and connecting it with a plain metal connector. The hose is of the common ¾-in. variety, 75 ft. long, in 50 sections of 18 in. each. It is formed into a cylindrical helix of 12½ turns on a diameter so as to use four sections per turn and so as to make corresponding metal connectors line up in four columns on the surface of the helix-cylinder. The turns are spaced, insulated and held together by strain insulators and light galvanised steel strands located at the metal connectors. The hose starts at the bottom from one branch of a supporting cross formed of ¾-in. galvanized iron pipe and a five-way fence-pipe fitting. It ends at the top in a branch of a duplicate pipe structure. The bottom end is attached to the water supply. The branch of the top cross is connected to one of the high-voltage source terminals and extended horizontally to a convenient distance, 5 ft., and terminated downward in a common sprinkler nozzle.

One of the four columns formed by the strain insulators is selected for mounting the tapping-in terminals of the conductors that lead through the interior of the helix to their corresponding metal hose connectors. These tap conductors are made of No. 10, B. & S. gauge galvanized steel wire. To make probe connecting terminals at the outer ends of these tapping wires, such ends are formed into nearly complete rings finished with eyes and clamped with small bolts in proper order around the strain insulators.

Ordinarily 75 kv. will set up about 50 milliamperes through this distributor. This current should always be large in comparison with the charging current that passes from the probe cable to surrounding objects. The length of the cable used with this distributor is 10 ft. Its capacitance to earth does not exceed 0·000025 mfd. The charging current liberated from it at 75 kv. to earth is, therefore, not more than seven-tenths of a milliampere.

Experience with the transformer and condenser types of distributor shows that the water resistance distributor yields reliable results. No great accuracy is claimed for the outfit. It is intended only for those studies in which the results are not required to be known within 2 or 3 per cent. of their actual values.

The potentiometer may be used to determine the potential of any outline or surface of an insulation system whereat or where-on a metal wire or sheet may be mounted and to which the potential probe can be applied. Such wire or sheet is called the insulator potential electrode. In general the capacitance of the insulator potential electrode is relatively small. The presence of the probe may, therefore, be such as to alter the potential of the electrode somewhat, but the only result is to widen the zone of potential through which the detector indicates an equally good balance. This effect occurs alike above and below the true potential of the insulator electrode and is eliminated by reading at the middle of the potential balance zone. The true balance must often fall between the potential taps as actually provided in the distributor. This is an additional cause that generally prevents a tap being found at which absolutely no probing spark is discernable in full darkness.

It is believed that anyone whose general training and experience have prepared them to take up work of the present character will have no difficulty in learning quickly from their own perceptions and efforts the correct procedure for this sort of potentiometer. Obviously two persons must work together to apply it. One handles the probe and the other handles the probe cable from tap to tap in the distributor until a potential balance is found. The probe and tap ends of the probe cable are each handled at the end of a suitable stick of clear quality wood, such as redwood, white pine or poplar, impregnated with paraffin as a precaution against the absorption of water. In work upon such insulation systems as a suspension type insulator the person or the operator should be as distant as possible and permit of the proper handling of the probe in order that the electric field about the insulator and therefore the voltage duties of its parts will not be disturbed. It is thought unnecessary to point out the many expedients that may be employed in locating and mounting insulator potential electrodes so as to explore the intensity of the electric fields in the air, oil or within the solid dielectrics of any system of insulation. These will promptly suggest themselves to anyone accustomed to such work.

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* Abstract of a Paper read before the Proceedings of the American Institute of Electrical Engineers.

† "Distributing Potential over a String of Insulators." By J. L. Brenneman and Harold M. Crothers. "Electrical World," Vol. LXIV., Dec. 5, 1914, p. 1095.

A Curious Electromagnetic Phenomenon.—In "Metallurgical and Chemical Engineering" E. F. Northrup describes a curious effect noted in an electromagnet with a wire core. When subjected to a heavy alternating current the wires at the centre of the core began to creep forward out of the solenoid until finally the extremity of the core instead of being flat became conical. By giving one of the wires a slight twist in one direction or the other the extended cone of wires could be made to form at either end of the solenoid. The core thus appeared to be in unstable equilibrium, the direction of motion being determined by a slight mechanical displacement. The effect can also be illustrated by making the core in two sections a central iron rod in a surrounding iron cylinder. The central core is free to move, and on suddenly applying a direct current, jumps completely out of the solenoid and takes up a position in prolongation of the cylinder wall. The motion is quicker than the eye can follow. On the other hand, it is found that if the diameter of the movable core be nearly equal to the diameter of the immovable position the former tends to be sucked into the solenoid. By suitably proportioning the movable and immovable portions of the core, a neutral condition could be obtained, the central portion being neither drawn in nor projected. A similar result could be obtained by increasing the magnetic permeability of the fixed core, as compared with that of the movable portion.

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TRADE ORGANISATION.

Of the many important matters before us in these days trade organisation is one of the most vital. By trade organisation we mean trade in its broadest sense, embracing all our industries and, therefore, the means of production. So long as we are a nation of manufacturers and traders our national well-being is bound up with this subject, and consequently ample discussion thereon is highly desirable.

The latest contribution to the question is by Mr. E. J. P. BENN, who last week delivered a lecture before the London School of Economics. From the abstract which we give elsewhere it will be seen that the underlying idea consists in a partnership between the manufacturer, the workman and the State. Mr. BENN would have every manufacturer a member of the trade association of his particular trade, and every workman a member of a trade union; from these various associations and trade unions he would construct trade councils, to which the Government would give a status, and from these numerous trade councils he would elect a National Trades Council, over which would be placed a member of the Government especially responsible for the promotion of the trading interests of the country. The idea of combination between capital and labour by means of such councils has been already advanced from time to time, more particularly by the Garton Foundation, but Mr. BENN goes further than this, and suggests that the Government should take a hand in the matter. In other words, the Government is no longer to be a passive looker on, merely a collector of revenue, but is to take an active part in the promotion of trade.

With this sentiment on the broadest possible lines we have no doubt that many will agree. It is this idea that has brought forward such an insistent demand for a Ministry of Commerce. The only point that may be questioned is how far it is desirable that the State should intervene. Mr. BENN makes it clear that the sphere of the Government should not consist of direct intervention with actual trade transactions, but that the State should assist trade and industry by means of trade organisation, direction or control. This is important, for interference by the State may lead to serious difficulties.

We suppose the chief difficulty in bringing about this kind of arrangement is that in general there are two main parties to be considered—namely, the employer and the employés. Both these parties wish to do the best for themselves, and in this process they are inclined to forget the benefits desired by the other party, or what is advantageous to the industry as a whole. Any particular industry may also ask the question, "Who is the State?" From their point of view the State consists largely of other people who know nothing, and care less, about their particular business, except in so far as they wish to have their particular product cheaply. From the point of view of cheapness the desire of the "other people" might be to insist on restrictions being placed on the minority, but it is clear that if an industry is to flourish, anything in the shape of irksome restrictions must not be applied. Rightly or wrongly the keynote of Great Britain is individual freedom, and the principle applies equally to organisations considered as individuals; therefore, it is generally a case of leading rather than driving. This attitude of mind has been particularly noticeable during the present war, where it has been seen that the Government has often refused to take the initiative, and has waited to be almost forced by public opinion. In other words, the elected Government looks upon the general population of the country as the actual Government, which it is intended to be, though whether lack of leading is always beneficial is open to question. Bearing in mind this national characteristic, when Mr. BENN suggests that the initiative should come from the Government we feel that it would be necessary for the initiative to be of a somewhat modest kind. Anything in the nature of interference would probably be resented, but, on the other hand, much good should come of any real effort by the Government to be of serious use to manufacturers and traders. One of the troubles is, as has frequently been pointed out, that Parliament mostly consists of politicians and not of people who are keenly interested in manufacture or trade; consequently, such problems are not handled in an efficient way. There seems to be no reason, however, why the Government should not make an effort to bring both capital and labour together, and to see what can be done for the benefit of both these essential partners, and for the benefit of each particular trade as a whole. As Mr. BENN rightly says, from the point of view of the State it is important that each trade should flourish to the maximum possible extent, and there is something wrong in our affairs when it is possible for either the masters or the men to do incalculable harm to a particular trade through labour disputes.

The suggestion is that the Government should recognise and control both trade unions and trade associations, and in return for this assistance the trade union must give up its independent and irresponsible attitude, while the masters' association must give up those elements which are contrary to the public interest. It is there, no doubt, that the rub will come. A vast deal of education must be carried out before such privileges will be abandoned, but something has already been done towards this end. One difficulty, which must not be forgotten, is that we are in competition with other parts of the world where the conditions are entirely different, and there is also the fact that capital will only flow where there is sufficient inducement. The only way of overcoming the latter difficulty, if the inducement is insufficient, is for the State to enter into trade, which course is generally recognised as a sure road to national bankruptcy.

The view that the demand of labour is not really for money is one which we think is scarcely tenable. The demand for money may be converted into a demand for the necessaries and luxuries of life, but in so doing we come back to the old plan of barter. Money in itself is only a medium for transactions, and the main thing is to be able to get as much as possible in exchange for a given amount of the medium. The amount of money in itself has not any definite meaning unless its purchasing value is expressed, and in this respect it may be said that it is quite as advantageous for the working classes to ask for cheap production as for high wages.

We fully agree with the plea that is put forward for the "little man." He is undoubtedly an asset (as the electrical industry has already proved), owing to the desirability of individualism, which is one of our strong points, but unless he is sufficiently strong financially he is a source of weakness to his trade as a whole. From this point of view there should be more combination, and also more specialising, though it is probably a mistake to carry this to the extreme.

In conclusion, we may say that we hope the Government will do very much more in the future than in the past to assist trade in this country on some such lines as are laid down by Mr. Benn, and, provided that such matters are taken up in full consultation with the trades concerned, we do not doubt that the initiative of the Government would be fully appreciated and would lead to far-reaching results.

REVIEWS.

[Copies of the undermentioned works can be had from The Electrician Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Mechanical Engineers' Handbook. Edited by Lionel S. Marks. (London: Hill Publishing Co.) Pp. xxxiii.+1,836. 21s. net.

This new handbook is based on the "Hütte"—a three-volume German book, now in its twenty-second edition. Like the "Standard Handbook for Electrical Engineers," the new handbook is the work of a large number of contributors. Thus for an adequate handling of the section devoted to "Properties of Engineering Materials" it was found desirable to enlist the services of no less than 13 specialists. To ensure sufficiently specialised knowledge, and to be certain that the practice is truly representative, a number of the contributions which deal with engineering practice were submitted to one or more specialists for criticism and suggestions.

In looking through the book one is impressed by the vast mass of engineering theory and practice compressed into its pages, and by the care that has obviously been taken to secure accuracy. Although of American origin, the book is likely to be used by many British engineers, and for this reason we think that reference could, with advantage, have been made to the work of the British Engineering Standards Committee.

Of the 15 sections into which the book is divided the first five are devoted to Mathematical Tables, Mathematics, Mechanics, Heat and Strength of Materials. These sections are well balanced. Section 6 on "Materials of Engineering," referred to above, forms an up-to-date treatise on the subject and covers a very wide field. The next section deals with Machine Elements, and although a good deal of ground is covered, the treatment is not, in our opinion, sufficiently broad. This also applies to Sections 9, 10 and 12, which deal respectively with Hoisting and Conveying, Transportation and Machine-shop Practice. Section 8, on "Power Generation," contains a large amount of useful matter arranged in such a way that it can be found easily. The eight contributors responsible for the ninth section, "Building Construction and Equipment," are to be congratulated on the excellence of their work. It is seldom that one finds useful tabloid information on the construction and equipment of factory buildings in mechanical engineers' handbooks.

The remaining three sections deal with Pumps and Compressors, Electrical Engineering, Measurements and Miscellaneous Subjects. In some respects we think it would have been preferable not to employ learned "electrical" men for the section on electrical engineering. Although no fault can be found either with the matter or method, in our opinion the greater part of the section is likely to be more useful to electrical engineers than to mechanical engineers. As a rule the latter require information of an elementary kind, such as the reading and making of diagrams of connections, simple jointing, the care and management of machines, motor starting and control, localisation of faults, elementary testing and so forth.

The book is a worthy companion to the "Standard Handbook" by the same firm, and in all likelihood it will be as popular as the "Hütte." When the next edition is called for it will be an easy matter, if found desirable, to remove the minor blemishes to which we have referred. The index is very complete and is well arranged, and the press work is excellent.

Eclipse or Empire. By H. B. Gray, D.D., and S. Turner. (London: Nisbet & Co., Ltd.) Pp. x.+316. 2s. net.

Of all the books published during the war this book is probably the most striking. After reading the book we are surprised that it was not publicly burned by those who, not daring to face the truth themselves, profess to be angry with those of their fellow men who are less cowardly. Being strikingly true, the picture will appear to be over-drawn to the majority of the people of this country.

Long before "Eclipse or Empire" was published the lesson of our unpreparedness was brought home to us, and with feverish haste we set about reforming ourselves. As a nation of engineers and craftsmen we allowed many of our fittest men to be sacrificed for want of war material. When one of the few patriots, who think less of their pockets than of their country, drew attention to our ineptitude, he was anathematised. Nevertheless we acted on the suggestions which we affected to despise; and later we imagine that we shall be subscribing to memorials if we be as honest as we claim to be.

The many committees of successful business men doing useful work without seeking publicity is a sure sign that reforms are taking place and that reforms will take place in the future. Notwithstanding the truly awful mismanagement, the fact that we can supply ourselves and our allies with manufactured goods and maintain our exports at a satisfactory level shows that reforms are taking place in industry. The appointment of an expert on education at the Board of Education leads to the belief that something may be done to unravel the education muddle. But we fail to see what good can be done in higher education even by an expert as long as the colleges and schools are allowed to remain empty.

This book shows us what we are; what we might be, and what we shall be unless we take heed. Such being the case, it will be read, or should be read, eagerly by all classes of the community, including Members of Parliament.

The Fan: Including the Theory and Practice of Centrifugal and Axial Fans. By C. H. Innes, M.A. Revised by W. M. Wallace and F. R. Jolley. (London: The Technical Publishing Co., Ltd.) 2nd edition. Pp. viii.+302. 8s. 6d. net.

The first edition, of this book appeared about 12 years ago, and the present edition the second, has been thoroughly revised by Messrs. W. M. Wallace and F. R. Jolley. Various alterations and expansions of the text have been made; the calculations have been checked, and a revised and uniform system of notation has been adopted.

Of the new matter, that dealing with recent practice in the construction of fans and centrifugal compressors in Chapter XIII. is noteworthy. The book deserves to be carefully studied by all those interested in the theory and practice of centrifugal and axial fans.

THE LUMEN AS A MEASURE OF ILLUMINATING POWER.

At a meeting of the Illuminating Engineering Society, held at the Royal Society of Arts on Tuesday, Jan. 16th, a discussion on the above subject was opened by Prof. J. T. Morris. Mr. A. P. Trotter was in the chair.

Prof. Morris pointed out that the distribution of light from illuminants could now be varied so widely by the use of suitable globes and reflectors that the only proper basis of comparison was in terms of the total light in all directions. It had been suggested that lamps should be rated in terms of mean spherical candle-power, but this would involve giving most lamps a smaller rating than at present, which was inconvenient commercially. In addition, the mean spherical candle-power was an imaginary quantity, somewhat difficult of conception.

In the report of the Committee of the American Illuminating Engineering Society on Nomenclature and Standards presented at the Convention last September, it had been definitely specified that illuminants should be rated in terms of lumens in the future, and it was understood that this decision would be adopted and put into practice by the lamp makers in the United States.

In this country, also, the makers of electric lamps contemplated adopting the lumen, though it might be necessary also to state candle-power values and to show their relation to lumen values during the transition period. The time was therefore ripe for the Illuminating

Engineering Society to consider this matter. The use of the lumen in connection with illuminating engineering calculations had several advantages. For example, if the lumens, in each zone from a lighting unit were tabulated the addition of these values gave the total output of light, *i.e.*, the total flux of light produced by the unit; this could be at once compared with the corresponding output in lumens of the lamp used in the lighting appliance (globe, reflector, &c.), and the efficiency of the latter readily ascertained.

It was also convenient to work with lumens in the usual formulæ for determining the average illumination in a room resulting from a given arrangement of lamps, and particularly when the approximate average illumination over an area needed to be quickly determined. It also assisted calculation of the illumination derived from extensive illuminated surfaces, such as occurred in the case of indirect lighting.

Mr. F. W. Willcox, who followed, illustrated the diversity in polar curves of light distribution of modern illuminants by a large number of diagrams. The lumen, he said, was a term that could be readily adopted by the Latin races as well as the Anglo-Saxon, and was, therefore, well adapted to international requirements. The term was originally proposed by Prof. A. Blondel, and had now been adopted by the American Illuminating Engineering Society, the Association of Edison Illuminating companies in the United States, the National Electric Light Association and other bodies.

Although at first unfamiliar, the general use of this method of rating would ultimately be much more convenient. Besides being the most scientific basis of comparison, the use of the lumen would simplify the formulæ used in calculations. This simple equation for determining the number of lamps required to light a given area was as follows:—

$$\text{Number of lamps} = \frac{\text{Floor area in sq. ft.} \times \text{illumination in ft. candles}}{\text{"utilisation efficiency" as a decimal} \times \text{lumens per lamp}},$$

the utilisation efficiency being a factor depending on the arrangement and type of lighting appliance used. It would remove several opportunities for misunderstanding and misrepresentation which arise through statements of the candle-power from lamps in a single direction only. In addition, as Prof. Morris had mentioned, if the values of lumens were tabulated, one avoided the complexities of the Rousseau diagram. A glance at such a table gave a true impression of the total output of light, whereas, as was well known, the popular impression that the amount of light from a source was represented by the area of the polar curve of light distribution was quite wrong, and was hard to eradicate.

Finally Mr. Willcox stated that the lumen was now being adopted by a number of lamp manufacturing companies in Great Britain, and by makers of reflectors. Naturally it would be necessary to take special measures to make this method of rating familiar to the public, and no better work could be undertaken by the Society than the preparation of a pamphlet explaining, in popular language, the lumen and its application.

DISCUSSION.

In the discussion Mr. S. H. Callow, Mr. A. Blok, Mr. E. Stroud, Mr. G. Campbell and others expressed their recognition of the advantages of the lumen rating, and Mr. Blok specially emphasised the need for the preparation of a clearly worded pamphlet in order to popularise the term.

Mr. J. G. Clark thought that in any case it would still be necessary to have polar curves of light distribution, in addition to tables of lumen values.

Mr. L. Rabinovitch, as a lamp maker, was inclined to think that it would be sufficient if makers invariably furnished the reduction factor enabling mean spherical candle-power of lamps to be obtained, if the mean horizontal candle power was known.

Mr. J. G. Dow agreed that from the scientific standpoint there was no doubt that the lumen was the preferable unit. The only question was how to make the term a familiar one, and lamp makers would have to recognise and meet the difficulty. Mr. Dow also gave some examples of the convenience of the lumen in calculations with beams from searchlights and optical lanterns.

Mr. Gaster, in referring to an article urging the need for precise definition of illuminating power of electric lamps in "The Times" of about 50 years ago, said that the present was a favourable opportunity for bringing about a common basis of rating. He hoped that the conception of flux of light would be favourably considered by makers of lamps generally, and the Society would be very glad to help by drawing up a popular description or pamphlet with a view to making the term more generally understood.

Mr. A. P. Trotter, in winding up the discussion, emphasised the desirability of formulating a more satisfactory definition of the lumen.

Prof. Morris and Mr. Willcox briefly replied to some of the points raised in the discussion, and the Chairman announced that the next meeting of the Society would be held on Jan. 20th, when Dr. James Kerr would read a Paper on "The Eye in Relation to Practical Lighting Problems."

A DECIMAL MONEY SYSTEM.*

A Plea for the Pound.

BY JOHN JOHNSTON, M.A., LL.B.

There can surely be no doubt as to what should be the basis of this system if the extent to which banking and other more or less large financial transactions enter into the very life of the nation is taken into consideration. It is said that the poor man would find it difficult if a small difference was made in the value of the penny: the poor man, however, would be in no great difficulty, and would always be able to get explained to him anything he might not know.†

But any change that would affect the value of the pound would lead to absolute confusion in the accounts and the business of the banks, wholesale and retail traders and industrial companies of every kind. Even the smallest shopkeeper, who has hitherto looked on the pound as his unit when his takings get large enough, would be greatly inconvenienced if there was any difference in its value. And it must be remembered that Britain has many large investments in many parts of the world. If there is any misunderstanding, any dispute as to what amount of money ought to be paid, those who are to receive the money are always in the worst position. Bismarck said—referring to a very different matter—"*Beati sunt possidentes.*" The loss to the country would be great if any change was made in the value of the pound.

In a recent issue of The Electrician there was a proposal by Mr. G. O. Parsons to make the shilling the basis. This would cause a large amount of unnecessary calculation to the very large number of the people of these islands who make their accounts in pounds. If they adopted the new system they would have to use many more figures than now, and, if they did not adopt it, they would have to be continually multipliyng and dividing by 20. Such a proposal, moreover, would not get over the difficulty of the poor man—the alteration in the value of the penny, half-penny, farthing and any coins depending on any of these, such as the sixpence. Mr. Parsons' system would, on the contrary, give the poor man a lot of coins which were absolutely new to him.

A decimal system based on the pound would make use of the present florin, and would have a new coin of the value of one-tenth of the florin. This would be equal in value to two and two-fifths of the present pennies or two and a half of the suggested new pennies. It will be convenient in what follows here to call this new coin a "hund"—as being a contraction of "hundredth"—though probably some better name could be found for it. There would be the shilling—which would have its present value of half a florin. And there would be a two-hund piece, and also a half-hund—equal to five of the new farthings. One penny would be equal to four of these farthings, and one half-penny to two. The penny, half-penny and farthing would each have twenty-four twenty-fifths of its present value. The value of the farthing would be one-tenth of that of the hund and one-hundredth of that of the florin. The sixpence, threepence, half-crown and crown would remain in the meantime, but the sixpence and threepence would each have only twenty-four twenty-fifths of its present value. This system was described in full by the writer in an article in the "Westminster Review" for March, 1913.

In calculations there would be pounds, florins, hunds and farthings. A penny would be taken down as four farthings, a half-hund as five farthings, a shilling as five hunds or fifty farthings, a half-crown as one florin, two hunds and five farthings, or as 125 farthings, a crown as two florins and five hunds, or as 250 farthings, and a half-sovereign as five florins. All this would be similar to the present practice of taking down a half-sovereign as ten shillings, and a half-crown as two shillings and sixpence. The threepence, sixpence, half-crown and crown are not the most suitable coins for a decimal system, but their retention for a while would tend to lessen some of the difficulties which would be caused by the change of coinage. The threepence, sixpence, half-crown, and perhaps the crown, might be abolished afterwards—when the nation had got accustomed to the new system.

The following remarks may be quoted (with a few alterations and omissions) from the "Westminster Review" article to which reference has been made:—"In taking down under this decimal system the sums represented by some of the coins which have just been mentioned, more figures would be necessary than under the present system. This is because these coins are, to a more or less extent, unsuitable for this decimal system. If the sums were not exactly represented by these coins—if they were a little more or a little less—they could be taken down more simply by the decimal system. Thus 5½d. would be taken down as two hunds, two farthings, or as 22 farthings, and 6½d. as two hunds, six farthings, or as 26 farthings. Mixed sums could, as a general rule, be taken down more simply by the decimal system than by the present one. £1. 13s. 7½d. would be taken down as one pound, six florins and eight hunds, or as one pound, 68 hunds; £1. 16s. 2½d. as one pound, eight florins and one hund, or as one pound, 81 hunds; and £1. 19s. 11¾d. as one pound, nine florins, nine hunds, and seven farthings, or as one pound, 997 farthings. In no case would any sum under one pound require more than three figures. (The pence, half-pence and farthings in the above-mentioned sums are the proposed new ones—equal in value to twenty-four twenty-fifths of the present ones, and the shillings are worth 12½d.)

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* A decimal coinage has, it need hardly be said, nothing whatever to do, either directly or indirectly, with a decimal system of weights and measures, whether such a system is the metric one or any other. There are overwhelming reasons against the adoption of the metric system of weights and measures by this country. Our present weights and measures should be simplified and decimalised.

† People could be got to understand easily that the pennies, &c., were of very slightly less value than now—almost of the same value. When they were told that 12½d. was equal in value to 1s. and 25d. to one florin they would understand the difference.

"People might, if they wished, have headings on their money columns as at present, but instead of £ s. d. they would have £ f. h. f., and they might place the numbers relating to each denomination in a separate column (with perpendicular lines to divide the columns), or place marks between pounds, florins, hunds and farthings, instead of between pounds, shillings and pence. They would, however, find it much easier, when adding or multiplying, to divide always by 10 than by four and by 12 and by 20, and, when dividing, to multiply by 10 instead of by these other numbers. But the vast majority of people would soon dispense with such headings and columns and marks. They would place the sign of pounds at the beginning and at the end of a calculation, with a decimal point after every number relating to pounds, and in the case of sums under one pound they would arrange the figures in these in their right positions. Thus, one pound, two florins, three hunds and four farthings would be written down as £1·234, and two florins three hunds as £0·23. If this last sum was by itself it might be written as f.2·3. In banks these sums might be called "One point two hundred and thirty-four," and "point twenty-three." By the public generally they might be called "One pound, two hundred and thirty-four farthings," and "two hundred and thirty farthings." This would be similar to the practice in the United States of seldom using any terms but "dollars" and "cents" when mentioning sums of money. Time alone would show to what extent the names of the intermediate coins—florins and hunds or whatever these latter were called—would be used. £1·234 would be seen at a glance to be equal to 1,234 farthings, or 123 hunds, four farthings, or 12 florins 34 farthings or one pound 234 farthings, or one pound 23 hunds, four farthings, &c.

"Such a system would be fairer than the present one as between payers and receivers of money, since division beyond farthings could be carried so very easily. At present, if division is carried beyond farthings, unwieldy fractions of different denominations have to be dealt with, and, if it is not so carried, more or less error must result.

"In order that as little difficulty and inconvenience as possible might be caused by the changes it would be advisable that they should not be made all at the same time. There are various ways in which the transition period might be got over. Perhaps the first change should be the alteration of the penny, halfpenny, farthing, threepence and sixpence. These coins all depend upon the penny, and it would be best to deal with them all together. The coins of these denominations at present in use would be withdrawn as soon as possible from circulation. The shilling would then be equal to 50 farthings or 12½d., the florin to 25 pence, the half-crown to two shillings and sixpence farthing, or to 31¼d., and the crown to two florins and one shilling, and any new coins of these denominations which were issued should have on them their equivalents in farthings. Financial and commercial men could now use the decimal system in their calculations by simply adding, subtracting, &c., pounds, florins and farthings. The next change which might be made is the introduction of the new coin, equal in value to one-tenth of a florin. Afterwards the coin double the value of this one and the coin half of its value might be introduced. Soon after this the threepences might be withdrawn from circulation, and, perhaps, the sixpences not long afterwards."

It will be observed that in this system there is only one new coin name—that of the coin of the value of one-tenth of a florin. It seems to be advisable to keep the old names of penny, half-penny and farthing, since to do away with these would cause difficulty to many people. To introduce the word "cent" would certainly result in confusion with the American cent—which would be of a different value from either Mr. Parsons' or Mr. Allcock's cent.

Moreover, gold must be the basis of international exchange between Britain and the other chief countries in the world, since gold is the standard of value in Britain and in such other countries. Florins and shillings in Britain are only token money; they have in them a smaller quantity of silver then they could buy in the market; and the Government could at any moment make this quantity smaller still. A florin and a shilling have always the values of certain definite parts of a pound, however much the price of silver may vary. Mr. Allcock's system makes the florin the basis—the unit of calculation—in this country, and, according to his system, the pound can remain as the basis of international exchange. To make the unit of calculation in this country different from the coin which is the basis of international exchange would cause needless calculation and great inconvenience in other ways, and no good could result from it.

Mr. Parsons refers to the rate of exchange between Britain and other countries as varying from day to day, and he seems to conclude from this that the gold standard gives no real basis of exchange. The rate of exchange varies according to the amounts of money which have to be sent to and from Britain and other countries. But the cost of changing the money of one gold-standard country for the money of another will never be greater than the cost of sending gold to the latter country (if there is gold to send)—along with, in some cases, the cost of coining, which is always small. With gold the standard of value and, consequently, the basis of international exchange, everything is fixed in such a way that the variations just mentioned can never be great. There are some silver-standard countries—very few now—and some have an inconvertible paper currency based on silver. The rate of exchange between gold standard countries and such other countries will vary as the result of various factors coming into play—among other things, the price (the gold-value) of silver.

It is clear that no coin that is merely token-money can be the basis of international exchange. If the shilling were made such a basis the British Government could at any time flood the country with shillings with practically no silver in them, and could take away the fixed relation between shillings and sovereigns. The shillings would at once lose much of their purchasing power, and a very much greater number than 20 would have to be given in exchange for one sovereign. But international contracts expressed in terms of shillings could be carried out by these shillings being given.

Mr. Parsons, however, states that on the day appointed for the change of system the sovereign would become automatically the 20s. piece, and in a few months would lose its former identity both at home and abroad. And in his letter in THE ELECTRICIAN of January 19th he states that "if we adopt a token coin as a unit, then for international exchange the sovereign as a measure of value is as dead as mutton," and that "if it is necessary to maintain the single sovereign as our measure of value, we must make it the basis of our system." Mr. Parsons evidently does not wish to maintain the sovereign as our measure of value. Does he think that Britain should abandon the gold standard and adopt a silver one? Or does he think that Britain can do without any?

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

In my last letter I note, that by a clerical error, the sovereign is represented as being about the mean of the units used in Europe. Of course I intended to say that the shilling held this position.

Mr. Allcock champions the florin which has been chosen by the Decimal Association. Now the real objection to the rationalisation of our coinage lies in the trouble to which the nation must be put during the change. Once this has been overcome, almost any of the well-known units would answer very well. It is not the bankers and high financiers who stand in the way. They can easily adapt themselves to any change: indeed if we had only to consider them, our choice would probably be the dollar of 100 halfpennies, or perhaps the franc of 10d. Either of these would exactly interchange with existing coins, and either would form an admirable basis for foreign trading.

The real obstacle is the man (and woman) in the street, for one cannot expect Parliament to pass the necessary Bill until they are sure that these important people will be satisfied. The shilling unit has the immense advantage that it gives the least trouble in converting from one basis to another, for we must remember that at first, everyone will think in the old system and convert to the new. Besides, the old coins will not be removed from the market for about two years after the change is made.

For instance, how is Mr. Allcock going to get old ladies to understand that 7s. 6d. becomes F.3·75, and that the change from half a sovereign is F.1·25? Or again if a man's wages come to £1. 19s. 3d., how is Mr. Allcock going to persuade him to take F.19·63? In the florin system, 1s. 3d. becomes 63 cents, 2s. 11d. becomes F.1·45, and 9s. 9d. becomes F.4·87, or at any rate somewhere about these figures. To see a ticket clerk on an excursion day, just after the alteration was made, when the poor man was trying to deal with a mixture of old and new coins, and also trying to persuade the passengers that their change was right, would be a sight worth seeing. The payment of wages at a big works would also involve friendly discussions between men and pay clerks. One may add that people would not fail to notice that penny fares in trams and trains, and pennyworths generally had gone up by 20 per cent., which would involve further friendly discussions with regard to remuneration of employees.

Now take these figures with the shilling unit. 7s. 6d. becomes S 7·50. Change from half a sovereign becomes two shillings and fifty. £1. 19s. 3d. becomes 39·25. As the man already speaks of his wages as 39 shillings and 3d. he has only to note that 3d becomes 25 cents. 1s. 3d. becomes 1·25, 2s. 11d. becomes 2·92, and 9s. 9d. becomes 9·75. To most people it is much easier to say that £4 is 80s. than to say it is 40 florins, so that the conversion of sovereigns involves no difficulty. In short, the shilling unit involves a minimum of difficulty during the period of change, while it has the immense advantage that all present coins work in down to the 3d. bit, and the only appreciable alteration in value would be in the equivalent of one penny which would be increased by 8 per cent. A little card printed with the copper equivalents will do all that is necessary to help people to recognise the new money if the shilling unit is adopted. A whole book will be required if we get the florin.

Tynemouth, Jan. 19. C. TURNBULL.

TO THE EDITORS OF THE ELECTRICIAN.

Mr. Parsons' reply to my recent letter is dangerous in that it might give rise to the opinion that there are enormous difficulties to be overcome before we can establish the British system of coinage on a decimal basis.

I take it that Mr. Parsons and most of your other contributors in this matter agree with me on the fundamental point that a decimal basis is desirable, and I suggest this is all that really matters at the moment. Once we have convinced the Government upon the advantages of the decimal basis, details of the precise coins to be introduced can safely be left to H.M. Treasury and any other Government departments concerned.

The florin basis is put forward by the Decimal Association as one method whereby our present currency might be decimalised with perhaps the minimum of inconvenience, but I should like it to be clearly understood that the Decimal Association does not take up the attitude of the florin basis or nothing, but it does urge all concerned to assist them in convincing the Government on the broad issue that our present system is unwieldy and unsatisfactory, and that it could be replaced with advantage by a decimal system of British coinage.

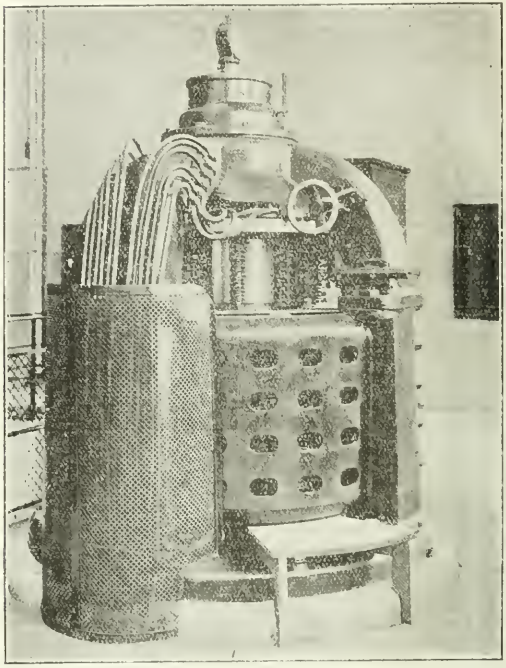
Manchester, HARRY ALLCOCK,
Jan 23. Manchester & District Decimal Association.

POLYPHASE ALTERNATING-CURRENT COMMUTATOR MOTORS.

TO THE EDITORS OF THE ELECTRICIAN.

Referring to the article published in THE ELECTRICIAN of January 12th, page 470, and containing the reproduction of the polyphase commutator motor built by the B.T.H. Co., it appears to me from the number of brush studs and the spacing of the brushes that the rotor of this commutator motor is fed with a greater number of phases (6, 9, 12) than the stator (usually three). This arrangement, which cannot be avoided in high-powered motors, is the object of my German patent No. 145,433, of September, 1901, and I have used it most extensively in recent years.

The illustration herewith shows a 500 H.P. motor (50 cycles), the rotor of which is fed with 12-phase current from 12 equidistant brush studs. The speed can be varied from 350 to 700 revs. per min. Motors of this type have been in continuous operation for several years.



POLYPHASE COMMUTATOR MOTOR.

Paris, Jan. 19. M. LATOUR.

STEEL MOTOR COACH CONSTRUCTION.*

The new steel interurban cars used by the Northern Ohio Traction & Light Company, of Ohio, represent the product of a very careful study of the service requirements. They are 12,000 lb. lighter than this company's steel-underframe cars of exactly the same type, and they have 120 H.P. more motor capacity.

The total weight of the new steel motor passenger car, completely equipped, is 70,000 lb. Of this, 35,000 lb. is in the body and its equipment, including air brakes, heaters and other fittings. The motor equipment weighs 15,000 lb. and the trucks weigh 10,000 lb. each. The new cars are equipped with GE 240-B, 105 H.P. motors, and both cars have type MK control. Steel girder construction was adopted for these new cars because it was believed that they would give a longer life in service at a lower maintenance cost, and in case of an accident they were much safer than a wooden or a semi-steel car body.

The general dimensions of these steel interurban motor and trail cars are as follows:

Length over body corner posts	42 ft.	$1\frac{3}{4}$ in.
,, front platform	4 ft.	9 in.
,, rear platform	4 ft.	9 in.
,, vestibule sheathing	51 ft.	$7\frac{3}{4}$ in.
,, crown piece	52 ft.	$10\frac{7}{8}$ in.
Width over sills, including sheathing	8 ft.	6 in.
,, posts at belt rail	8 ft.	6 in.
Width at widest part of car body	8 ft.	8 in.
Centre to centre of window posts	2 ft.	$10\frac{1}{4}$ in.
Height, top rail to underside of side sills..		$41\frac{1}{2}$ in.
Length of smoking compartment	11 ft.	$9\frac{7}{16}$ in.
,, main passenger compartment	29 ft.	$3\frac{13}{16}$ in.

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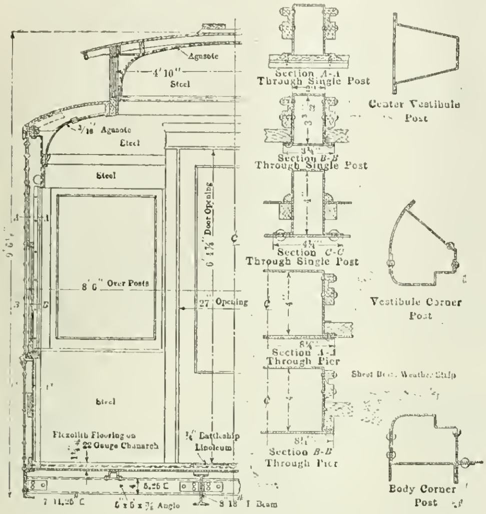
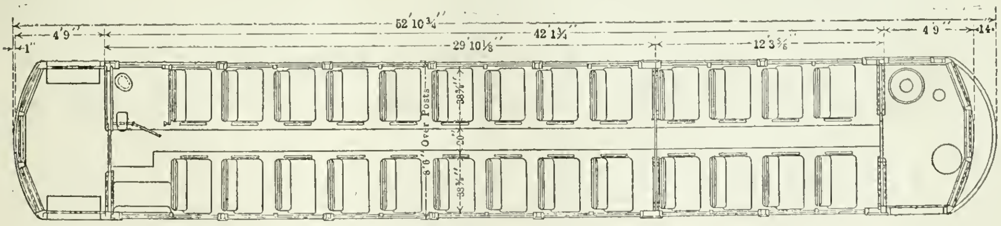
* Abstracted from an article in the "Electric Railway Journal."

Steel Framing Details.—Commercial sections and pressings were used in the framing of these cars. There are two 8 in., 18 lb. I-beam centre sills at 16 in. centres extending from the front buffer to the rear body corner post; 7 in. 12¼ lb. side sills, and a ⅛ in. × 34 in. side plate reinforced at the belt rail with a ⅜ in. × 2½ in. bar. All cross-sills, excepting those at the rear body bolster, are 4 in. 5¼ lb. channels riveted to the webs of the centre and side sills. The cross-members at the rear bolsters of the car body are formed of 6 in. 10½ lb. channels. The end sills are 7 in. 12¼ lb. channels, and the needle beams are formed of 6 in. 12¼ lb. I-beams



Cross-section of Steel Motor-Coach and Post Sections.



Floor Plan of Steel Motor-Coach.

A drop platform 7⅛ in. below the main car floor level is provided at the rear end of the car body. The centre and outside supports of this consist of 6 in. 10½ lb. channels arranged to clear the motors and trucks, and they extend to the rear body bolster. The front buffer is depressed below the body framing, and it is built of two 4 in., 8½ lb. I-beam riveted to the bottom framing between the side and centre sills. The top of this buffer framing is 8 in. below the main car floor level, and it is reinforced by ⅛ in. top plates, riveted to the four buffer framing members. The buffer end is formed of a 7 in. 9·8 lb. anti-climber riveted to a 7 in. 12¼ lb. channel. The rear buffer is constructed in a similar manner, except that the longitudinal member are the extensions of those supporting the platform. A pressed U-section longitudinal support is also provided between the centre and side sills. The body bolsters are of the built-up type, the top and bottom plates being 1 in. × 10 in. in size, and separated by grey iron castings. The bottom member of the bolster is arranged so that it can be removed without disturbing any part of the underframing.

Other Steel Details.—All body posts, including side, corner, vestibule and door posts are made of pressed sheet steel. The bases of these posts are securely riveted to the underframing and the tops are riveted to the side plates, to the vestibule plates and to the end plates. The belt rail proper is formed of a 3/32 in. pressed brass section extending the full length of the car body. The several post sections and the belt-rail section are shown in one of the accompanying illustrations. The brass belt-rail or sash rail is brazed to each post along all lines of contact. The letterboard is formed of ¼ in. steel and is continuous for the full length of the car body. It is riveted to the side and corner posts as well as to the body side plate, which is formed by a ¼ in. × 2 in. × 3 in. angle. The letterboard is further reinforced between the side posts by ⅛ in. × ⅞ in. × 1 in. angles, which also serve as a fastening for the Gothic sashes.

The sash rest in the vestibules is of pressed steel and the dash is formed of No. 14 sheet steel. It is also of interest to note that the pressed steel posts which are exposed on the interior of the car body are grained like mahogany to harmonise with the rest of the interior finish. This is also true of the wainscoting, which is formed of No. 16 sheet steel. As a weather-proofing and vibration deadener, all the outside sheathing of the car is covered with ¼-in. cemented felt. The framing of all sashes, doors, moulding and the toilet and smoking-room partitions is of mahogany. The flooring is a No. 22 gauge Chanarch, covered with 1 in. of Flexolith. The Chanarch is riveted to all longitudinal members in the underframing and thus serves as a diagonal bracing. In the aisle the top surface of the Flexolith flooring is depressed ¼ in. below the surface of the floor beneath the seats. This depression is covered with ¼ in. battleship linoleum thoroughly cemented to the floor. The roof is reinforced with steel carlines forged from ½ in. × 1¼ in. bars and concealed between the wooden carlines. The lower ends of these carlines were forged so that they could be riveted to the body side-plate angle.

Interior Equipment.—A feature of these cars appears in an interior lighting system which consists of six 94-watt lamps on a single circuit installed along the centre line of the car body, with an extra lamp arranged in the circuit so that it may be cut in through a selector switch in case one of the six lamps in the car lighting system burns out. In addition to these there is a 23-watt side lamp on the deck rail at each panel post. This arrangement of the lighting system required three circuits, whereas the system employed on the old-type steel underframe cars required five circuits.

Other specialities in these cars include a Westinghouse straight and automatic air-brake system, Brill trucks, Tomlinson automatic couplers, automatic closing trapdoors equipped with a self-folding device, hot water heaters on the double-circulating system, air sand boxes, sand valve and traps, arc and incandescent head lamps. The 'bus line receptacles providing for train operation are all installed on a wooden block mounted on the vestibule dash. The back of this block is cut to fit the dash, and it is fastened to it with a rubber gasket for weather-proofing purposes. This block serves as an insulator and is cut away from behind the block to permit the bus lines to connect with the receptacles. A plug for the headlight is also provided in this block so as to shorten the leads.

LEGAL INTELLIGENCE.

British Association of Glass Bottle Manufacturers (Ltd.) and Others v. Forster & Sons and Others.

Last week Mr. Justice Sargant delivered judgment in this action, which was brought by the British Association of Glass Bottle Manufacturers, (Ltd.) and Cannington Shaw & Co. (on behalf of themselves and all other British licensees [other than defendants Forster & Sons] having licences under "Owen's Patents") against Forster & Sons, the Owens European Bottle Machine Company, of Toledo, the Treuband Vereinigung A.G., and the Europäische Verband der Flaschenfabriken (G.m.b.H.). Plaintiffs claimed a declaration that an order made by the Board of Trade on May 19, 1915, and a deed made on May 27, 1915, between the Board and Forsters' Co. were both null and void; and they sought an injunction restraining Forsters' Co. from taking any steps under the deed or order.

In delivering judgment, his Lordship said that the questions in issue arose out of arrangements made in and after 1907 for the commercial development in various European and other countries, including Great

Britain, of certain valuable American inventions for the manufacture of glass bottles, known as the "Owens Inventions" or the "Owens Patents." It was thought essential, not merely to provide for the supply and distribution of those machines, but also to arrange for limitations on their number and output. The methods and the agreements under which that result was sought to be attained were somewhat complicated, involving the grant of an option to three German firms who subsequently dropped out, the exercise of that option with certain variations by a substituted company, and other steps. There was formed in Germany, and under German law, a central association called the Europäische Verband der Flaschenfabriken, with a capital of 1,000,000 marks, which was subscribed and taken up in shares roughly proportionate to the relative national output of glass bottles by six national associations of glass bottle manufacturers in each of the six nations or States of Germany, Great Britain, Austria-Hungary, Denmark, Sweden and Holland. The Verband then agreed to purchase the Owens inventions and patents over a territory referred to as "the German contract territory," which included the whole of Europe and much more, at 12,000,000 marks, of which 3,000,000 marks was payable on March 1, 1908, and the remainder was payable in nine equal annual instalments of 1,000,000 marks each on March 1 in each succeeding year down to and including March 1, 1917, on which day the final payment was to be made. That purchase was made from the defendants, the Owens European Bottle Machine Co., of Toledo, an American company, who were the then owners of or had power to dispose of the Owens inventions and patents within the German contract territory. Arrangements were made for securing the payment of the unpaid purchase money for the time being, and the protection of the relative rights of the Verband and the Owens Co. pending the complete performance of the contract of purchase, by vesting the patents securing the inventions within the German contract territory in another German company, the Treuband-Vereinigung-Aktiengesellschaft, on trusts whereunder, on the due completion of the purchase, they were to be assigned to the Verband, but in case of default they were to be reassigned to the Owens Co. The Verband then entered into six separate agreements to substantially the same effect with each of the national associations, although only one of those agreements—namely, that between the Verband and the British Association of Glass Bottle Manufacturers, had been put in evidence before him.

Having recited certain clauses of the agreements, his Lordship said it was common ground that since the above agreements the Verband had completed the purchase of the patents sold to them in accordance with their obligations, but he assumed that the Verband had still to pay the last instalment of 1,000,000 marks, and that until payment had been made the Owens Co. had some interest in the patents sold which they could enforce through the instrumentality of the Treuband. It was obvious, however, that the interest of the Owens Co., and the Treuband on their behalf, in the patents sold was a very shadowy one. He might take it that the supply of Owens's machines to the British Association had probably amounted to a comparatively small part of the machines to be ultimately supplied. He had had in evidence the licence granted (on Feb. 6, 1914) by the British Association to Cannington Shaw & Co., as being a specimen of the licences granted or to be granted to members of the British Association. The royalty payable by Canningtons to the British Association was at the rate of 3d. per gross of bottles, being a rather higher rate than that reserved by the agreement of Nov. 16, 1907. Since the outbreak of the war it has been impossible for the Verband to continue to supply the British Association and their members with Owens's machines, or for the other obligations of the agreement of Nov. 16, 1907, to be carried out between them. A possible exception from that proposition was an agreement of Feb. 8, 1916, between the Verband and the British Association, made with the sanction of the Board of Trade, under which the British Association were to be at liberty to import direct from the United States six Owens machines. He took the view that what was sanctioned was merely one isolated transaction. The immediate occasion of the present litigation was the making of an order and the granting of a licence by the Board of Trade, under sec. 1 of the Patents, Designs and Trade Marks (Temporary Rules) Act, 1914, as amended by sec. 1 of the Patents, Designs and Trade Marks Temporary Rules (Amendment) Act, 1914. The Board of Trade had made an Order dated May 19, 1915, and granted a licence dated May 27, 1915. By the Order the Board in effect suspended the Owens's patents (the English letters patent) in favour of Forsters and persons notified to and approved by the Board of Trade as manufacturing for Forsters, but subject to the licence therein mentioned being executed and subject also to a power to the Board to revoke the suspension, so far as regarded the persons so notified to and approved of by the Board. And, by the licence, the Board granted to Forsters liberty to make and use the inventions described in the Owens's patents during the period not exceeding the unexpired residue of the terms of the respective patents, during which the suspension order should be in force, and on the terms as to payment, &c., in the licence mentioned. Thereupon, the British Association and Canningtons, [illegible], brought the present action against Forsters, the Owens Co., the Treuband and the Verband for a declaration that the Order and the licence of the Board of Trade are void, and for an injunction to restrain Forsters from acting under the Order and licence. The ground of plaintiffs' case was that the Board had no jurisdiction to make the Order or grant the licence, and that want of jurisdiction was said to be due to the fact that, although the Treuband and the Verband were unquestionably subjects of a State at war with His Majesty, neither could be held to be substantially entitled to the benefit of the Owens patents within the meaning of the legislation. Forsters, the only defendants who need be considered (all the other defendants being friendly to plaintiffs or neutral), alleged that the Treuband and the Verband though they were [illegible], were the persons entitled to the benefit of the Owens's patents, particularly having regard to the position produced by the war, and that that was sufficient to bring the case within the Emergency Legislation. In his judgment Forsters were right in both those contentions. In the present case not only were the plaintiffs not the exclusive licensees or the assignees, but the agreement with the Verband expressly provided that the Verband were to maintain and protect the patents in this country, and sue for infringements, a provision which excluded the idea that plaintiffs should be entitled to sue. Plaintiffs were not entitled to an injunction against Forsters, and, though the the Court may have jurisdiction to grant a declaration, it ought not to exercise it. Indeed, to grant a declaration would obviously result in enemy corporations (the Verband and the Treuband) being enabled by a side-wind, and at the suit of friendly subsidiaries, to obtain relief or, at least, an important step towards relief in this Court which it would be impossible for them to obtain directly. Plaintiffs were seeking to restrict, in the legislation, the meaning of the phrase "the person entitled to the benefit of which," to either a single absolute legal and beneficial owner or to the whole of a number of persons having together an absolute legal and beneficial ownership. That was too limited a construction having regard to the object of the Act, and to the fact that the powers in question were given to an important State Department with a very large discretion as to avoiding or suspending, either wholly or partially, and as to making fresh grants on any conditions. That legislation must be broadly construed. He thought that what had to be considered was: Who was the person or corporation substantially entitled to the benefit of the patent or licence, as the case might be? When the person so substantially entitled was a foreign enemy, the jurisdiction of the Board at once arose. As between the Verband and the Owens Co., the Verband were substantially entitled to the benefit of the patent. It would be altogether improper to make an anticipatory declaration as to the contingent rights of the Owens Co.

As regards the executed rights given by the actual purchase and delivery of Owens machines, it was clear that the British Association and their nominees were not entitled to the benefit of the Owens's patents, and had no rights exceeding a licence to use those particular machines, subject to certain restrictions. Whether those restrictions had or had not been abolished or suspended by the war, such rights were no bar to the exercise by the Board of Trade of their statutory powers, since the legislation clearly separates patents and licences, and allowed the revocation of a patent belonging to an alien enemy though an existing licence might be in friendly or neutral hands, or the revocation of a licence belonging to an alien enemy though the patent might be in friendly or neutral hands. The British Association and their nominees were still entitled to go on using the machines actually delivered to them; and might be, and probably were, placed in an improved position in that respect by the removal of restrictions on the user of the machines, while, as regards the very large additional payments which had been made by the British Association in the whole transaction by way of subscription to the capital of the Verband, the British Association had received corresponding share capital of the Verband. The effect of the war had been not merely to suspend, but to avoid, the agreement of Nov. 16, 1907, so far as not carried out. The present position of the British Association and their nominees was no better than that of persons who had purchased and were licensed to use the particular machines delivered to them.

The action was dismissed, with costs.

Liability for Tramway Passenger's Luggage.

At Newcastle-upon-Tyne County Court on the 19th inst. Judge Greenwell heard an action by a passenger (named Elsie Hewitson) agianst Newcastle Corporation for damages for the loss of suit-case on a tramcar on Sept. 21, and which was lost owing to the negligence of the conductress. Plaintiff had paid 1d. and got a ticket in respect of the case.

It was stated that plaintiff handed the suit case to the conductress, who placed it at the back of the car. The journey was completed, and when plaintiff was getting off the car her case was not to be found. Under the circumstances it was said that defendants were responsible for the loss of the case. Plaintiff paid the sum of 1d. for its carriage and received in return a ticket containing the following:—"The Corporation accepts no responsibility for the safe transit of passengers' luggage or parcels. Any luggage or parcel left on the platform of car is there entirely at owner's risk. Passengers must themselves see to the safe custody of their property."

It was submitted that the Corporation by accepting luggage on the cars became common carriers, and that they had broken their obligations as common carriers. Even if the Corporation were not common carriers they were the bailees of the suit case for reward. They refused to allow a passenger to retain the goods in his own custody. They in effect accepted the custody of anything left on the platform of a car, and passengers went inside a car and had no means of watching their property. That being so, reasonable care ought to be exercised so as to ensure the safety of the articles left outside the car. The ticket did not relieve defendants from the liability. The ticket, which could hardly be read in daylight, was issued on a dark night in a car with shaded lights.

Plaintiff, in her evidence, stated that when the conductress took her bag from her she put it at the back of the car underneath the stairs. She paid 1d. for the luggage ticket, but she could not have read what was printed on it.

After a discussion, the value of the bag was agreed at £9.

For defendants, Mr. [illegible], submitted that plaintiff was suing on negligence and proved none. He also contended that the Corporation tramways were not common carriers. The only obligation upon them was that a passenger could carry with him or her 28 lb. of luggage.

THE JUDGE: Where does the charge of a penny come in. I do not see why they should charge and accept no responsibility.

His Honour reserved judgment.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The War Loan. We are pleased to see that many electrical engineering firms, electric supply companies, &c., figure among the subscribers to the new War Loan. No doubt there are many who have not yet subscribed but intend to do so at the earliest opportunity. Up to the present we notice the following names among the subscribers :—

Victoria Falls & Transvaal Power Co. (£500,000), Pease & Partners (£500,000), H. R. Merton & Co. (£250,000), General Electric Co. (£200,000) Mather & Platt (£100,000), British Insulated & Helsby Cables (£80,000) Automatic Telephone Mfg. Co. (£25,000), Federation of British Industries (£20,000), Charing Cross, West End & City Electricity Supply Co. (£50,000), James Keith (£26,500), Kerr, Stuart & Co. (£50,000), Automobile Association (£77,000), John Batt & Co. (£60,000).

In addition, many local authorities have given large sums, and as subscriptions are flowing in at a brisk rate the public are determined to support the loan as far as they are able. However, there must be no slackening of effort between now and the date of closing if the loan is to be the huge success it should be.

* * * *

Electric Furnace Steel in Canada. The Canadian Department of Mines reports that of the total production of steel ingots and castings in 1916, about 43,790 short tons were made in electric furnaces. In 1915 only 61 short tons were reported as having been made in such furnaces.

* * * *

London Telephone Service. For the year ended Dec. 31, 1916, the total number of subscribers' telephones in the London telephone area was 251,607, compared with 247,187 in the previous year.

* * * *

Price of Aluminium. The selling price of aluminium ingots of ordinary commercial purity of 98-99 per cent. has been fixed by the Ministry of Munitions at £225 per ton, carriage paid to consumers' works.

The maximum selling price of re-melted aluminium scrap and swarf ingots of 98-99 per cent, has been fixed at £210 per ton, carriage paid to consumers' works. The maximum price must not be exceeded, but a lower one may be fixed by agreement between the seller and the buyer, based upon the metallic aluminium content. These prices are to take effect as from Jan. 1, 1917, and permits under Regulation 30A of the Defence of the Realm Regulations will be granted only for such dealings in the above-mentioned materials as are in accordance with the above prices.

* * * *

Engineering Exhibition. It is announced that the Shipping, Engineering and Machinery Exhibition, which was postponed from September and October, 1914, owing to the outbreak of war, will be held at Olympia after the conclusion of the war.

* * *

United Kingdom Trade with Canada. In accordance with practice it has been arranged that H.M. Trade Commissioner in Canada and Newfoundland (Mr. C. Hamilton Wickes) will pay a further official visit to this country.

Mr. Wickes is expected to arrive early in March, and will be prepared to interview (by appointment) representatives of those firms who may be able to see him in London at the Offices of the Department of Commercial Intelligence of the Board of Trade for several weeks before Easter. Immediately after Easter he will visit such trade and industrial centres in the United Kingdom as it may appear most advantageous to visit in view of applications that may be received from firms in or near those centres, and from Chambers of Commerce. Firms who desire to interview Mr. Hamilton Wickes are requested to apply as soon as possible, but not later than Feb. 19 in the case of London, and March 5 in the case of the Provinces. Applications to the Comptroller-General, Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. The reference number (D.C.I. 2,360/17) should be quoted.

* * * *

The Electric Drive in Machine Shops. Messrs. Wm. Asquith (Ltd.), drilling machine makers, &c., of Halifax, have found such an increased demand for the electric drive in machine shops that they have taken steps to facilitate such equipment.

The firm have put down a special testing plant to enable them to test machines with their own motors before despatch. An advantage of this is that the motors can be adjusted and put into perfect running order to suit the machines they are to drive. They have facilities for testing motors on A.C. or D.C. ; the former at pressures from 100 to 600 volts, single, two or three-phase, 25 to 60 cycles, and the latter at 100 to 600 volts.

* * * *

A State Owned Atlantic Cable. It is reported that when the Special War Conference takes place next month the question of a State-owned cable between this country and Canada will be revived.

Hitherto, when this question has been raised the Treasury and the Post Office have objected on the grounds that the cost would be excessive and that a State-owned cable could not hope to compete profitably with the other cable companies. They have also objected on the ground that all the land telegraph lines in Canada are in the hands of private companies closely connected with existing cable companies.

The war has caused many persons to modify their views on this subject, and as there is no British-owned cable across the Atlantic at present there is an increasing demand for laying another cable between this country and Canada. It is also felt in Canada and the Australasian Dominions that a national cable would cheapen and make more effective telegraphic communication between themselves and the Mother Country if complete control were acquired of all the telegraphic and cable lines along the "all-red route." They also intend to ask that the British Post Office should give preference to cablegrams over the proposed State-owned cable.

* * * *

The Decimal System. The Manchester and District Decimal Association is issuing a circular in order to focus attention on certain considerations connected with the use of a decimal system of British coinage and the metric system of weights and measures.

It is pointed out that the normal output capacity of our factories and workshops has been greatly increased in order to provide the essential munitions of war in adequate quantities. It is feared that much of this new plant and thousands of our workpeople will be rendered idle at the end of the war unless we *now* devote ourselves to the removal of whatever obstacles there may be in the way of that enormous expansion of our export trade which will be needed to ensure continuity of employment and the maintenance of our national economic stability.

It is stated that the British Empire stands alone amongst the nations of the world (excluding only Siam and Persia) in her neglect to adopt a decimal system of coinage. Canada and Ceylon have already adopted decimal coinage, and both Australia and New Zealand are now contemplating a similar step. That it would be to our advantage to adopt a decimal system of coinage must be apparent from the fundamental fact that all our financial transactions, involving such everyday questions as rates of interest, dividends, discounts, commissions, &c., are based on a rate per cent. Our present system could be re-arranged on a decimal basis without altering the existing values of our gold and principal silver coins, and instances of how this could be done are given.

Metric Weights and Measures.—At present British manufacturers and merchants are compelled to work in the Imperial system of weights and measures for their home trade, and in the metric system for their trade with "metric" markets abroad. The extra work and liability to error attendant on the necessary conversion of a metric inquiry into imperial terms, and its subsequent re-conversion into the metric system, obviously hamper the British exporter in his efforts to develop his foreign trade. For many years our consuls abroad have consistently advocated our adoption of the metric system. The ideal arrangement would be the establishment of one international system of weights and measures, whereby the producers and consumers of the world could readily communicate without any necessity for conversions. Bearing in mind that, with the exception of the United States and Russia (in both of which countries a strong demand exists in favour of its adoption), practically all other civilised countries have already adopted the metric system, it should be clear that the British Empire can best accelerate the attainment of the above ideal by herself falling into line with these "metric" countries. The scientific and practical advantages of the metric system have already been demonstrated, as is evident from its adoption as the universal language of quantity by the scientists of the world and by its practical use in our newer industries, such as the manufacture of motor cars, aircraft, electrical apparatus, &c. Any attempt to impose our chaotic and cumbersome imperial weights and measures upon the world would not only be foredoomed to failure, but bring ridicule upon us. Although the abandonment of the lb. weight and the yard measure in favour of the kilogramme and the metre may sound alarming to some, it is pointed out that the resultant benefits, accruing to the whole community would speedily far outweigh any temporary difficulties and inconveniences encountered during the period of transition.

The Council of the Association urge those who approve of their proposals to support the association by joining. Communications should be addressed to the acting secretary, Mr. Fred Hilton, 55, Market-street, Manchester.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 13, 1917, *to* Jan. 19, 1917.

IMPORTS.

LONDON.—*U.S.A.:* Elec. machinery, £2,318; elec. carbons, £82; wire and cable £3,643; unenumerated, £1,802. *Japan:* Unenumerated, £8,073. *France:* Elec. machinery, £53; unenumerated, £555. *Switzerland:* Elec. machinery, £154; elec. carbons, £608; unenumerated, £594. *Canada:* Unenumerated, £170. *Holland:* Glow lamps, £2,795; unenumerated, £277. *Sweden:* Unenumerated, £1,341. *Denmark:* Unenumerated, £1,155. *Spain:* Elec. carbons, £700. *Norway:* Wire and cable, £2,710; elec. machinery, £15.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £255. *Melbourne:* Elec. machinery, £317; elec. meters, £113; unenumerated, £2,893. *Sydney:* Elec. machinery, £533; glow lamps, 700 n.o.; unenumerated, £1,117. *Wellington:* Elec. machinery, £543; elec. lamps, £106; unenumerated, £680. *Lyttelton:* Unenumerated, £20. *Adelaide:* Unenumerated, £21. *Perth:* Unenumerated, £83. *Dunedin:* Unenumerated, £210. *Fremantle:* Elec. machinery, £646.

AFRICA.—*Cape Town:* Elec. machinery, £26; unenumerated, £471. *Port Elizabeth:* Unenumerated, £420. *East London:* Unenumerated, £45. *Durban:* Elec. machinery, £151; unenumerated, £130. *Accra:* Wire and cable, £82; telegraph material, £30.

EGYPT.—*Alexandria:* Unenumerated, £133. *Suez:* Elec. machinery, £333. *Aden:* Unenumerated, £57.

JAPAN.—*Kobe:* Elec. machinery, £247. *Yokohama:* Unenumerated, £158.

U.S.A.—*New York:* Elec. machinery, £46; unenumerated, £368.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £107; elec. glow lamps, 300 n.o.; elec. machinery, £270; unenumerated, £1,034. *Calcutta:* Wire and cable, £779; elec. machinery, £32; unenumerated, £2,562. *Madras:* Wire and cable, £126; elec. machinery, £12; unenumerated, £215. *Ceylon:* Wire and cable, £42; unenumerated, £211. *Singapore:* Wire and cable, £24; unenumerated, £89. *Penang:* Wire and cable, £40; elec. machinery, £21; unenumerated, £80. *Rangoon:* Wire and cable, £129; unenumerated, £187. *Karachi:* Unenumerated, £336. *Port Swettenham:* Unenumerated, £36.

CHINA.—*Hongkong:* Unenumerated, £34. *Hankow:* Unenumerated, £321. *Shanghai:* Wire and cable, £315; elec. machinery, £82; telegraph material, £365; unenumerated, £411.

U.S.A.—*New York:* Unenumerated, £438.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. lamps, 1,000 n.o.; elec. machinery, £242; wire and cable, £1,559; unenumerated, £1,622. *Valparaiso:* Unenumerated, £63. *Monte Video:* Wire and cable, £88; unenumerated, £293. *Rio de Janeiro:* Elec. machinery, £719; telegraph material, £1,000; unenumerated, £449. *Antofagosta:* Elec. machinery, £231; unenumerated, £30. *Port Alegre:* Unenumerated, £49. *Punta Arenas:* Wire and cable, £13; unenumerated, £49. *Talcahuano:* Wire and cable, £34. *Rosario:* Unenumerated, £147.

HOLLAND.—*Amsterdam:* Wire and cable, £205; unenumearted, £62.

FRANCE.—*Paris:* Elec. machinery, £528; unenumerated, £1,137. *Dieppe:* Elec machinery, £32; unenumerated, £318. *Calais:* Unenumerated, £201. *Hovre:* Unenumerated, £218. *Boulogne:* Unenumerated, £42. *Bordeaux:* Elec. lamps, 6,805 n.o.; wire and cable, £400; unenumerated, £209.

CANADA.—*Montreal:* Unenumerated, £22. *St. John's, N.B.:* Elec. machinery, £19; unenumerated, £25.

GIBRALTAR.—Unenumerated, £163.

MALTA.—Unenumerated, £10.

NORWAY.—*Bergen:* Wire and cable, £2,000. SWEDEN.—*Stockholm:* Unenumerated, £10.

RUSSIA.—*Petrograd:* Elec. machinery, £27; unenumerated, £1,155.

ITALY.—*Genoa:* Wire and cable, £303; unenumerated, £3,008.

SPAIN.—*Barcelona:* Elec. machinery, £200; unenumerated, £67.

FOREIGN GOODS (duty paid and free).

Sydney: Elec. lamps, £138. *Adelaide:* Unenumerated, £135. *Melbourne:* Elec. meters, £108. *Singapore:* Unenumerated, £146. *Shanghai:* Unenumerated, £32. *Stockholm:* Unenumerated, £45. *Alexandria:* Unenumerated, £67. *Boulogne:* Unenumerated, £23. *Calcutta:* Glow lamps, 200 n.o.; unenumerated, £325. *Geelong:* Unenumerated, £171. *Madras:* Unenumerated, £43. *Port Elizabeth:* Unenumerated, £96. *Rosario:* Unenumerated, £19. *Port Said:* Unenumerated, £6. *Barcelona:* Unenumerated, £475. *Bombay:* Elec. glow lamps, 3,050 n.o. *Bordeaux:* Elec. machinery, £127. *Horgkong:* Unenumerated, £180. *Buenos Ayres:* Unenumerated, £336.

IN TRANSIT.

Biera: Elec. mining machinery, £480.

NOTE.—**The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."**

EDUCATIONAL.

University of Liverpool.—The Lent term of the 1916-17 Session began on the 9th inst. In the Faculty of Engineering complete courses of instruction are provided in mechanical, civil, electrical and marine engineering, naval architecture, mathematics, physics and chemistry. The special matriculation or the entrance examination must be passed to secure admission to the courses. Prospectuses of the Faculty can be obtained from the Registrar, Mr. Edward Carey.

Educational Co-operation.—There has been an interchange of facilities between certain departments of the University of Leeds and Bradford Technical College.

During last year the college rendered an important service to the university, which has been ungrudgingly acknowledged, by providing for the attendance of some of the advanced students of the university for instruction at the college in electrical engineering, and also in lending to the university the services of a member of the college staff (Mr. W. H. N. James) as lecturer in electrical engineering to students attending the coal mining course at the university. This co-operation obviated the necessity of making a new appointment to the university staff at present in place of the head of the department of electrical engineering, who had resigned his position, and of the assistant lecturer, who had been released for military service.

BUSINESS NOTICES.

We are notified by the Secretary of the Cable Makers' Association that they have left No. 64, Victoria-street, Westminster, S.W., and taken new offices at Sardinia House, Sardinia-street, Kingsway, London, W.C., to which address in future all communications should be sent.

Patent Development.—The proprietor of patent No. 4,228/1909, for "Improvements in electric cutouts," desires to make arrangements by way of licence or otherwise for exploiting same in this country. Communciations to Messrs. Haseltine, Lake & Co., chartered patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

Plant Wanted.—Messrs. John M. Henderson & Co., King's Works, Aberdeen, require electric generating plant of 400 kw. to 650 kw., with either gas engines and suction plant, steam turbine or engines, with boilers, condensers, &c.

Names of Permanent Magnet Makers Wanted.—An advertiser requires the names of makers of permanent magnets for small moving coil recording instruments, or suppliers of steel suitable for making same.

BANKRUPTCIES, LIQUIDATIONS, &c.

Chas. Benjamin Ogilvie, electrical engineer, 43, Dudley-road, Whalley Range, has been adjudicated bankrupt.

The Technical Engineering Co. (Ltd.) is being wound-up voluntarily. A meeting of creditors will be held on Jan. 31 at the offices of the liquidator, Mr. P. S. Booth, Exchange-chambers, Bixteth-street, Liverpool.

An order was made in the High Court on Jan. 16 for the winding-up of the Aluminium Stamping Co. (Ltd.), 77, Garnham-street, Stoke Newington, London, N.

Claims against the Kilowatt Publishing Co. (Ltd.) are to be sent by Feb. 16 to Mr. Arthur Webster, 203, Temple-chambers, Temple-avenue, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

London County Council.—At the Council's meeting on Tuesday sanction was given to Woolwich Council to borrow £2,442 for the purposes of their electricity supply department, repayable as to £1,816 for mains within 25 years and as to £626 for plant within 15 years.

Willesden.—On Tuesday the Clerk reported to the Council that the L.G. Board had sanctioned the borrowing of £5,000 for a new feeder, and it was decided to apply for permission to borrow £3,860 for rotary converters and transformers, and £6,250 for h.t. cable extensions.

The electrical engineer (Mr. A. W. Blake) reports having received a permit from the Priority Branch of the Ministry of Munitions from which it appeared that when the existing stock of cable and material is exhausted, no further service can be laid before separate applications, giving full particulars as to quantity, reasons, &c., are put before the Ministry of Munitions.

With regard to additional supply of power required at the local works of a well-known electrical firm, the vicar has agreed to the necessary cable being laid through his land subject to the payment of £2. 2s. per annum.

The L.G. Board have authorised the borrowing of £5,000, being part of a loan of £21,000 sanctioned in August, 1914, for laying a new feeder to Willesden Green Library.

In a report by Mr. Blake it is stated that owing to the rapidity of the growth of the demands for electric current there is no margin of safety or capacity in either cables or machinery, and extensions must be made before next winter. Application is to be made to the L.G. Board to sanction the borrowing of £10,110, made up as follows: New 500 kw. rotary converter, with transformers, switchgear, foundations and connections, £3,600; a new 1,000 kw. cable, with switchgear, £2,900; a new 700 kw. cable-drawn into ducts, £3,350; enlargement of a transformer chamber, and installing a duplicate set of existing transformers, £100; and a new 400 kw. transformer for £160. From April 1 to Dec. 31 last 61 services were laid at customers' expense, amounting to £186.

Having considered a report presented by Mr. Blake as to the present position of the negotiations for interlinking and interworking of electricity undertakings in the Metropolitan area, and in view of the fact that the agreement with the North Metropolitan Electric Power Supply Co. expires on March 31, 1918, Mr. Blake has been authorised to make inquiries in connection with the situation.

In view of the progress of the undertaking and the important duties discharged by Mr. Blake, the Finance Committee have decided to increase, as from April 1 next, his salary from £400 to £500, and thence by two annual increments of £50 to £600. The Council has approved this step.

Wolverhampton.—Last week the Council authorised extensions of the electric supply mains, at a cost of £151.

GENERAL.

Aldershot.—Upon the application of the Postmaster-General current is to be supplied to premises in Pickford-street.

Cinema Theatres and Power Rate.—St. Pancras (London) Electricity Committee has been considering a communication from Mr. W. C. C. Hawtayne, consulting engineer for the principal cinema theatre proprietors in the borough, with regard to the prices charged for the supply of current used for the projecting lanterns.

The Committee also received a deputation of the cinema theatre proprietors in St. Pancras, who contended that the current used in projecting the pictures on to the screen should be charged at the ordinary power rate instead of at the lighting rate as at present, and urged in support thereof that the projector is in use practically throughout the day, and the current is used for what might be termed the manufacturing side of the theatre. They also informed the Committee that they had taken opinion on the subject, and had been assured that their contention was a just one, and would, if necessary, be upheld by the Courts. The present charge for current supplied to cinema theatres in this borough is at the special rate of 3d. per unit. The Committee considered the point at issue to be a legal one, and consulted the Parliamentary and General Purposes Committee, who are of opinion that the current used for the purpose named should be charged at the lighting and not at the power rate.

Dublin.—At a meeting of the Corporation last week the various reports on the position of the electricity supply undertaking, together with a new report by the deputy city electrical engineer, Mr. L. J. Kettle, were down for discussion, but it was decided to defer consideration of the whole of them until the next monthly meeting.

Eccles.—The Corporation have asked Salford Corporation and the Lancashire Electric Power Co. for their terms for supplying electrical energy in bulk.

Epsom.—Negotiations are proceeding with the South Metropolitan Electric Tramways & Lighting Co. as to the company's application for an Order to supply Ewell with electricity.

It is suggested that the company should not supply electricity in the area of the Council's supply in Ewell without the consent of the Council. Objection is to be made to the proposed order and the Board of Trade will be asked to withhold their consent, as the Council, which already supplies a portion of Ewell, is quite capable and willing to extend the supply when the proper time arrives.

Increased Charges for Electrical Energy.—Increases in charges are being made at the following places :—

Winchester Corporation is increasing its charges by a further 10 per cent. for current for all purposes, making a total of 25 per cent. over pre-war rates.

At Beckenham the Council is recommended to charge a flat rate of 7d. per unit, the consumers also paying the cost of installation in cases of assisted wiring.

Leigh (Lancs).—The Council have decided to link up their electricity undertaking with that of the South Lancashire Tramways Co. This, together with extensions to a local works, will involve an outlay of about £3,540.

Newport (Mon.)—At the last Council meeting the recommendation of the Electricity & Tramways Committee to increase the salaries of the general manager of the electricity and tramways department (Mr. N. J. Young) and the borough electrical and tramways engineer (Mr. A. Nichols Moore), each by £100 per annum was referred to the Salaries Committee.

Oban.—At a recent meeting of the Lighting Committee the engineer reported on the damage done recently to the cables by rats, and that he was authorised to cement all pipes leading into consumers' premises from the manholes.

Poor Law Institution Lighting.—Chippenham Guardians have decided to adopt electric lighting throughout the institution.

Poplar (London).—Owing to the growing difficulty in obtaining carts, the increasing residue of clinker and trouble in relation to shutes, the Electricity Committee has decided to purchase out of the profits of the current year a second Foden steam wagon, at £744.

The Surveyor of Taxes made an assessment on the electricity undertaking of £4,201 in respect of excess profits tax for the year ended March 31, 1915, but objection was successfully taken on behalf of the Council to the assessment which has been discharged.

St. Pancras (London).—In November, 1912, the Council accepted a tender of the Brush Co. for a 5,000 kw. turbine and for the loan of a 1,000 kw. set while the large one was being built.

Owing to the war the large set has not been delivered, and it is expected that it will not be ready for three years from now. Consequently, the Electricity Committee has been in communication with the company who have submitted a proposal for remodelling the turbine, rendering it capable of continuously developing 1,500 kw., with an overload capacity of 20 per cent. for two hours, for an additional sum of £2,500, on condition that the Council exercise their right of purchase on completion of the alterations. The cost of the 1,500 kw. set is £6,500, less £1,500 already paid for hire, and as the chief electrical engineer (Mr. S. W. Baynes) is of opinion that this set is one of the most economical machines of the present day the Committee is of opinion that the offer of the Brush Electrical Engineering Co. should be accepted, providing that it does not in any way prejudice the delivery of the 5,000 kw. turbine.

West Ham.—The Corporation has granted the following increases of salary :—

E. Tombs, stores manager, from £200 to £220 ; J. Layton, senior shift engineer, 70s. a week to 75s. ; A. J. Giffin, ditto, 67s. 6d. to 72. 6d. ; W. Bridger, ditto, 65s. to 70s. ; W. Spittle, ditto, 62s. 6d. to 67s. 6d. ; W. J. Watson, mains foreman, £117 to £160 ; W. A. Wiggins, electricity collector, from £150 to £165, increasing after 12 months to £175. These figures are exclusive of the bonuses payable.

TRACTION NOTES.

Belfast.—The working of the Corporation tramways during the nine months ended Dec. 31 shows a revenue of £229,580 (an increase of £17,825 over the corresponding period of 1915).

Working expenses were £136,894 (an increase of £18,815), and net revenue charges increased by £5,715, total increase £24,530, the surplus profit for the nine months being £4,448 (against £11,154). Revenue per car-mile was 11·66d.

Birmingham.—The Tramways Committee has had under discussion the question of better tramway terminal facilities for the centre of the city.

The Committee discussed the matter of better terminal facilities from the point of view of surface and underground methods, and eventually the general manager (Mr. A. Baker) was instructed to prepare a definite scheme for subways in the centre of the city. When the scheme is ready it will be fully considered by the Committee, and if it is approved by them and by the City Council it will, doubtless, be one of the first progressive measures undertaken after the war.

The provision of trailer cars on certain of the tramway routes of the city, if not on the whole of them, has been under consideration by the Committee for several months. The chairman said that it was hoped shortly to make arrangements for entirely equipping one route with tractors and trailers.

Blackburn.—In addition to about 40 women conductors, the tramways department have five female drivers. The manager (Mr. J. H. Cowell) intends to continue to employ women as drivers so long as he can get suitable applicants.

Carlisle.—Reference was made to the bad state of the tramway track at last week's meeting of the Council.

The Watch Committee had drawn the attention of the Carlisle Tramways Co. to the unsatisfactory state of the tramways and the rolling stock. Mr. Gibbings said the condition of the track, the cars and the general system left much to be desired. The Committee appreciated the company's difficulties, but the time must shortly arrive when very drastic steps must be taken in regard to the condition of the tramways. Further, the Committee were not in favour of women being allowed to drive the cars.

The action of the Committee was approved.

London County Council.—At the Council meeting on Tuesday, Mr. J. D. Gilbert called attention to a falling off in tramway receipts, and stated that from Jan. 1 to Friday last there had been 50 breakdowns in the tramway service.

Sir John Benn, while admitting the great difficulties under which the tramways were working, thought it was time that a consulting physician was called in.

Mr. Holland and others also criticised the tramways, and in reply,

Mr. Hume said the Highways Committee hoped that by internal reorganisation they would be able to effect an improvement. They would shortly bring up a scheme which, he hoped, those who criticised the committee would support, though it would involve some cost to the Council.

War Bonuses.—An emergency report of the General Purposes Committee was presented by Mr. Percy Simmons. It recommended that officers and servants other than those already in receipt of war wages or war bonuses, subject to their proving to the satisfaction of a special committee that they were suffering from special hardship by reason of obligations to dependents or contractural liabilities, should be awarded, at the discretion of the special committee, a war bonus not exceeding 3s. a week if on weekly wages, or at the rate of £7. 10s. a year if on annual salary, provided that the total wages and salary, including such war bonuses, should not exceed £200 a year. The consideration of the report was adjourned for a fortnight.

Megaphones for Tramcars.—At the last meeting of the Tramways Committee of Ayr Town Council, the convener of the Committee (Mr. Learmont) proposed that megaphones be purchased for six tram cars at a cost of £24, and explained that it would be the duty of the drivers to shout out the names of the stopping places. The proposal was ultimately rejected.

Southampton.—A double line of tramway track is being laid in the High-street in place of the existing interlacing line.

West Ham.—In August last authority was given to the tramways manager to proceed with the reconstruction of such car bodies as he deemed expedient, the work to be carried out by the department by the direct employment of labour.

The method of reconstruction is sound, but Mr. L. Slattery now points out that even if it were possible to maintain the anticipated rate of progress of reconstruction (eight cars per annum), which, having regard to the dearth of suitable labour and the growing demands of the military authorities, being a doubtful quantity, it would take years to go through the whole of the cars. The condition of many of these renders it necessary that the rate of progress should be expedited, and as it is impracticable for the department to do more, he suggests, as the only alternative, to purchase a number of lower saloons constructed to the department's drawings and specifications, and completed ready for mounting on the trucks. The rolling stock consists of 118 cars, 89 per cent. of which are of the single truck type of various designs. Thirty of these require immediate reconstruction. Tenders are, therefore, to be obtained forthwith for 20 car bodies completed ready for mounting on trucks.

The through tramway service from Stratford to Chingford Mount is to be discontinued, and notice is to be served on Walthamstow Council to terminate the existing agreement. In lieu thereof a service is to be instituted between the Baker's Arms and the Docks, via Stratford and Prince Regent's-lane, in conjunction with Leyton Council.

TELEGRAPH AND TELEPHONE NOTES.

U.S.A. Radio Service.—On Dec. 19 a Bill was introduced into the Senate to regulate radio communications.

The measure was referred to the Committee on Commerce. It is, in effect, based upon that Act passed by Congress in 1912, which, Senator Fletcher explained, had served its purpose admirably, but experience had shown the necessity of strengthening some of its provisions. The present Bill would change the existing act in the following important provisions :—

1. All Government stations, mainly naval stations not reserved for Government business exclusively, may be opened to commercial business.

2. The Bill enables the Government to purchase such commercial coast stations communicating with ships at sea, as the companies operating them are willing to sell at a fair valuation. The purpose is ultimately to establish the complete and exclusive Government system of commercial radio communications between the coast of the United States and outlying possessions and ships at sea.

3. It provides that not to exceed one-third of the stock of corporations operating stations in the United States may be owned by aliens, and not more than one-third of the board of directors of these operating corporations may be aliens.

4. All licensed operators hereafter, except those serving on board ship, must be American citizens.

EMPIRE NOTES.

Australasia.—Mr. V. J. Crowley is promoting a company at Yarram (Victoria) to supply the town and district with electric light and power, in the production of which water power from the Tarra River is to be employed. The capital is to be £10,000. At present the local butter factory is supplying current for lighting, but the new company is expected to reduce the price of current by 25 per cent.

Canada.—H.M. Trade Commissioner in Canada (Mr. C. Hamilton Wickes) reports that a Vancouver firm wish to represent British manufacturers of builder's supplies, including gas and electric fittings, hardware, paints, &c. Mr. Wickes adds that the Germans studied this business thoroughly, to their profit.

India.—At the new Allahabad High Court building, which was opened on Nov. 27, there is a system of exhaust ventilation operated by electrically-driven fans in the roof.

The six court rooms have electric thermantidotes, the space between the ceiling and the roof also having mechanical exhaust ventilation. These cooling arrangements are said to be the first of their kind in India.

"Indian Engineering" states that, in consequence of the high price of petrol, no better opportunity than the present will be found for the introduction of electric taxicabs in the larger Indian towns. Our contemporary urges in favour of the electric cab that it has lower running and maintenance cost, that its simplicity of manipulation would be sure to bring about a great reduction in the number of accidents, and that it was less noisy while standing still.

The Poona Electric Supply Co. (Ltd.) has been incorporated under the Indian Companies Act with a capital of Rs.10,00,000. The following are directors:—Sir S. B. Broacha (Chairman), Sir C. Jehangir, the Hon. Dewan Bahadur K. R. Godbole, and Mr. H. M. Mehta. Messrs. Cromptons (Ltd.) have applied to the Government of Bombay for a licence for the supply of electrical energy to portions of Poona City, Poona Cantonment, Kirkee, the Poona suburban areas, &c., and an agreement has been entered into between them and Messrs. H. M. [illegible] and H. M. Watson (on behalf of the new company) for the purchase of the licence. The managing agents are Messrs. H. M. Watson and Co., Apollo-street, Bombay.

The Government has passed a resolution concurring with the report submitted by the Committee appointed in June last to advise the Government on the question of the charges levied by the Calcutta Electric Supply Corp. With rebates for prompt payment the present cash rates for current are 5 annas for lighting and 3 annas for fans, with further reductions in the case of large consumers, while the meter rent was reduced from Re. 1 to 8 annas in 1915. The Committee was of opinion that "there is a sufficient margin to admit of a further reduction in the cash price per unit for lighting. There has been a reduction of one anna since the agitation for lower rates commenced in 1914. This reduction was (the Committee think) unduly delayed and it would have been more fitting if the additional profits had been utilised in working out the loss on the old plant rather than increasing the dividend of the shareholders."

Electricity in Transvaal Collieries.—In the report of the Clydesdale (Transvaal) Collieries (Ltd.) it is stated that the original estimate of costs (£50,000) had been exceeded by £24,592, but a portion of this extra expense was for electrical plant not originally thought necessary.

South Africa.—The South African Railways Administration has under consideration the question of electrifying certain sections of the railway system, including the Wynberg line, the Sea Point railway, the Springs-Randfontein line on the Rand and some of the short railways in the neighbourhood of Durban and Pietermaritzburg. The conditions of the Simon's Town and Sea Point lines appear specially favourable for electric traction, as all coal employed on these sections has to be hauled from the north of the Union or from Natal.

FOREIGN NOTES.

Italy.—A consular report from Taranto states that a local firm wish to represent British makers of electric light fittings, and refiners of oils, chemicals, &c. Occasional visits from representatives of British firms are recommended.

Peru.—The following information is contained in a report by a Special Agent of the United States Department of Commerce :—

The principal demand for machinery and machine tools in Peru arises from the cotton mills and mines, but there is also a demand to some extent from the smaller industries. There is every reason to expect an increased demand for mining machinery in the future. Openings exist for the sale of prospecting tools and small engineering supplies, stocks of which are carried by local importers and dealers. Peru also offers a market for hydraulic machinery and for pumping plant. In time, as the small mines develop it is expected that the more prosperous of them will sooner or later instal compressed air or electric drills, dynamos, and the necessary repair shops will also require machine tools. In the meantime the small market should not be neglected. The various plants are widely separated, and long residence in the country is required in order to learn the peculiarities of the market and the reliability of possible customers. Moreover, it is hard to sell for cash. The probable market for the smaller kinds of industrial machinery is limited, and it would hardly pay any single manufacturer to send out a salesman.

Spain.—A concession for the construction and working of an electric tramway in Saragossa has been awarded to the Sociedad Los Tranvias de Zaragoza.

A concession for the construction and working of an electric tramway for goods traffic between Miravalles town and station has been granted to Chavarre, Petrement & Co.

Uruguay.—H.M. Minister at Montevideo states that imports into that port from the United Kingdom are being well maintained. Articles in demand are electrical goods, hardware, glassware, &c.

Venezuela.—The Ministerio de Fomento has granted permission to Van Dissel, Rode & Co., of San Cristobal, to construct a telephone line about 11 miles in length in the San Cristobal district (State of Táchira).

The British Consul at Ciudad Bolivar states that imports into his district in 1915 decreased by about one half, but British imports did not decrease quite to the same extent. The chief articles that might be imported from the United Kingdom are machinery, motor cars and accessories, glass and chinaware, pottery, &c. The present is considered a very favourable time for the establishment of a British firm, financially strong, to do business in Ciudad Bolivar. It must be prepared to offer generous credit terms and to accept produce in payment of accounts. The Royal Bank of Canada is shortly opening a branch at Ciudad Bolivar and would no doubt be of material assistance to a firm contemplating opening such a business as is suggested.

MISCELLANEOUS NOTES.

British Industries Fair, 1917.—Manufacturers who are exhibiting at the British Industries Fair have received their allotments of space from the Board of Trade during the last few days, and the work of erecting stands has begun.

The total amount of space applied for has again largely exceeded the space at the Board's disposal, with the result that exhibitors have found their allotments considerably reduced. For this year the Board of Trade have secured not only a portion of the Victoria and Albert Museum, but also the great Hall and certain Galleries in the Imperial Institute, which have been kindly lent by the Executive Council of the Institute and the University of London, the space covered by the fair will be considerably larger than last year, and the number of exhibitors will also be greater. The Fair will be opened on February 26 and will remain open till March 9. The London Fair, like all such undertakings, comes under the restrictions imposed by the Ministry of Munitions, and consequently certain trades, which would otherwise be included, cannot participate. The trades which will exhibit in London are: Toys and games, earthenware and china, glass, fancy goods, stationery and printing. At the London Fair, which is, of course, as in previous years, under the sole control of the Board of Trade, the charge for space will be 2s. a square foot, and exhibitors have no other expense except the cost of the erection of their stands. At last year's Fair many exhibitors had stands as small as 6 ft. by 6 ft., and their total expenses, including the erection of their stands, probably did not exceed £7. None the less for an outlay of that small amount many of them booked (it is stated) orders for several thousand pounds.

Under the system now adopted by the Board the duplication of invitations is done away with. When the Fairs were inaugurated in 1915 the exhibitors were asked to send to the Board the names of all buyers whom they would like to be invited, and many of them took advantage of the Board's offer, sending lists of names which ran into thousands. A card index was compiled containing all the names included in the hundreds of lists which were submitted by exhibitors, and an invitation was sent in the name of the Board to each individual and firm whose name was included in the card index, which now contains 77,000 names. New names are constantly being added to the index, and any names submitted by exhibitors are carefully compared with it, and, if necessary, added. The names of foreign buyers are classified under countries, and have an index of their own. They have been obtained from various sources, and number about 20,000. Each of them receives an invitation. In addition a supply of invitation cards and printed notices drawn up in the language of the country for which they are intended is sent to H.M. Consuls and Trade Commissioners all over the world, all of whom are requested to make the Fairs known in their respective districts.

Customs Duties.—According to recent Presidential Decrees the following import duties are payable upon importation of the goods mentioned into Venezuela :—

Electrical accumulators (to be declared as accumuladores electricos) 0·391 bolivares per kilog. gross (£11 0s. 10d. per cwt.), electric stoves over 60 kilogs. each 0·391 bolivares per kilog. (£11 0s. 10d. per cwt.), ditto up to 60 kgs. each, 0·704 bolivares per kg. (£19 17s. 8d. per cwt.).

Institute of Chemistry.—The results of the examinations of the Institute of Chemistry recently held in London have now been published.

Four candidates passed the final (A.I.C.) examination, viz.: In organic chemistry: J. W. Ingham, B.Sc., and E. W. J. Mardles, B.Sc.; in chemistry (and microscopy) of food and drugs, fertilisers and feeding stuffs, soils and water: Alan Haythornthwaite, B.Sc., A.R.C.S., and Ernest Paul, B.Sc.

Labour Exchanges.—At the recent meeting of the Dundee Chamber of Commerce, the president (Mr. Wm. Low) stated that the Labour Exchanges had been a failure.

The officials responsible for them recognised that they had been a failure, and they were now petitioning the Government to make it impossible to get people or for people to get employment except through the exchanges. They would require to watch the question carefully, for at times unofficial things of this sort had a way of being recognised through the persistence of people who were wanting the benefits.

Misleading Trade Names.—The Russian Consul-General in London (Baron A. Heyking) calls attention to the fact that certain private firms in the United Kingdom are adopting names which give the erroneous impression that they have received official recognition, and he desires to inform the public that a prefix such as "Anglo-Russian" to the style of a firm has not necessarily any official significance.

Trading With the Enemy.—The "London Gazette" of Jan. 19 contains additions to the statutory list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include: *Brazil*—Fabrica Metallurgica Allema (Sao Paulo); *Denmark*—Union Special Maxkin Kampagni Kjobenava (Ltd.) (Copenhagen); *Netherlands*—Electrische Vleeschwarin Fabr. (Hellegersberg, near Rotterdam).

Women and Engineering.—The Ministry of Munitions is extending its scheme for the employment of women on engineering work.

Classes for training in setting-up and skilled operating on various types of machines are being held in London, and the Ministry appeals to women of good education and physique, between 20 and 35 years of age, to undertake the training. The course will last from eight to nine weeks. Maintenance grants will be paid during this period, and those who become fully proficient for service in aero-engine or other munitions works may expect a minimum wage of £2 per week. Candidates must be prepared to accept employment in any factory to which they may be sent on the completion of their training and to work during the usual factory hours. Application in writing, giving particulars as to age, educational qualifications, and previous mechanical experience (if any), should be made to the Ministry of Munitions (Training Department), 6, Whitehall-gardens, S.W.

TENDERS INVITED.

Automatic Telephone Exchange.

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Copies of specification and conditions of contract may be obtained at the offices of the High Commissioner, 32, Victoria-street, Westminster, S.W., where tenders must be lodged by noon March 8. *See advertisement.*

Turbo-Alternators, Dynamos, Switchboards, Motors, &c.

Bedford Corporation is about to carry out extensions at the electricity works, comprising buildings, boiler-house plant, turbo-generator plant, steam and water auxiliaries, h.t. and e.h.t. switchgear, transformers and cables. In consequence of the present conditions and the urgency with which the works must be executed no detailed specification will be issued, but British manufacturers in a position to contract for any part of the works may obtain particulars by writing to the borough electrical engineer, Mr. R. W. L. Phillips, A.M.I.E.E.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of Melbourne electricity works. Tender forms from Messrs. McIlwraith, McEacharn & Co. Pty. (Ltd.), Agents for the City Council, Billiter-square-buildings, London, E.C.; tenders to Chairman, Electric Supply Committee, Town Hall, Melbourne, by noon March 5.

The Australian Commomwealth Navy Department, Melbourne (Victoria), require tenders by noon Jan. 31 for supply of Dynamos, Switchboards, Motors, Balancers and Control Gear for Flinders Naval Base. Specifications from Director of Navy Contracts, Melbourne, and the Naval Staff Offices, Brisbane, Sydney, Birkenhead (S. Australia), Fremantle and Hobart.

Public Lighting.

Banbridge Urban Council want tenders by 7.30 p.m. Feb. 3 for Public Lighting (gas or electric).

Electric Light Wire.

The Victorian Railway Commissioners, Melbourne, require tenders by 11 a.m., Feb. 7, for supply of v. r. Electric Light Wire (p. d. ½ per cent.). Particulars from the Contractors' Room, Railway Commissioners' Offices, Spencer-st., Melbourne.

Electric Cranes.

Tenders are required until Feb. 12 for the supply of six 4-ton Electric Travelling Portal Jib Cranes for Durban Harbour. Specifications from Secretary to Tender Board, S. African Railways Headquarter's Offices, Johannesburg, or from the High Commissioner for South Africa, 32, Victoria-street, London, S.W., at which addresses tenders will be received.

Cooling Towers.

Manchester Electricity Committee require tenders by 10 a.m. Feb. 2 for supply and erection of fan draught Cooling Towers at Stuart-street station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Train Lighting Cells.

The South African Railways Administration require tenders for the supply of 3,120 Train Lighting Cells, the approximate requirements for the year ending Feb. 28, 1918 (Tender No. 756). A revised drawing of the cells required may be inspected at the Railway Stores at Cape Town, Port Elizabeth, East London, and Durban and at the office of the Chief Railway Storekeeper, Park Station Chambers, Johannesburg. A copy of the drawing may be obtained from the Stores Offices mentioned on payment of 10s. 6d., to be refunded on receipt of tender and return of the drawing.

Electrical and General Stores.

MIDDLESBROUGH Corporation require tenders by first post Feb. 1 for 12 months' supply of Electric Lamps, Rubber Goods and General Stores. Specification, &c., from the Borough Engineer.

BATTERSEA (London) Council require tenders by noon Feb. 6 for supply of Various Stores and Materials for their electricity department. Forms of tender from the Engineer, Lombard-road, Battersea, S.W.

PEMBROKE (co. Dublin) Council require tenders by Feb. 5 for 12 months' Electrical Supplies, Ironmongery, Rubber Goods, &c. Specification, &c., can be obtained at the Town Hall, Ballsbridge, co. Dublin.

Tramway Materials and Stores.

The Tramways Committee of MANCHESTER Corporation invite tenders for the supply of Materials and Stores, including Motor and Controller Parts, Resistances, Coils, Trolley Poles, &c., Lamps, Switches, Bells, Insulation Material, Carbons, Overhead Equipment, Cable, Wire, Oils, Paints, Ironmongery, Bolts, Screws, Axles, Tyres, Castings, &c. Schedules from the general manager, Mr. J. M. McElroy. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by 10 a.m. Feb. 13. *See advertisement.*

HALIFAX tramways department require tenders by Feb. 12 for 12 months' supply of lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor-Bronze Wire, Brake Blocks, Trolley and Overhead Line Materials, Castings, Oils, &c.

TENDERS RECEIVED AND ACCEPTED

HORSHAM.—The Council have accepted the tender of Pritchett & Gold & Electrical Power Storage Co. for the maintenance of the new battery at the generating station for 10 years, at £45 per annum.

LAUNCESTON (TASMANIA).—The City Council has accepted the tender of the Australian General Electric Co., for 47 B.T.-H. motors, £1,481. 5s. 6d.

LONDON COUNTY COUNCIL.—The Council has accepted the following tenders:—

Pope's Electric Lamp Co., drawn wire, metallic filament lamps (estimated £2,472); Cryselco (Ltd.), metallic filament lamps (not drawn wire) (estimated £2,538); Maxim Lamp Works, electric lamps (£134); L. Andrew & Co., R. W. Blackwell & Co., G. Hattersley & Sons, Hooper's Telegraph & India Rubber Co., G. MacLellan & Co., Siemens Bros. & Co., insulating materials.

Ferguson, Pailin & Co., alterations and additions to switchgear (£2,444), and Brightside Foundry & Engineering Co., additional steam, exhaust and condensing water piping, &c. (£5,902), in connection with the third new turbo-generator at the Greenwich generating station.

Underfeed Stoker Co., mechanical stokers for four water-tube Stirling boilers at Greenwich generating station, £5,447.

Government Contracts.—The following tenders were accepted by the British Government Departments during December:—

War Office.—Dorman & Smith, distributing boards; British Ebonite Co., rod and sheet ebonite; J. Keith & Blackman Co and Sturtevant Engineering Co., motor-driven fans; Barton & Sons, Cable Accessories Co., Electrical Conduits (Ltd.), Eureka Conduits & Fitting Co., General Electric Co., Ingram & Kemp, Nettlefold & Sons, Oriental Tube Co., Perfecta Seamless Steel Tube & Conduit Co., Rainsford & Lynes, G. Roe & Sons, T. Saveker, Simplex Conduits (Ltd.), C. J. Thursfield & Co., Veritys (Ltd.), Walsall Hardware Mfg. Co., and Ward & Goldstone, elec. light fittings; Aster Engineering Co., Austin Motor Co., and A. Lyon & Wrench, generating sets; Dorman & Smith, and Lancashire Dynamo & Motor Co., switchboards and dynamos; Sperryn & Co. and J. H. Tucker & Co., switches; British Insulated & Helsby Cables, Callender's Cable & Construction Co., I. Frankenburg & Sons, Fuller's Wire & Cable Co., W. T. Glover & Co., A. Green (Ltd.), W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works, Liverpool Electric Cable Co., and Midland Electric Wire Co., elec. wire.

India Office.—Siemens Bros. & Co., cable core, transmitters, &c.

Post Office.—Wynn, Timmins & Co., wire repairing apparatus; India Rubber, Gutta Percha & Telegraph Works Co., British L. M. Ericsson Mfg. Co., and Peel-Conner Telephone Works, telephone apparatus; Bullers (Ltd.), telegraph pole arms and clamps; Telegraph Construction & Maintenance Co., submarine cable; Henley's Telegraph Works Co., Johnson & Phillips, and Siemens Bros. & Co., telegraph cable; Western Electric Co., loading coils; Edison Swan Electric Co. and W. G. Pye & Co., galvanometers; British Insulated & Helsby Cables, distribution cable plugs; P. Huntington & Co., cable suspenders; T. Bolton & Sons and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; British Insulated & Helsby Cables, copper wire.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Wellington (N.Z.) The capital expenditure of the electric lighting department is £231,553. Total loans raised amount to £176,900, sinking funds to £32,887 and depreciation fund to £59,961.

Revenue in the year ended March 31 was £67,623 (compared with £62,856 in previous year), working expenses were £28,508 (£28,259) and, after meeting capital charges and providing £7,871 (£7,941) for depreciation, the net surplus was £20,917 (£16,315). Units generated were 5,158,806 (4,829,474) and sold 3,865,486 (3,369,355).

Capital expenditure on the tramways department is £760,224 (increase £43,385), of which £130,557 was contributed from depreciation fund and £16,797 from revenue. Sinking funds amount to £76,015. Tramway revenue was £187,864 (against £167,331), working expenses were £118,817 (£111,138) and capital charges £41,927 (£40,824) leaving net surplus £27,120 (£15,369). The Wadestown tram-way revenue was £1,266 (£1,015) and the net deficit was £476 (£755), while the power supply revenue was £12,763 (£11,638) and the net surplus £1,306 (£311). The net surplus from tramways and power supply was £28,426, or, after deducting £6,952 for special works and amount written off preliminary expenses, £21,471. Passengers carried were 28,687,773 (25,517,515).

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

BROWNLIE & GREEN (LTD.) (145,806). Private company. Reg. Jan. 18, capital £30,000 in £1 shares (10,000 preference), to carry on the business of engineers, electricians, machinists, chemists, importers and exporters of and dealers in merchandise and produce. Reg. office: 2, Austin Friars, E.C.

N.S.O. MOTOR & ENGINEERING CO (LTD.) (145,765).—Private company. Reg. Jan. 15, capital of £5,000 in £1 shares, to take over the business of general and motor engineers carried on by J. J. Blackett and to carry on the same and the business of electrical engineers, &c.

MORTGAGES AND CHARGES.

BURNHAM & DISTRICT ELECTRIC SUPPLY CO. (LTD.).—Debentures dated Jan. 2, 1917, to secure £1,000, charged on company's undertaking and property, present and future. Holders: Lloyds Bank.

ELECTRIC CONSTRUCTION CO. (LTD.).—The whole of the £50,000 4½ per cent. redeemable second mortgage debenture stock secured by trust deed of Feb. 18, 1899, was redeemed by purchase in 1909-10, but resolutions were passed by the board to keep the stock alive for purpose of re-issue. By board resolution of Jan. 11, 1917, the whole of the said stock was cancelled and the property comprised in the trust deed has been released.

CITY NOTES.

MEMORANDA (Jan. 24).—Bank rate 5½ per cent. (since Jan. 18, 1917). Consols, 54⅛. Consols Pay Day, Feb. 1. Stocks and Shares Ticket Day, Feb. 8. Pay Days Jan. 26 and Feb. 9. Price of Silver, 37$\frac{5}{16}$d.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of one per cent.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—Mr. Samuel White has been elected chairman of this company, in succession to the late Sir George White, and Mr. Sidney Edgar Baker has been appointed a director of the company.

MONTREAL LIGHT, HEAT & POWER CO.—A quarterly dividend of 2 per cent. has been declared for the quarter ended Jan. 31.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—The directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference and ordinary shares in respect of the half year to December 31, 1916.

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NOTES.

The Rating of Electricity Works.

The rating of electricity works is one of those subjects on which the law unfortunately differs in England, Scotland and Ireland; consequently, what is a fair valuation in one country is not necessarily a fair valuation in one of the others. In this respect the Irish law is more advantageous to the occupier when it is a question of machinery, for although the plant supplying the motive power must be taken into account, this does not apply to machinery that is driven. This distinction may be a comparatively simple matter when dealing with a textile mill or an engineering shop, but the matter is more complicated when we come to electricity works. The question has recently been raised in an appeal by the Clones Electric Lighting Co., and, as will be seen from the account which we give on another page, the Judge gave a clear statement of the position of affairs according to Irish law. From the rating point of view there are three classes of property, namely, things movable, such as office furniture: things so attached to the freehold as to become part of it; and things which, though capable of being removed, are intended to remain permanently connected with the premises and are essential for their working. The things movable are never brought into account, and the things attached to the freehold are always rateable in both England and Ireland, but the third class is rateable in England and not so in Ireland, excepting the machinery for motive power. Arguing on these lines judgment was given to the effect that the gas engine and oil engine in this particular case are rateable, but the switchboard, shafting, dynamos and accumulators are non-rateable machinery. We do not doubt that this decision is good in law, but from the point of view of common sense it seems to us that electricity works occupy a very different position from that of other industrial establishments. In a textile mill, for example, the motive power is only one item of many, and not a very large proportion of the whole. The plant that is driven may be vastly more valuable than the plant supplying the motive power in many industrial works. In electricity works, on the other hand, we are dealing simply with the conversion of power and, consequently, the plant for motive power is a far greater proportion of the whole. It seems to us also that the matter would be very much complicated if an electricity works were to change over and take a bulk supply, merely converting by means of transformers or rotary converters, as the case might be. What then would be the proportion of plant supplying motive power?

The Sperry Searchlight.

THE account of the Sperry searchlight which we publish this week is interesting as showing the difficulties which have to be overcome in the problem of producing a source of light of very high intensity. If ordinary carbons are used difficulties are very soon encountered, as the forcing up of the current density does not produce the desired result. In the Sperry arc, vapour is used in the positive crater, instead of the carbon itself, as the source of light, and by this means a very much higher intensity is obtained, the statement being made that the brilliancy is 500 c.p. per square millimetre, as against 150 c.p. for carbon. For this purpose the positive crater is cored, the core being impregnated with suitable salts; but the chief difficulty appears to have been to concentrate the vapour and maintain it under control. This difficulty has been overcome by a combination of devices. The carbon itself is so proportioned that the core, which is comparatively large, burns away faster than the shell, and therefore incandescent vapour is obtained, as it were, at the bottom of a narrow cup. In order to avoid the burning away of the shell too rapidly, the carbon passes through a holder with air passages, through which a current of air flows; also the carbon is rotated, so that the burning away is symmetrical. It appears that the negative flame is so directed as to keep the incandescent vapour pressed into the positive crater. Again, the carbons are of quite small diameter, the positive being only 16 mm. in diameter for the 90 cm. searchlight: consequently, with a current of 150 amperes, the burning away is rapid, being about 20 cm. per hour, and on this account the carbons are made a metre in length. A very neat part of the equipment is the thermostat, by which the arc is brought into focus. Owing to the fact that the focal length is short, close regulation is essential. This is obtained by reflecting an image of the arc on to a thermostat consisting of two strips of metal. As soon as the image moves to one side or the other of the correct position the thermostat comes into operation, and regulation takes place until the arc is brought into focus. We recently had an opportunity of seeing one of these searchlights in operation, and we were particularly struck with the efficient action of the thermostatic control and the ingenuity shown in many other details.

Organisation of Provincial Electric Supply Companies.

THE present is essentially a day of organisation. Almost every branch of the industry appears to have its own society or committee to look after the particular interests involved. Thus, the municipal electric supply undertakings have their associations in London and the provinces. The electric supply companies in London have a committee and likewise the power companies. Quite recently the beneficial result of combined action was seen in a marked way when Mr. H. B. RENWICK organised an appeal on behalf of the electric supply companies to obtain an increase of the statutory percentage before excess profits were taken into account. This appeal represented the views of a large number of companies, and no doubt gained materially in weight by so doing. It was the provincial companies which gained particularly on this occasion, as their views would not otherwise have been represented collectively, and they have now come to the conclusion, as will be seen in another column, that combination is desirable in other matters. The Provincial Electric Supply Committee of Great Britain has, therefore, been formed, with Mr. H. B. RENWICK as chairman to look after the interests of the provincial companies. A strong Executive Committee has been formed whose members represent big groups of provincial companies, and have just the commercial experience necessary to deal with such subjects as rating, income tax, assessments, excess profits tax, legislation and other kindred matters. The General Committee is limited to Directors only. We hope that the provincial companies will support this movement heartily, for we do not doubt that in the near future private enterprise in the electricity supply industry will find combination even more desirable than in the past. Many problems are arising on which a settled policy should be followed, and unless these questions are considered on broad lines by some competent body immediately they arise the electric supply companies will no doubt suffer.

Lighting of Night Landing Grounds for Aeroplanes.—In the Final Report of the Committee on the Administration and Command of the Royal Flying Corps we notice that Mr. Charles Bright advocates the use of flame arc lamps instead of petrol flares for this purpose, as being more readily under control and giving the best light for penetration of fog.

Early Electro-Mechanical Interlocking on Railways.—In the "Railway Gazette" there has been some discussion regarding the date at which electrically-operated shunting signals were first introduced on railways. It has been stated that the first occasion on which such a system was used in the United States was at Gap, on the Pennsylvania Railroad, on December 30, 1909. On the other hand, electrically-operated shunting signals were installed at Victoria Station (London) in a form similar in principle to that now generally used on railways, as early as 1880. It appears, therefore, that in this matter the London Chatham & Dover (now South Eastern & Chatham) Railway forestalled the United States by 30 years.

Development of Magnesium Manufacture.—Magnesium compounds, besides being largely used for incandescent mantles, have now many important applications, and in particular have great possibilities in connection with the production of light by luminescence. According to a Paper by Mr. W. M. Grosvenor before the American Electro-Chemical Society, the United States in 1913 imported 38,000 lb. of metallic magnesium, chiefly from Germany, at a price in the neighbourhood of $1.15 per lb. The price rose to $10 after the outbreak of war, but in 1916 had fallen to $5, owing to the fact that magnesium works had been successfully started in France and England. It is stated that two American factories can now meet the general demand in that country, while a third factory is devoted entirely to the manufacture of magnesium for munitions.

The Advantages of Scientific Societies.—The desirability of our young engineers taking an active part in the proceedings of our scientific and engineering societies is well set out in the following extract from the presidential address recently delivered by Sir Maurice Fitzmaurice to the Institution of Civil Engineers.

> I am not at all sure that young engineers realise the importance of attending the meetings, joining in the discussions, and contributing Papers to this and other institutions. I don't think I have ever written a Paper, or got out notes for a discussion, without discovering that there were several points on which my information was deficient in some particular, which otherwise I should not have known it was necessary to look further into.
>
> It is extremely difficult in many cases for even a very good young engineer to get himself known, and the reading of Papers and joining in discussions is almost the only legitimate form of advertisement open to him. I can bring to mind, in my own experience, two cases where speaking at this Institution was the means of obtaining two excellent appointments. I happened to be particularly impressed by the practical remarks made here by two young engineers whom I had not known or heard of before. Very shortly afterwards I was asked to suggest men for two good posts, and after I had made a little inquiry I recommended these two men. They fully justified their selection, and I think are now on their way to high places in the profession.

"Revue Générale de l'Électricité."—On the 6th ult. there appeared the first issue of the "Revue Générale de l'Électricité," under which name will henceforth be combined "La Lumière Electrique" and "La Revue Electrique." This first issue opens with an article by Prof. A. Blondel, which should give pleasure to all readers, as it voices the importance of breadth of view in scientific journalism and in those who wish to keep abreast of developments, both theoretical and applied. As Prof. Blondel points out, there is a curious psychological phenomenon which results in the scientific engineer being looked upon as too practical by some of his co-workers and too theoretical by others. Similarly, the technical journal may appear too scientific to those engaged in industry and too practical by those who are engaged in pure science. The important thing is that a journal should include everything that is desirable and necessary for its readers as a whole. Above everything, it is important to maintain contact between science and technology. We notice that Prof. Blondel is in favour of much greater publicity on the part of those who are responsible for trade secrets, and he points out that it is undoubtedly advantageous for the engineers of manufacturing concerns to contribute to technical journals. If we may judge by the first issue of the "Revue Générale de l'Électricité," and by the long list of well-known men who are associated with the journal, this new departure should meet with great success.

OBITUARY.

G. A. HOBSON.—The death has occurred of Mr. Geo. Andrew Hobson, M.Inst.C.E., aged 62. He was a native of Leeds, and was formerly chief assistant to Sir Douglas Fox. He took part in the construction of the Mersey Tunnel and Railway, the Liverpool Overhead Railway, &c.

KILLED IN ACTION.—The following deaths in action or of wounds are reported:—

We regret to learn that Lieut. E. G. Waters, R.F.C., has been killed. Mr. Waters was in the service of Messrs. Ferranti Limited, and was the inventor of the Ferranti-Waters and the Callender-Waters systems of cable protection.

Flight Sub-Lieut. Neville W. Frames, of the staff of the Port Elizabeth (Cape Province) Municipality electricity department, was killed on active service in November last.

Lieut. Henry B. Hele-Shaw, R.F.C., 20 years of age, unofficially reported killed in aerial action, was the only son of Dr. H. S. Hele Shaw.

Lieut. Gilbert S. Hall, R.F.C., 27 years of age, who is reported to have died in an enemy hospital on Nov. 20, 10 days after being brought down with his machine by enemy fire, was a graduate of the Institution of Mechanical Engineers.

Second-Lieut. W. G. Moore Orr (Highland L.I.), aged 22, was an engineering student at the City and Guilds Engineering College when the war broke out. He was wounded on 11th ult. and died the following day.

Lieut. W. E. S. Ellis (Somerset L.I.), who was recently killed in action, was a student in engineering at Bristol University and had passed the inter. B.Sc. examination in engineering, when he joined the O.T.C. in 1915.

Sergt. Jas. Smith (Scottish Rifles), who has been killed, was formerly employed in the Blackburn Corporation tramways department. He had been awarded the Military Medal for bravery.

Pte. Jas. McLaughlin, formerly employed at Messrs. Dick, Kerr & Co.'s works at Preston, has been killed in action.

Gunner H. D. Whitworth, R.F.A., who has been killed, was formerly on the staff of the Birmingham Corporation tramways.

PERSONAL.

We learn that Mr. S. E. Bastow, who for the last four years has been joint manager of Messrs. Bruce Peebles & Co. (Ltd.), Edinburgh, has accepted the position of chief engineer to British Dyes (Ltd.). Mr. Bastow's headquarters will be at Huddersfield.

Mr. John H. Bunting, who for the last four years has been joint manager of Messrs. Bruce Peebles & Co. (Ltd.), has been appointed general manager of the company.

In consequence of Mr. Edmund L. Hill's resignation, Mr. H. T. Wilkinson has been appointed honorary secretary of the Engineers' Club, Manchester.

Mr. James J. Guest, B.A., has been appointed as from the 12th inst. Reader in Graphics and Structural Engineering, tenable at University College, in succession to Prof. W. H. Eccles, D.Sc.

Mr. J. M. M'Elroy, general manager of the Manchester tramways, has, at the request of the Admiralty, been released from his work to take up duties in connection with the organisation of shipyard labour.

WAR HONOURS.—Major Bertram Hopkinson, who has been awarded the C.M.G., is a son of the late Dr. John Hopkinson. He was called to the Bar in 1897, but on the death of his father started practice as a consulting engineer in partnership with Mr. Charles Hopkinson and Mr. Ernest Talbot, and jointly with his partners was responsible for the design of the electric tramways at Leeds, Newcastle and elsewhere. Since 1903 he has been professor of mechanism and applied mechanics at Cambridge University.

Sergt. P. Galley, York and Lancaster Regt., who has won the D.C.M., was a conductor on the Leeds tramways before the war.

ROYAL ENGINEERS (T.F.)—Sec. Corp. John Paley Yorke, head of the physics and electrical engineering depot at the Poplar School of Engineering, has been appointed Second Lieutenant in the London Electrical Engineers.

APPOINTMENTS VACANT AND FILLED.

Shift engineers are wanted for large power station in the Midlands. *See advertisement.*

A temporary charge engineer is wanted for the Borough of Southwark electricity department. Salary £3, rising to £3.10s., with bonus. Applications to Mr. D. M. Kinghorn, Electricity Works, Penrose-street, Walworth, London, S.E.

Mr. Joseph Mallagh has been appointed civil engineer to the Dublin Port and Docks Board.

Mr. E. J. C. Rennie, B.E., son of Prof. E. H. Rennie, M.A., D.Sc., Professor of Chemistry in the University of Adelaide, has been appointed acting lecturer in electrical engineering at Melbourne University, taking up the work of Mr. E. B. Brown, M.Sc., who has left for munition work in Great Britain.

INSTITUTIONS AND SOCIETIES.

Paris Academy of Sciences.—The programme and prizes for 1918 have been issued and include the following, which are open without distinction of nationality :—

La Caze prizes (two of 10,000 francs each), for the best work in physics and the best work in chemistry (the prizes cannot be divided); the Hébert prize (1,000 francs), to the author of the best treatise or most useful discovery in popularising or using electricity; the Hughes prize (2,500 francs), to recompense the author of an original discovery in physical science, especially eletricity and magnetism or their applications; the Danton foundation (1,500 francs), for the encouragement of researches relating to radiant phenomena; the Henry Wilde prize (one of 4,000 francs or two of 2,000 francs), for a discovery or work on astronomy, physics, chemistry, mineralogy, geology or experimental mechanics.

Association of Mining Electrical Engineers.—A joint meeting of the Notts and Derbyshire Branch of the Association of Mining Electrical Engineers and the Midland Branch of the Association of Colliery Managers took place at University College, Nottingham, on Jan. 15. A Paper was read by Mr. C. Jones on "Electrical Experiences in Collieries." Mr. F. Church, who presided, emphasised the importance to managers of collieries of a study of electrical matters, especially in regard to questions of safety.

Association of Municipal Electrical Engineers, South Africa.—The first congress of the Association of Municipal Electrical Engineers in South Africa took place on Nov. 15-20, 1915. No congress was held during 1916, owing to the absence of the president and other members on active service. It is, however, hoped to hold a congress during the present year, either at Cape Town or Durban, for which the following Papers have been accepted: "Tariffs," by John Roberts (Durban); "Standardisation," by John Roberts (Durban) and B. Sankey (Port Elizabeth); "Gas Plant," by F. Castle (Oudtshoorn); and "Design and Management of Small Power Installations," by E. J. Hamlin (Stellenbosch). The association, together with the South African Institution of Electrical Engineers, has for some time had under consideration the standardisation of sizes of plant, mains, material and supply pressures, and it is hoped that some definite proposals will be framed by a committee to meet at Johannesburg shortly. It is the intention to abide by existing British standards as closely as possible.

Rontgen Society.—At the meeting of the Röntgen Society on Tuesday next, February 6, Dr. E. E. Fournier d'Albe is to demonstrate his type-reading optophone by which blind persons are enabled to read ordinary letterpress by ear. Dr. Fournier d'Albe also proposes to show other properties and applications of selenium, including its direct action by which one lamp is made to light another without a relay. The meeting will be held in the Institution of Electrical Engineers on Tuesday next at 8.15 p.m. Visitors interested in the subject will be welcomed on this occasion.

ARRANGEMENTS FOR THE WEEK.

MONDAY, Feb. 5th.

WESTERN LOCAL SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

5.30 p.m. At Merchant Venturers' Technical College, Bristol. Paper on "The Parallel Operation of Electric Power Stations," by Mr. J. S. Peck.

TUESDAY, Feb. 6th.

ENGINEERS' CLUB.

7.30 p.m. At Albert-square, Manchester. Paper on "Enemy Influences in Great Britain and their Effect," by Mr. S. Ransome.

RÖNTGEN SOCIETY.

8.15 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. Dr. E. E. Fournier D'Albe will demonstrate his selenium apparatus for type reading for the blind, and will show other properties and applications of selenium.

THURSDAY, Feb. 8th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, W. Paper on "The Mechanism of Chemical Change," by Prof. F. G. Donnan, F.R.S. (Lecture II.)

GREENOCK ELECTRICAL SOCIETY.

7.45 p.m. Masonic Rooms, 22, West Stewart-street, Greenock. Paper on "H.T. Conduit Systems," by Mr. H. J. Roberts.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. At Victoria Embankment, W.C. Paper on "Frequency Changers," by Mr. R. Townend.

FRIDAY, Feb. 9th.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S.W. Annual General Meeting.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Col. C. B. CLAY, V.D., Commanding.

Orders for the Week.

Officers for the Week.—Platoon Commander C. H. C. Bond.

Next for Duty.—Platoon Commander L. C. Hughes Hallett.

Monday, Feb. 5.—Technical for Platoon No. 9, at Regency-street. Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.30 to 8.

Tuesday, Feb. 6.—A volunteer fatigue party is required to assist the Quartermaster.

Wednesday, Feb. 7.—Instructional Class, 6.15; Platoon Drill, Platoon No. 1.

Thursday, Feb. 8.—Platoon Drill, Platoon No. 7; Ambulance Class by M.O., 6 to 6.30.

Friday, Feb. 9.—Technical for Platoon No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.30 to 8.30.

Saturday, Feb. 10.—N.C.O's Class, 2.30, under Company Commander Fleming.

Sunday, Feb. 11.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday ration to be carried. Railway vouchers will be provided.

Musketry.—For all companies, *see* Notice at Headquarters.

Note.—Unless otherwise indicated, all drills, &c., will take place at Headquarters.

Appointments.—Corporal C. W. Smith to be Section Commander of No. 1 Section; Sapper H. G. Wood to be Corporal, both in No. 3 Company (dated Jan. 19, 1917). The appointment of Section Commander P. F. Allan is cancelled at his own request.

THE SPERRY SEARCHLIGHT.

We recently had an opportunity of seeing one of these very interesting searchlights in operation, and through the courtesy of the Sperry Gyroscope Co. we are now able to give an account of the development of this searchlight up to its present state of perfection. This work has been carried out under the personal supervision of Mr. E. A. Sperry, the chief engineer and president of the company.

The principal parts of any type of searchlight are the reflector, the electrodes and the lamp mechanism. As the searchlight reflectors had already reached a high degree of perfection and the parabolic silver backed mirror generally used could not be much improved, the only possible improvement in the output of searchlights lay in the increase in the intrinsic brilliancy of the source of light.

Up to the present time the standard source of light for searchlights has been the positive crater of the pure carbon arc. This pure carbon crater has a fairly constant brilliancy of 150 c.p. per square millimetre and, as carbon has the highest volatilistic point of any known substance, this was thought to be the highest intrinsic brilliancy attainable.

Attempts were first made to increase the power of searchlights by impregnating the carbons with certain special substances producing a white flame from the positive. This flame was not as bright as the positive crater of a pure carbon arc, but more light was obtained since the area of the light source was increased. These flaming arcs were unsuitable for projector work, however, owing to the large area of the light source and the fact that the crater brilliancy was lowered by the presence of the flaming materials.

It was observed, however, with certain types of flaming arcs that a bright spot would sometimes appear in the positive crater. This was found to be produced by a superheated gas or vapour produced from certain substances in the carbons, and though the size of spot was somewhat increased by using larger quantities of these substances it was very unsteady and could not be maintained for any length of time. Finally it was found that by using a high current density and a deep positive crater, the bright gases could be trapped in the crater by the flame from the negative and a steady spot obtained, having an intrinsic brilliancy more than three times as great as that of the ordinary carbon arc.

Though the principle of introducing light producing materials in the carbons is used in the high intensity arc, the character of the arc is quite different from the flaming arc, since the bright substances are concentrated in the positive crater instead of forming a bright flame above the arc. Indeed, it has been found that the successful use of the bright gas as a source of light depends entirely upon its concentration into a small area. The attainment of this end was the principal problem in the development of the high intensity arc, and though the supply of the bright vapour and the formation of the crater depend on the electrodes, the major part of this problem is that involved by the mechanism, since the maintenance of the proper crater, the most important factor in the operation of the arc, depends entirely upon it.

Special carbons have been developed by the Sperry Gyroscope Company, in which the problem of obtaining a constant supply of bright gas and the formation of a deep crater have been satisfactorily solved, and the objectionable features of this type of arc have been eliminated. With these carbons, a quiet and steady arc is obtained having an intrinsic brilliancy of 500 c.p. per square millimetre, and giving a very white and steady beam. By the combination of this high intrinsic brilliancy and the reduction of the area of the light source, a very powerful beam has been obtained. Tests made with the Sperry lamp show that this beam produces an illumination at the target more than 11 times as great as that produced by an ordinary carbon searchlight of the same size.

Requirements of the Searchlight Mechanism. Although, as stated above, special carbons are used in the Sperry lamp, the real problems in the production of the high power searchlight were not those involved in the development of the carbons, but those involved in the development of [illegible] mechanism for operating these carbons, since owing to the high temperature and special characteristics of the new arc, a number of problems were introduced which greatly increased the requirements of a mechanism for its operation.

Of these requirements, the most important was the necessity for cooling the positive carbon. It was found necessary to prevent the carbon from becoming so tapered by the action of the intense heat of the arc and the high current density that a suitable crater could not be formed to hold the bright vapour. One method that had been used to cool the carbons was to surround the end nearest the arc with an alcohol flame, which, on account of its comparatively low temperature, protects the carbon from oxidation, and thus prevents them from tapering. The Sperry Company state that it is difficult to get good results with this method.

In the Sperry lamp, the cooling of the positive carbon is accomplished very simply and effectually by a strong current of air from a small blower in the base of the lamp which forces the air through the hollow electrode supports and around heat radiating discs which form part of the carbon holders. This current of air not only cools the carbon, but forms a protecting shield between the positive holder and the arc, which permits the lamp to be tilted at any angle without endangering the positive head.

In addition to cooling the positive carbon, it is also necessary to rotate it in its holder in order to maintain a uniform deep crater in which the bright vapour can be held. If the carbon is not rotated the upper edge of the crater burns and allows the bright vapour to escape as fast as it is formed.

A further complication of the carbon holders is due to the necessity of feeding the carbons through the holders instead of feeding the holders themselves, as in the old type of searchlight. This is due to the length and small diameter of the carbons, which make it impossible to support the carbons or to supply current to them from the ends. In the Sperry lamp the rotating of the positive carbon and the feeding of the carbons through their holders is done through suitable gearing by the blower motor in the control box.

It was also found that the negative flame, which is used to keep the bright vapour pressed into the positive crater, must be carefully directed to effectually trap the vapour and not destroy the edges of the crater. The proper angle of impingement for each size of lamp has been carefully determined by experiment, and the negative head designed accordingly.

Owing to the large quantities of waste gases given off by the high intensity arc, forced ventilation of the searchlight drum is also necessary. This has been found extremely difficult in nearly all cases owing to the sensitiveness of this type of arc. With the Sperry system of air cooling, however, the lamp itself becomes a natural ventilator, since the exhaust air entrains the waste gases and fumes and carries them directly to the exhaust fan. In this way the waste gases are at once eliminated, and at the same time the arc is so protected by the exhaust air that the complete ventilation of the drum can be effectually carried out without disturbing the arc in the slightest.

The makers state that the other requirements of the new arc have also been completely satisfied by the Sperry lamp mechanism without undue complication or the introduction of further difficulties in the operation of the lamp. This mechanism provides for the entirely automatic operation of the lamp, even to a thermostatic control of the positive feed to keep the positive crater in the focal point of the mirror.

Description of the Sperry Lamp.

The Carbons. In the special carbons developed by the Sperry Gyroscope Company the object has been to obtain a steady arc free from unsteadiness and flickering, and to reduce the tail or exhaust flame to a minimum. These results have been obtained by the suitable combination of certain light-producing substances in the positive core, and a very steady arc produced in which the tail flame has been so reduced that it does not appreciably affect the steadiness or symmetry of the beam.

The deep positive crater required to hold the bright vapour is obtained by proportioning the cored positive carbons so that the core burns away faster than the carbon shell. The formation of this crater is further aided by the fact that the contact resistance drop at the positive is greater for the hard shell than for the core. The The greater part of the current therefore flows to the core, though this path is longer than that to the shell tip.

Owing to the small size of the carbons, a rapid burning of the positive carbon is necessary to secure a sufficient supply of the bright vapour required. The positive carbons are, therefore, made very long to avoid frequent renewals. For the 90 cm. searchlight, they are 16 mm. in diameter and 100 cm. long. The normal current for this size is 150 amperes, and the average rate of consumption about 20 cm. per hour.

The negative carbons are 11 mm. in diameter and 30 cm. long. They are made of solid carbon and are copper coated to protect them from oxidation, and to reduce the heating due to the electrode resistance. In order to prevent globules of molten copper from dropping off, this copper coating is made so thin that the copper is all volatilised as fast as the negative burns away.

The general appearance of the Sperry arc is shown in Fig. 1. The crater and the intensely luminous gas it contains is surmounted by a flame resulting from the combustion of the carbons. This flame consists of two parts, that from the negative being the larger and stronger so that the luminous flame from the positive is forced back and encloses the other as they rise together. Though this combined flame gives a small amount of light, it does not affect the steadiness of the beam.

With small currents (less than 100 amperes) the light producing gases escape from the positive crater and make the positive flame luminous as in a flame arc, but with the larger currents used the intense central jet in the negative flame has sufficient force to hold the bright gases in the positive crater. If this flame is not properly directed, it tears away the edges of the positive crater, allowing the bright gas to escape and throwing off pieces of the hot unconsumed material; this is entirely avoided, however, by the arrangement of the mechanism in the Sperry lamp.

The intrinsic brilliancy of the bright vapour in the positive crater is about 500 c.p. per square millimetre, and the distribution curve is much more uniform than in the pure carbon arc. Fig. 2 shows the candle power distribution curves for both the 90 cm. and 150 cm. sizes of the standard carbon arc and the Sperry arc. The maximum candle power for the 90 cm. size of the former is 44,000 over a small angle, whilst the Sperry arc shows a maximum of 104,000 c.p. with a very wide angle of high intensity. In more recent tests a maximum of 112,000 c.p. has been obtained for this size. A much greater amount of light is, therefore, available for the searchlight beam, and this with the decreased angle of divergence of the beam, due to the small area of the light source, produces an illumination at the target more than 11 times as great as with a carbon arc of the same size.

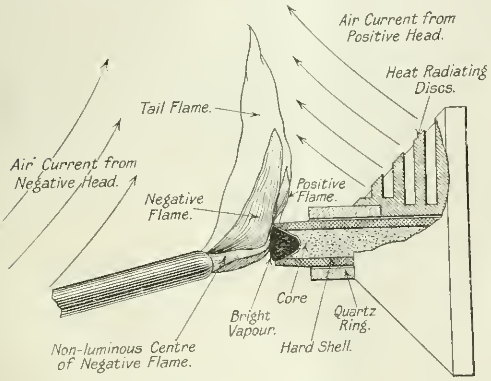

Fig. 1.—Diagram of Arc.

The theoretical candle power of the beam is given by the following formula:—

$$T=\frac{D^2}{d^2}\times\frac{p^2}{p^2+D^2}.\ I,$$

in which
T = theoretical candle power of beam
D = mirror diameter.
d = crater diameter.
p = four times focal distance.
I = mean hemispherical candle power.

The projector efficiency without shutters or with iris diaphram is stated to be 73 per cent. and with shutters, 65 per cent.

The Sperry Lamp Mechanism.—The general appearance and arrangement of the lamp mechanism are shown diagrammatically in Fig. 3. The actual searchlight mechanism differs somewhat from the diagram in mechanical details, as several improvements and simplifications have recently been introduced.

The cooling air is supplied through the hollow electrode supports 3 and 16 by a motor 20 and blower 22 in the control box. The air supplied to the positive holder is forced around a number of heat radiating discs, 12 surrounding the end of the holder nearest the arc, and escapes from a slot in the top. It therefore serves both to carry off the heat which is conducted along the carbon from the arc and also to shield the mechanism of the positive holder from direct radiation from the arc and its flame. The exhaust air escaping from the positive carbon holder tends to hold the arc flame in position and also entrains the waste gases from the arc and carries them off. This allows the lamp to be tilted at any angle without danger to the positive head, since the air blast always holds the arc flame perpendicular to the positive carbon.

The cooling air for the negative passes up the hollow electrode support and out around the carbon and the feeding mechanism. Less air is required to cool the negative, since it is protected from oxidation by its copper coating, and because the tip of the negative carbon is much cooler than that of the positive.

The rotation of the positive carbon is effected by the blower motor which rotates the positive holder 13 in its support by means of a gear train, 19, and the vertical shaft 17. The negative is not rotated. The current passes into the positive carbon through silver brushes, 14, which are pressed against the rotating carbon by springs, 15.

The positive holder is firmly fixed to the control box, and the positive carbon is fed through it, since the feeding of the holder is impracticable, owing to the length and small diameter of the positive carbons. This feeding is done by the blower motor by means of a gear train and a suitable mechanism in the positive head which forces the carbon through the head.

The positive crater is kept at the focal point of the mirror by controlling the rate of feed of the positive carbon either manually by means of handle 21 in the control box, or automatically by means of a thermostat and solenoid.

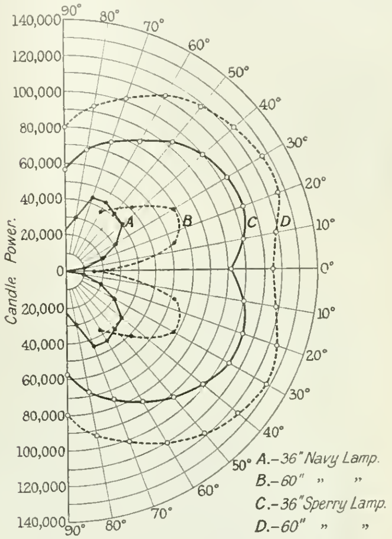

Fig. 2.—Candle Power Distribution Curves.

When the manual method is used, the positive is fed forward at a uniform rate and a lens projecting an image of the arc on a ground glass screen is provided to enable the operator to see the position of the crater. On this screen a line is drawn which indicates the correct position of the positive tip. The speed of the positive feed is varied by means of the lever 21, and when the carbon burns back too far the operator merely shifts this lever to increase the speed of feed and vice versa.

With the automatic method of control, a thermostat and solenoid, 18, are used. The thermostat consists of two strips of metal fixed at one end, and attached to multiplying levers at the other. These levers carry contacts at their ends which are opened when the ray from a focussing mirror strikes one of the metal strips. The focussing mirror and thermostat are mounted so that the reflected ray from the arc does not strike the rod when the crater is in its proper position. The normal rate of feed is more rapid than is actually required, but as soon as the crater is fed nearer to the mirror than the focal point the reflected ray strikes one of the rods, the contact is opened, and the feed interrupted until the carbon burns back to the correct position.

This thermostatic method of control has been carefully tested out under working conditions, and has been found to be satisfactory in every way. It automatically provides closer regulation than the manual control, and is reliable under all conditions, being entirely unaffected by changes of temperature or currents of air.

The negative carbon is also fed through its holder, but it is not rotated. The feed is controlled by means of the shunt solenoid, 11, and spring, 9. This solenoid is connected directly across the arc and moves a series of levers, as the voltage rises and falls, so as to cause the blower motor to feed the negative carbon backwards or forwards as required. The voltage across the arc may be regulated by varying the tension of the spring 9 opposing the shunt solenoid.

The negative carbon is moved back and forth by the knurled wheels, 1, which grip it. These wheels are driven by the voltage regulating mechanism in the control box through the vertical shaft 4. The negative carbon is inclined at an angle of 14 deg. to the horizontal, and the intense central jet of the negative flame is directed at the centre of the positive crater. The entire negative holder has been carefully designed to cast as little shadow on the mirror as possible.

The negative carriage 6 can be turned about 10 deg. to the right to permit new negative carbons being inserted from the front. When so turned, the second vertical shaft 5 is moved upwards a short distance by a cam, 7, and separates the knurled wheels so as to permit a new carbon to be slipped in place easily.

The negative holder is mounted on a carriage which slides in a track on the top of the control box. When the current is off, the carriage is moved up to the striking position by a strong spring, 8. When the arc is struck, a series solenoid, 10, moves the negative carriage and holder back to the proper running position.

Forced ventilation of the searchlight drum is absolutely necessary with all high intensity arcs to remove the gases produced by the rapid consumption of the carbons, since it has been found that unless these waste gases are drawn out of the drum at once they not only decrease the beam intensity by forming dense clouds in the drum, but also leave a deposit on the mirror and front glass. This deposit naturally reduces the reflecting power of the mirror and the power of the beam when the lamp has been in operation a short time. In addition, the deposits contain fluorides which attack the front glass and mirror, and greatly decrease their life and efficiency. By properly ventilating the drum, however, the clouding of the beam and corrosion of the mirror may be completely eliminated.

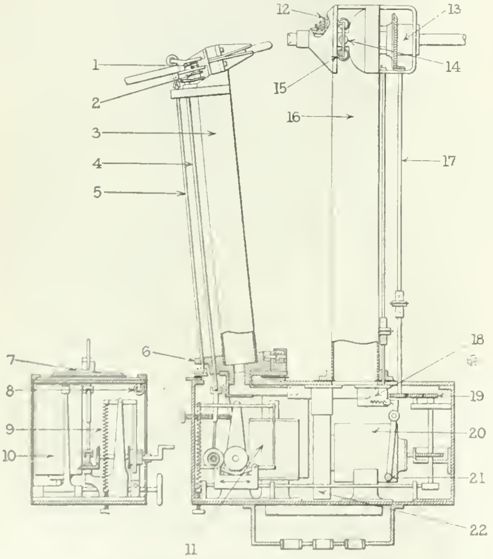

FIG. 3.—ARRANGEMENT OF LAMP MECHANISM.

In addition to the forced ventilation of the drum it is usually necessary, especially with mirrors of short focal length, to provide means of cooling the mirror and its supports to prevent it from being cracked by the intense heat of the arc.

As the high-intensity arc is very sensitive to outside disturbances, the forced ventilation of the drum has been found extremely difficult in nearly all cases. With the Sperry system of air-cooling the continuous current of air issuing from the carbon heads effectively shields the arc from any currents set up by the ventilating system, and large currents of air can therefore be drawn through the searchlight drum by the ventilating system without affecting the arc in the slightest. The lamp itself also assists the ventilation, since the exhaust air entrains the hot gases and fumes and carries them directly to the exhaust fan.

A method of drum ventilating which combines mirror cooling and fume exhaustion has been devised and incorporated in the Sperry searchlight. This system keeps the mirror and its supports at a uniform temperature, and also draws a large current of air through the projector, effectually removing all fumes and gases, and preventing any clouding of the beam or corrosion of the mirror.

The searchlight is provided with elevating and training motors and remote control apparatus when required.

ADJUSTABLE SPEED POLYPHASE INDUCTION MOTORS.

BY F. CREEDY.

One of the chief difficulties still remaining in the application of alternating currents to industrial work is the provision of a satisfactory variable-speed motor, more particularly in the case of polyphase machines of considerable size. After a comprehensive study of all sides of the problem it has been decided that the best solution is to be found by developing a new type of variable-pole machine, in which every polarity can be used, thus rendering available a number of different speeds which is ample for all purposes, with very rare exceptions. By this decision we recognise the fact that in the polyphase induction motor, especially when of the squirrel-cage type, we possess an almost ideal form of motive power whose advantages should not be sacrificed without grave necessity. Moreover, in a noticeably higher proportion of cases, large machines are required to have variable-speed characteristics, since they usually supersede an individual steam engine, which itself has excellent variable-speed characteristics, whereas smaller machines supersede line shafting, which necessarily runs at a constant speed. It is precisely in large machines that commutating troubles are likely to arise if we endeavour to use any form of polyphase commutator motor. This may be proved by attempts which have been made, particularly on the Continent, to utilise commutating cascade sets to avoid the necessity of placing a commutator on the main motor.

The new motor, which is built under the author's patents, is identical in construction with the squirrel-cage induction motor, but has a drum-wound stator or primary; this is divided into a number of sections which can be connected in either "mesh" or "star." From each section a terminal is brought out, which connects through a suitable controller to a phase converter, consisting of a specially wound transformer, whose function is to convert from the two or three-phase line current to a number of phases equal to that of the sections in the motor winding. By the use of this phase converter and a suitable controller it is possible to vary the phase difference between adjacent sections of the stator winding in such a way as to produce any desired polarity. In Fig. 1 is shown such a winding, having 13 terminals connected to a phase converter, giving 13 phases, in such a manner as to give two, four or six poles. If every terminal of the motor is connected in order to the corresponding terminals of the phase converter the phase difference between the adjacent sections of the motor will be the same as that of adjacent sections of the phase converter (that is 360 divided by 13 in the case shown) when the motor will operate as a bi-polar machine. If the motor terminals, starting from a given point, are connected to every second converter terminal, the phase difference between the sections will be doubled, and the motor will operate with four poles. Similarly, if the motor terminals are connected to every third phase converter terminal, the phase difference between adjacent sections will be tripled, and the motor will operate with six poles, and so on. In all cases, if the number of sections is properly chosen, one converter terminal goes to one, and one only, of the motor terminals, so that all terminals of both apparatus are in use on every polarity. By the use of a machine operating on these principles we secure the following advantages:

1. We are able to supply variable speed machines in all sizes up to the very largest without incurring commutating troubles, and, in fact, without departing from standard induction motor

practice. This in itself is no small matter, as the accumulated experience which has been gained since the introduction of the induction machine still remains available, instead of it being necessary to accumulate a fresh store, such as we should require if an entirely new type of motor were used.

2. The well-known advantages of the standard induction motor are retained, such as a squirrel-cage or slip-ring rotor, capable of satisfactory service under the roughest and dirtiest conditions, with the minimum of attention, &c.

3. Although more terminals and wiring are used than in single-speed three-phase motors, the wiring is correspondingly reduced in section, so that the total cross-section of copper in the wiring is exactly the same as in a standard machine, and thus has only half the section required for a two-speed machine with two separate windings.

4. The whole of the stator winding is always in use, so that there is no dead copper on the stator, as in the two-speed motor just mentioned.

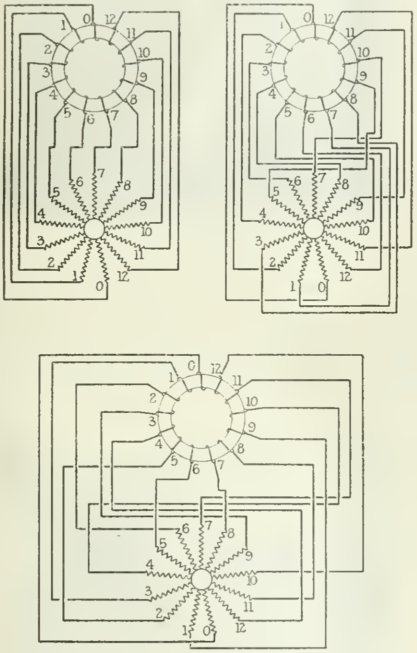

Fig. 1.

5. It is possible to offer a large number of steps in speed, from six in the 15 h.p. size up to nine in the 100 h.p. size, and even more in larger sizes, instead of two or three only.

6. The controller and phase converter form a separate unit, which can be placed at any convenient distance from the motor.

7. For reasons fully explained below, the difficulty as regards starting squirrel-cage motors is completely overcome, so that three to one speed range machines of the squirrel-cage type can be guaranteed to start at full load torque with not exceeding twice full-load current.

8. As compared with continuous-current variable-speed interpole shunt motors, the motor presents a very notable advantage. It is capable of giving the same torque at all speeds, and consequently a horse-power proportional to the speed, whereas a direct-current motor can only give its full torque on the lowest speed, since at all speeds above this the field has to be weakened. As a result of this, the direct-current motor will give no more horse-power at the highest speed than it will at the lowest, whereas the characteristic of almost every type of industrial apparatus is such as requires a constant torque at all speeds, and therefore a horse-power proportional to the speed. It will be seen, therefore, that the natural characteristics of the motor correspond much more closely with those of ordinary industrial machinery than do the characteristics of direct-current motors.

Having discussed the principle and some of the main advantages of the machine, it will now be of interest to describe more in detail an apparatus as it is actually constructed in an equipment recently completed.

The motor, which is shown in Fig. 2, consists of a massive cast-iron frame, which forms the base, supports the bearing brackets and holds the stator punchings, which are hydraulically pressed in and keyed on. The stator punchings contain semi-closed slots, insulated with mica, and these slots contain a lap-wound drum winding, of quite a normal type, which, however, is divided into a number of exactly similar sections, there being in the case described two coils per section. One end of each of these coils is brought to a common star point, while the other is taken to a terminal mounted on the stator frame. The rotor consists of laminated steel discs mounted on a spider, exactly as in a standard machine. This rotor carries a squirrel-cage winding of quite a normal type, which calls for no special remark. The bearings are of the journal type, lubricated by oil rings in the standard manner. Thus it will be seen that the motor differs from a standard induction machine in no respect except in the terminal block and the connections thereto. In fact, comparing the six-speed machine we are describing with a standard drum-wound three-phase machine, having, say, 10 poles, thus giving a speed midway between the highest and lowest speeds of a variable-pole motor, we see that such a machine will have 30 sections or groups in its stator winding, as against 31 in the variable-speed motor, these sections being interconnected among themselves, so that only three or six terminals need be brought out, while in the variable-speed motor no such interconnections exist, but each section of the winding is brought out to a separate terminal.

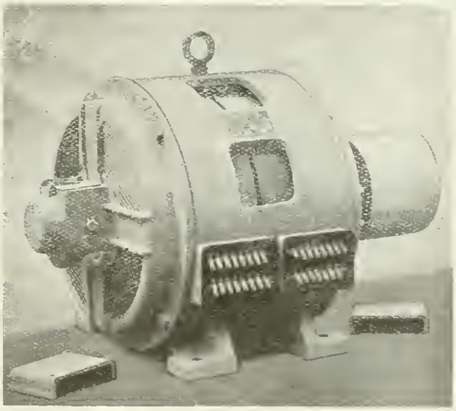

Fig. 2.—View of Motor.

We now come to the phase converter. This consists of a mesh-connected three-limbed three-phase auto-transformer, the coils lying on each limb being tapped at a number of points and connected to a secondary wound on another limb, in the manner shown diagrammatically in Fig. 3, where, for instance, *w y* is a section of the main three-phase winding of the converter, while *w v* or *x y* are secondaries, the manner in which they are connected being more clearly shown on the left. Fig. 3, of course, shows a 3 to 13 phase transformation, but in the case of the 3 to 31 phase transformation we are discussing, two of the coils on the three-limbed transformer are divided into 10 sections each, while the third has 11 sections. Each of these sections is wound and insulated separately, so that in the event of a fault occurring only one section will need repair. Each section consists of a primary or thick wire portion, part of the mesh connected three-phase winding and a secondary of thin wire, and very few turns, which will be one of the coils marked *x y* in the figure. Thus far it will be seen the phase converter is identical with a standard three-phase transformer, since these are also, as a rule, sectionalised for the purpose of minimising self-induction. The only portion of the phase converter which we have not yet described is the arrangement of the terminals and cross-connections. The terminals are arranged in a row mounted on the steel head of the transformer which is also used for clamping and lifting. They are connected to all such points as *w* and *x*. In order to give some idea of the size of the apparatus, it may be mentioned that it is about equal to that of a normal transformer to deal with 25 to 30 per cent. of the motor input. It is supported in a cast-iron oil tank, from which the wiring is carried by means of tubing.

Controller.—One of the first questions which occurs on consideration of such a variable pole motor as has been described above, is whether a controller can be designed to accomplish the requisite changes of connections readily and within reasonable compass. Very great attention has been paid to the design of this controller, which has resulted in producing an article representing the very highest class of switchgear practice, and accomplishing its object with a maximum of simplicity and compactness. Externally, the controller is arranged in the form of a standard drum-type controller, 36 in. high by about 15 in. square, with sheet steel cover, mounted in the usual way. This cover is shown on the left. When the cover is removed, however, the controller is seen to consist of a rectangular piece of $\frac{3}{8}$ steel plate bolted to the cast-iron head and base of the controller. On this plate are mounted a number of rows of studs, eight in a row, these studs being insulated from the plate by porcelain bushes $\frac{3}{4}$ in. long, each tested to 2,000 volts. By this construction, an ample creepage surface of at least $1\frac{1}{4}$ in. is ensured between adjacent studs, although they are only $\frac{1}{2}$ in. apart from metal to metal. Mounted vertically above and parallel to the plate, are two circular polished steel rods or guides, which support the sliding carriage to which the controller brushes are attached. This carriage consists of two vertical steel angle pieces, to which are attached the sliding bearings which surround the guides, and on which are mounted four horizontal brushholder arms. These arms are parallel to the rows of eight contact studs mentioned above, and consist of round steel rods, insulated with mica, and mounted so as to be readily detachable for inspection or adjustment. On each of these rods are mounted eight cast brass brushholders carrying a phosphor bronze brush, which is pressed into contact with the stud below by a spiral spring with screw and nut adjustment. In this manner, since each brush has its own individual spring, it is impossible for any of them to lose contact with the studs. In addition, however, the studs are carefully milled to a finish to ensure that they form an accurately plane surface.

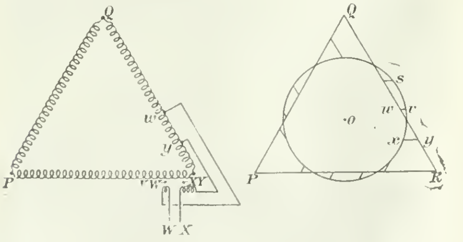

Fig. 3.

To each of the vertical supports which carry the brushholder arms, is attached a strip of insulating material, drilled for a number of bolts and nuts.

The brushholder carriage which we have just described, is actuated by a vertical lead screw and nut, the nut being carried on a cross bar parallel to the brushholder rods, while the lead screw is turned by a crank handle on the top of the controller, exactly similar to that of a standard drum-type controller. It will be noted that two of the studs which we have just described may be connected to different transformer sections, and hence a short-circuit between them, such as might be formed when the brush moves from one to the other, would form a short-circuit on the transformer, and, therefore, have very serious consequences. To avoid this, a special switch, known as a spark diverter switch, is fitted above the main field of contacts of the controller. This is actuated by a cam wheel, mounted on the lead screw, which also serves for notching purposes. These switches, which are arranged to break two out of the three line phases, consist of standard clapper switches, with circular carbon fixed contact, and copper moving contact, the fixed contacts being mounted by means of porcelain bushes on the steel plate described above. A notch is provided on the cam wheel, which engages with a roller attached to the two switches. When this roller lies in the notch, the switches are held in con-

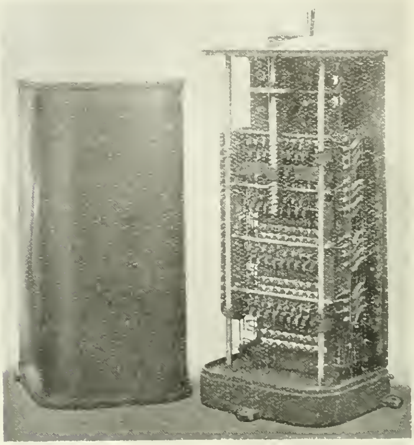

Fig. 4.—Front of Controller.

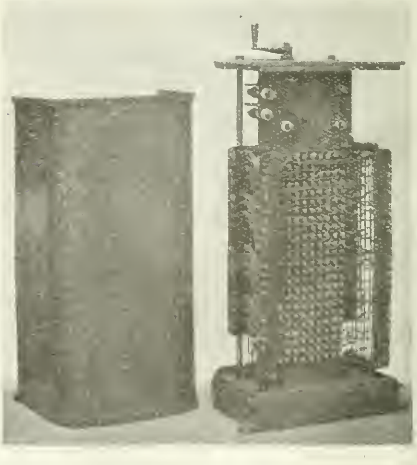

Fig. 5.—Back of Controller.

tact by means of a pair of spiral springs, and the motor is in operation. When we desire to change from one speed to the next, we turn the handle and this causes the roller to be forced out of the notch, which has the effect of lifting the two clapper switches, and breaking the main circuit. Having done this, a further motion of the handle moves the brushes from one set of studs to the next and when we have made a complete revolution of the lead screw, the roller falls into its notch again, thereby making the circuit, and the motor will operate on a different speed. An indicating arrangement, consisting of a star wheel engaging with a pin on the lead screw, is also fitted. Turning to the reverse or rear side of the steel plate, each of the studs is terminated by a pair of nuts between which the connecting wire is clamped. On either side of the studs are a number of vertical brass 'bus bars, mounted on a steel plate at the top and bottom. These 'bus bars connect through a hole in the base of the controller, with the phase converter terminals, and from them wires lying in the space between the horizontal rows of eight studs are taken to each stud. It will be seen that by this arrangement of wiring a very neat and compact job is secured, in spite of the somewhat elaborate nature of the connections to be made. Behind the 'bus bars, and at the extreme rear of the controller, are two strips of insulating materials, carrying the motor terminals. These motor terminals are connected to the corresponding screws fixed to the strip described above, as mounted on the sliding carriage, by means of a flexible connection, consisting of a copper or phosphor bronze spring. The range of motion of these springs is very small, and their construction being very substantial, they may be relied upon to last for many years. They are moreover, arranged to be extremely accessible for inspection, and repair, and can be wholly replaced at an extremely low cost. The front and rear of the controller are shown in Figs. 4 and 5 respectively.

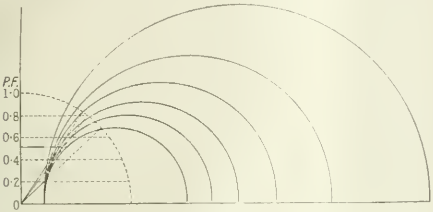

Fig. 6.

We have now fully described the equipment as actually supplied, and the next point of interest will be as regards its technical performance, particularly with respect to efficiency and power factor.

The machine as mentioned above is a constant torque machine, giving a horse-power directly proportional to the speed, and operating at all speeds with a constant field strength, thereby differing radically from the direct current motor, which owes its power of speed variation to the variation of field strength. Owing to the constancy of its field strength, the apparatus will absorb a constant magnetising current, whether running at high or at low speeds, and this is the main fact to be borne in mind in endeavouring to understand how the power factor varies with the speed. In Fig. 6 is shown a series of circle diagrams for such a motor, operating on all polarities from 6 to 16, absorbing the same magnetising current in all cases, and these diagrams assume that the leakage coefficient is proportional to the number of poles, being thus twice as great on a 12-pole machine as a six-pole. Experience has shown that this assumption is very nearly fulfilled in the type of motor we are discussing. The diagram also assumes a constant iron loss at all speeds. It will be seen that with constant power input, the power factor will be approximately the same, no matter what the number of poles. The diagram shows the maximum and minimum power factors, corresponding to a given input. The difference between either of these, and the average power factor will be seen not to exceed 3½ per cent. This may be further confirmed by the test curves of Fig. 13. Thus, we see that ignoring small differences due to variations in efficiency, the power factor depends only on horse-power load, and not on the speed. At low speed, of course, it is impossible to obtain a high power factor, but this is due to the small horse-power output of the machine. Fig. 6 also shows clearly the very great economy in starting current which we obtain in the pole-changing motor. It will be seen that on 16 poles the motor absorbs but one-third of the starting current taken with the 6-pole connection. Since the motor gives the same torque at all speeds the ordinates to each circle represent

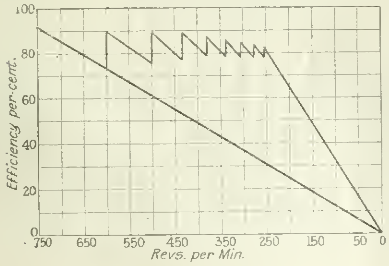

Fig. 7.

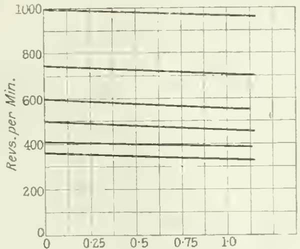

Fig. 8.

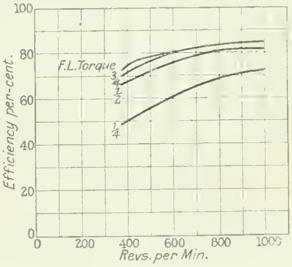

Fig. 9.

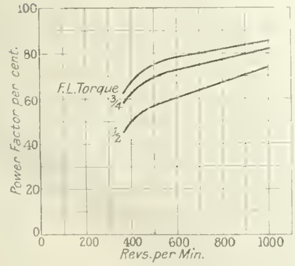

Fig. 10.

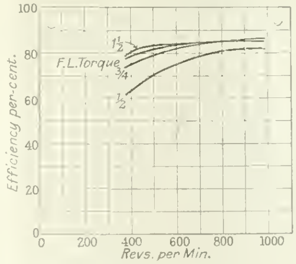

Fig. 11.

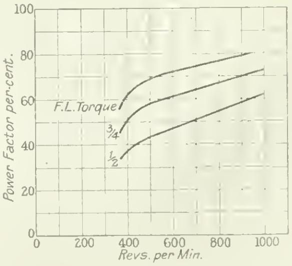

Fig. 12.

the torque to the same scale and hence in spite of the small current consumption the machine can nevertheless yield a powerful starting torque at the lowest speed.

The only thing, from the central station man's point of view, which need be borne in mind, is that these machines absorb a constant amount of wattless current, and that this amount is not greater than that absorbed by a standard machine, having the same rating.

Perhaps it may serve to make the matter clearer if we compare the equipment to a standard motor driving a load requiring a constant torque at all speeds through a gear box. At top speed the motor is fully loaded and operates with its best power-factor and efficiency. As the speed of the load is reduced by changing gear, the output of the motor falls off, and with it the power-factor and efficiency to some extent. To almost exactly the same extent do the power-factor and efficiency of the equipment described, fall off, when the load on it is reduced. In fact, the controller we have described may be regarded as an electrical method of changing gear.

In putting forward these machines to compete with other types, the two chief advantages which they possess may be considered to be as follows:

1. On every stop of the controller the speed is constant, that is, independent of the load; thus, as with a shunt control direct-current motor, and unlike the polyphase motor controlled by rotor resistance there is no tendency for the machine to slow up on heavy loads, or to speed up to an appreciable extent, when the load is light.

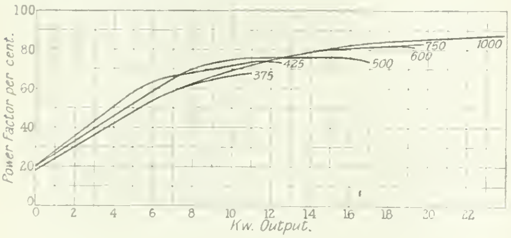

FIG. 13.

2. The second great advantage of the motor is its enormously improved efficiency, as compared with any other means of obtaining variable speed on alternating-current circuits. In Fig. 7 is shown a diagram of efficiencies in which the 9-speed motor is compared with a single-speed motor, controlled by rotor resistance. It will be seen that the efficiency of our machine is approximately double that of the single-speed motor. In fact, in machines controlled by rotor resistance, in spite of the reduction in the power taken by an apparatus at low speeds, there is no reduction in the power taken by the motor, the difference being wasted in the resistance, whereas in the variable speed motor just described, the power taken by the motor is reduced in practically the same proportion as that taken by the apparatus. Of course, owing to the fact that the constant losses remain approximately the same at all speeds, while the output is reduced in proportion to the speed, there is necessarily a slight reduction of efficiency at low speeds, amounting to about 10 per cent. If, on the other hand, we compare such a machine with a motor generator set, we see that the efficiency of the multi-speed alternating-current motor is about the same as that of the direct-current motor, and since the efficiency of the motor generator set, except in large sizes, is not likely to exceed 80 to 85 per cent., the overall efficiency of the multi-speed set will be from 15 to 20 per cent. higher than that of the motor generator set.

Performance Curves.—The equipment which we have just described has been now fully tested, the results of the tests being shown in Figs. 7 to 12. Fig. 8 shows the torque plotted against the speed for all six settings of the controller. It illustrates graphically the various points mentioned above, the wide range of speed and the close speed regulation between no load and full load.

Figs. 9 to 12 show efficiency and power-factor curves plotted against speed for cases in which the motor operates at full, three-quarter, half and one-quarter full-load torque. These curves show the performance for two distinct connections of the phase converter, which give different star voltages on the motor. In Figs. 9 and 10, which correspond to the lower of the two star voltages, we see that the full-load power-factor varies from ·85 per cent. at 1,000, falling off gradually to 70 per cent. at 125, and 63 per cent. at 375. Simultaneously, the efficiency varies from 85 per cent. at 1,000 to 70 per cent. at 125, and 72 per cent. at 375. It may be mentioned that on this connection the overload capacity varies from three times full load on the top speed to one-and-a-half full load on lowest speed. With the second connection, which might be preferred for some purposes, the efficiency is raised to 88 per cent. at highest speed, and 78 per cent. at the lowest, while the overload capacity is four times full load at top speed, and 1·85 at bottom speed. Simultaneously, however, the power-factor has fallen to 0·8 at the high speed, and 0·56 at the low, so that the first set of curves represents on the whole, the best all-round performance of the machine. Fig. 13 shows power-factor plotted against kilowatt output for all six positions of the controller.

These machines, which are thought to constitute a notable advance in induction motor practice, are being manufactured and placed on the market by Messrs. F. Parkinson & Co., Wells Works, Guiseley, Leeds.

RATIONAL TEMPERATURE GUARANTEES FOR LARGE A.-C. GENERATORS.*

BY F. D. NEWBURY.

Summary.—The Paper is an argument for the standardiastion of temperature guarantees when the guarantee is based on internal temperatures as measured by thermo-couples. It is recommended that in all cases the maximum safe operating temperature of the insulation be used as the temperature guarantee, instead of using a lower temperature. Curves are shown illustrating the temperature conditions in both stator and rotor of a typical large, high-voltage turbo-generator. Examples, based on these curves, are given to show that a low temperature-rise guarantee for the stator does not necessarily result in margin for overloads. This margin for overloads is the main argument that can be advanced in favour of low temperature rises. The only way in which the purchaser can be certain of overload margin is to have the specifications call for the maximum rating desired, in which case the maximum safe operating temperature may logically be made the temperature guarantee.

Operating engineers are familiar with the use of a single standardised guarantee of temperature rise by thermometer for large single-rated generators, and particularly for turbo-generators. The standard rise measured by thermometer was fixed at 50° C. because it was felt that this represented the maximum safe rise. It was recognised that with guarantees based on the temperatures of external surfaces, a single limit could not be fixed that would fit all cases; yet a single limit was fixed and has been adhered to in practically all commercial transactions. This standardised guarantee, moreover, takes no cognisance of the inherent variations in the actual temperature performance of individual units. A high-voltage generator and a similar low voltage generator under some conditions should be designed for quite different temperatures as measured by thermometer, yet both these units would be guaranteed for a rise of 50° C. in accordance with this established practice.

With the introduction of the thermo-couple or resistance-coil methods of measurement into contracts about three years ago, guarantees for "hot spot" rises as low as 40° C. were required in some instances. As the significance of the results obtained by internal measurements became better known, the specified temperature rises have gradually increased. With built-up mica insulation, a safe operation temperature of 150° C. may be guaranteed, and the corresponding temperature rise guarantee may be 105° C., or, in round numbers, 100° C. Yet even to-day there is no uniformity in guarantees. Temperature rises of 60° C. are often called for in specifications, even when mica insulation is employed, and practically all temperatures between 60° C. and 100° C. have been used as guarantees on one occasion or another.

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* Abstract of a Paper read before the American Inst. E.E.

In discussing maximum permissible rises, the author has in mind the limits allowed when mica or other Class B insulations are used.

From the standpoint of the designer of large generators, the desirability of a safe standardised temperature guarantee is apparent. When other conditions permit, full advantage can be taken of the heat-resisting properties of the insulation. In the largest generators, it is desirable and in many cases necessary that such advantage be taken in order that the safest mechanical design may be produced. There are so many real limitations imposed by the physical characteristics of the available materials that demand careful consideration that the imposition of additional "man-made" restrictions should by all means be avoided.

In a fair, sensible contract there should be no conflicting or inconsistent guarantees. It is now customary to include in many contracts for large generators a guarantee covering the total temperature that the insulation will continuously withstand without injury. Sush a guarantee of the insulation is virtually a guarantee of maximum capacity—so far as capacity is determined by heating and so covers, broadly, the same ground as the guarantee of temperature rise. Obviously, the two guarantees should be equivalent.

In considering the subject of low *versus* high temperature rise guarantees, one is apt to look upon a low rise in itself as an advantage just as low loss in a generator is an advantage. A temperature rise guarantee, however, is radically different in nature from a loss or efficiency guarantee. In the case of efficiency, any reduction in losses is of direct benefit. With temperature, on the other hand, the operator is only interested in temperature rise to the extent of knowing that it is safe; he is not primarily interested in temperature figures. If the operating temperature is safe, a lower temperature will be no safer and of no particular value.

The importance of a temperature guarantee lower than that permitted by the characteristics of the materials is frequently overestimated. It is felt, naturally enough, that this margin permits the generator safely to carry heavier loads than contracted for or to operate safely under abnormal conditions in emergency. The fact that the value of the guaranteed safe limiting temperature is based on continuous service gives sufficient margin for emergencies. For limited periods considerably higher temperatures are permissible, and this margin will cover any probable combination of emergencies. A completely mica-insulated generator has seldom, if ever, failed on account of insulation breakdown due to excessive loading in emergency. The limiting load is usually reached because of some other factor, such as turbine capacity, ability to maintain voltage, &c.

It may still be argued that a low stator rise is desirable on account of the margin it gives for continuous overloads. There would be a better basis for this argument if an equal margin were provided in the design of the generator in all other respects in rotor heating and exciting voltage particularly. But this is seldom, if ever, done. This at once makes it impractictable to take advantage of the assumed reserve capacity of the stator. Any increase in load, resulting in an increase in the temperature of the armature winding will cause a much greater increase in field winding temperature and voltage drop with this initial field temperature. Consequently, if an overload is contemplated, the temperature rise of the field winding at the nominal load should be approximately the same as that of the armature winding.

Some fundamental relations in large turbo-generators are illustrated by the curves, Figs. 1, 2 and 3. These curves will be used to explain, among other things, the above statement. Fig. 1 shows the variation of armature temperature rise with changes in load on the basis of 100°C. rise at 100 per cent. load. The rises in different parts of the stator are shown by the several curves. These curves are based on careful factory tests and may be considered as typical of the large, high-speed, high-voltage generator. Temperature tests were made at normal voltage and open circuit and at normal voltage and at various percentages of rated load. The temperatures at other than tested loads are taken as proportional to the losses involved. In the case of the cooling air, the temperature rise varies in proportion to the total losses of the generator; in the core, the temperature drop varies with the total stator losses (neglecting the relatively small loss dissipated through the coil ends); and in the case of the winding, the temperature drop through the insulation varies with the total loss in the embedded copper. These curves, which are only roughly approximate, give a picture of the temperature conditions in the stator of many of the large high-voltage turbo-generators that have been placed in operation during the past three years.

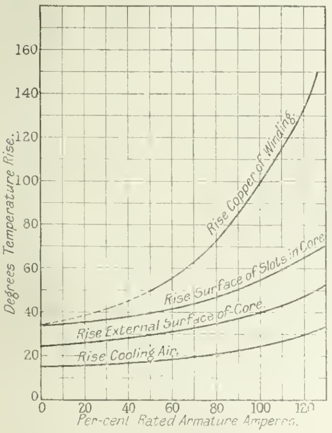

FIG. 1.—TEMPERATURE CONDITIONS IN LARGE TURBO-GENERATOR STATORS.

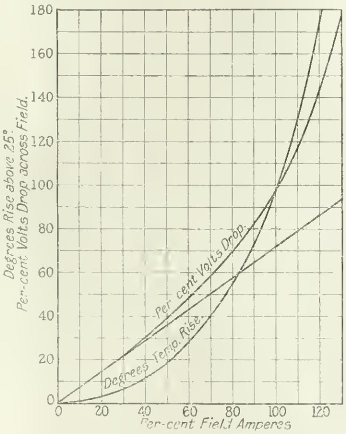

FIG. 2.—TEMPERATURE RISE AND VOLTS DROP IN LARGE TURBO-GENERATOR ROTORS.

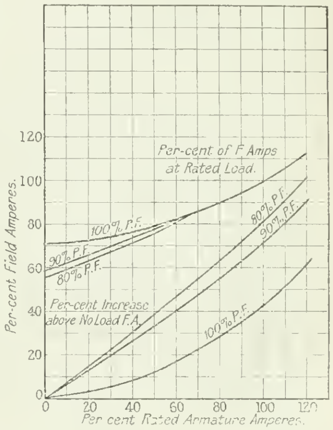

FIG. 3.—RELATION BETWEEN ARMATURE CURRENT AND FIELD CURRENT IN LARGE TURBO-GENERATORS.
Ratio of Field Amperes to generate Normal Volts on Open Circuit to Field Amperes to circulate Normal Armature Amperes on Short Circuit equalling 1·00.

According to these curves, in such a turbo-generator, at 100 per cent. of rated load, the cooling air rises 25°C.; the outside surface of the core rises 40°C. above the entering air, or 15°C. above the temperature of the discharge air in contact with this surface. There is a drop of 45°C. through the armature coil insulation, giving the total rise of 100°C. in the copper. It will be noted that nearly half of this total rise is accounted for by the temperature drop through the insulation, and consequently any material reduction in the total rise must involve a substantial reduction in the temperature drop through the insulation. In considering these curves it must be borne in mind that they represent the average generator of a particular class and are based on generators designed to operate at 100°C. rise in the stator copper at rated load.

On account of its importance it is well at this point to consider in detail the reasons for this relatively large temperature drop through the coil insulation and the factors that determine it. The temperature drop through the insulation is probably the most important single item in determining the copper temperature and is directly responsible for the greater part of the difference between temperature measured by mercury thermometers placed outside of the insulation on the coil ends and by thermo-couples placed so as to approximately measure the true copper temperature.

The most important path of heat flow in the stator of a generator having a long core is in the plane of the laminations, that is, from the copper of an armature coil, through the insulation, and through the sheet steel of the core to the air. The most important part of this path is the insulation. The temperature drop through the insulation is proportional to the heat transmitted, to the length of the path, to the cross-sectional area of the path and the heat resistance of the material.

A measure of the resistance to the flow of heat, or, more properly, a measure of the thermal conductivity, is that rate of heat flow, expressed in watts, that will cause a drop of 1°C. when transmitted through an inch length and a square inch section of the material. Values of thermal conductivity of composite forms of insulation are difficult to determine, because different samples, apparently similar, give widely differing results. This is largely due to the effect of air pockets in the insulation. For example, in tests made by Symonds and Walker,* solid mica was found to have a thermal conductivity of 0·00915 watt per inch cube, while built-up mica coil insulation had a conductivity less than one-third of this. It is safe to say that the degree to which air spaces exist in the insulation has more influence on the heat conductivity than does any difference there may be in the conductivities of the various component materials such as paper, cloth, varnish, mica, &c. From the best data available it appears that the heat conductivity of coil insulations, commonly used, varies from 0·0025 to 0·005 watt per inch cube of the material; the lower range of figures applies to the older hand-wrapped materials while the higher range covers insulation applied under heat and heavy pressure by machinery. From the standpoint of heat conductivity and temperature drop the importance of tightly wrapped, compact insulation is obviously very great.

When the rate of heat flow, expressed in watts, and the thermal conductivity and dimensions of the insulation are known it is possible to calculate the temperature drop through the insulation with a fair degree of accuracy. The determination of the rate of heat flow, however, involves two factors that require considerable experience to estimate; one, the proportions of the total heat that are transmitted along the copper to the coil ends and through the insulation to the core; and the other, the increase in loss due to eddy currents in the copper. Since the present purpose is only to show the order of magnitude of this drop and the reasonableness of the figure given for the typical generator in Fig. 1, it will be sufficiently accurate to assume that one factor offsets the other; that the eddy current losses are equal to the loss transmitted longitudinally through the copper. It will also be assumed that the insulation is as compact as it is possible to make it and has a thermal conductivity (including the air space between the coil and slot) of 0·0035 watt. It is usual in units of this class to work the copper in the neighbourhood of 1,600 amp. per sq. in., which results with slots of usual proportions, in a loss (considering only I^2R loss at the operating temperature as previously explained) of 0·6 watt per sq. inch of insulation surface. For 11,000 or 13,200 volts, a reasonable thickness of insulation from copper to core may be taken at 0·25 in. Using these figures the temperature drop may be calculated thus:—

$$\text{Thermal drop } ^\circ\text{C.} = \frac{\text{Watts} \times \text{thickness of insulation (inches)}}{\text{Surface of insulation (sq. in.)} \times \text{thermal conductivity}},$$

or thermal drop = 0·6 × 0·25/0·0035 = 43°C., and this checks with the 45°C. used in the typical curve.

It is apparent that the drop can be reduced by decreasing the watts per sq. in. (by decreasing the current density or increasing the slot surface, or by both) by decreasing the thickness of the insulation or by improving its thermal conductivity.

With existing insulating materials and methods it is not feasible materially to reduce this temperature drop by these latter methods. Neither can the slot surface be materially increased nor the current density be reduced except by correspondingly increasing the dimensions of the stator, and this may be undesirable or even impracticable.

The thickness of the insulation and therefore the thermal drop is a direct function of the rated voltage. At 2,400 volts, for example, the thickness of insulation and the drop are roughly half the corresponding values for 11,000 volts. While it is generally recognised that the internal temperatures in high voltage generators are greater than in low voltage generators for equal surface temperatures, it is, perhaps, not so generally appreciated that the temperature drop varies so directly with the thickness of insulation and amounts to such a large figure.

The question of temperature drop through the insulation has been considered at some length because it is the most important factor in determining the hot-spot temperature. If the magnitude of the temperature drop through the insulation is recognised, the difference between a 50°C. guarantee by thermometer and a 100°C. guarantee by a properly placed thermo-couple is immediately explained.

Fig. 2 shows the increase in field temperature and voltage drop with increase in field current. The temperature curve is based on the assumption that the temperature rise is rated load at 100°C. and is proportional to the loss at other loads. The loss and temperature rise increase considerably faster than in proportion to the square of the current, due to the increase in resistance with temperature. This factor becomes of very great importance at the relatively high temperatures at which turbo fields are ordinarily worked. Due to this effect and also to the second-power relation between the current and loss, the temperature rise increases at a greatly accelerated rate for current above normal. There is also a correspondingly rapid increase in required exciting voltage for field currents above normal. Even though the drop increases only in proportion to the first power of the current, the further increase due to the increase in resistance makes the total rate nearly as great as in the case of the loss and temperature rise. The drop on the basis of constant resistance is shown by the straight line in Fig. 2. The difference in the ordinate of this straight line and the total drop shows graphically the large effect of the change in resistance at currents above normal. To obtain only 25 per cent. increase in exciting ampere-turns, an increase of 60 per cent. in exciting voltage is demanded. This increase in exciting voltage is, in the majority of mica insulated generators, the real limit to overload capacity. The insulation used in the rotors of large turbo-generators with which the author is familiar is solid moulded mica between the copper and ground, and mica and asbestos tape between turns. Such insulation can obviously withstand temperatures of several hundred degrees, yet the total temperature is limited to 150°C., on account of the prohibitive increase in exciting voltage, just described, that occurs with higher temperatures. Thus, so far as the rotor is concerned, temperature is not directly a limit to capacity.

Fig. 3 shows the relation between armature amperes and field amperes in a large turbo-generator of average design proportions, and ties together the data given in Figs. 1 and 2. The three lower curves show the *increase in field current above the no-load value* for different power factors. In the upper curves this same data has been expressed as the *percentage of the full-load field amperes* at each of the three power factors. These curves show that in three different generators, one designed for 100 per cent. power-factor operation, a second for 90 per cent. power-factor, and the third for 80 per cent. power-factor, all having the same ratio between armature and field strengths, the increase in field current expressed as a percentage of full-load field current will be the same between 70 per cent. and 120 per cent. of rated load. For the present purpose, operating power-factor may therefore be disregarded, *providing the generator is assumed to operate at the power-factor for which it was designed.*

These curves may now be used to prove the statement, previously made, that, in order to provide additional capacity in a generator beyond the contract rating it is necessary that the temperature rise guarantees of the armature winding and of the field winding be approximately equal. If a generator has a true hot-spot rise of 60°C. in the stator and a rise by resistance of 100°C. on the rotor the promise of margin for overloads given by the low armature temperature will prove to be fruitless. To re-state this in the words of the original proposition; a low stator rise does not guarantee margin for overloads.

The question will be considered in two ways; first, to show what field winding temperature rise and exciting voltage are consistent with an armature temperature rise of 60°C.; and, second, to show what field winding temperature rise and exciting voltage will result when the load is increased so as to increase a low armature temperature rise to the safe operating temperature with a generator having an initial field temperature rise of 100°C.

Let it be assumed that a purchaser believes more margin in stator temperature rise is desirable in order to obtain margin in capacity for contingencies, and specifies that the stator temperature rise as measured by thermo-couple shall not exceed 60°C. What rotor temperature rise and what margin in exciting voltage should be specified in order that this expected margin may be realised? This condition requires that a consistently designed generator be assumed; that is, a generator capable of operating at the anticipated maximum load within the guaranteed safe limiting temperature of the insulation in both armature and field, and requiring an exciting voltage within that available, or, in other words, a generator having characteristics shown in Figs. 1, 2 and 3, at the maximum expected rating. This generator, as illustrated by Fig. 1, must be derated from 100 per cent. to 66 per cent. rating to meet 60°C. rise in the stator, so that a high voltage generator, of these relative core and copper temperatures, that meets 60°C. rise at its nameplate rating, can carry 50 per cent. overload continuously, and still operate within the same temperature of mica insulation. The relative core and copper temperatures may be varied somewhat in different designs, but on account of the magnitude of the core loss and winding loss, as compared with the stator copper loss, the feasible variation is not large.

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* "Heat Paths in Electrical Machinery," Harold D. Symonds and Miles Walker. Journal I.E.E., Vol. XLVIII, 1912, p. 671.

From Fig. 3, 66 per cent. of rated armature amperes requires 84 per cent. of the field excitation at 100 per cent. load. From Fig. 2, the temperature and exciting voltage at 84 per cent. field excitation are 64°C. and 76 per cent. respectively. Thus, consistent guarantees would be 60°C. by thermo-couple, for the armature, and 60°C. by resistance for the field winding, and the generator should be designed to require not more than 90 volts exciting voltage (on the basis of 125 volts available). In taking the required field current at the nameplate rating from 66 per cent. rating on Fig. 3, we have, in effect, maintained the assumed unity relation between armature and field strengths at the capacity rating. This results in a ratio of 1·5 at the nameplate rating, which is a higher ratio than would probably be used for a large two- or four-pole turbo-generator. In other words, in an actual design, the field would be relatively weaker than in the above case, and the increase in field current, temperature, and exciting voltage, would be greater than in the example and the guaranteed figures for the rotor should be correspondingly lowered. To complete the story, then, this ratio or an equivalent design figure, must also be specified.

The determination of consistent guarantees that will make certain a desired margin in generator capacity, no doubt appears, from this example, to be a complicated matter. It is, if the purchaser attempts to secure margin in capacity in this indirect fashion. If this margin is really desired, the purchaser should make the desired maximum rating and the contract rating the same, when all these difficulties will disappear. The low temperature rises will, incidently, also disappear from the contract.

To illustrate the second form of this question, assume that a generator has been purchased on the basis of a stator rise of 60°C. by thermo-couple and a rotor rise of 100°C. by resistance. It is assumed that both armature and field are mica-insulated. Thus there is a margin in capacity in the armature equal to 50 per cent. of its rating, while there is no margin, on the basis of the guarantees, in the field. If the load were increased to the limit of the armature, there would result a temperature rise in the neighbourhood of 400°C. in the field, and an exciting voltage would be required nearly three times normal. Of course, these are impossible operating conditions: with these assumed rises of 60°C. and 100°C. there is no possibility of taking advantage of the low armature temperature. Consider then a less extreme case. Let the armature rise be 80°C. when the field rise is 100°C. Then an increase in load of 16 per cent. (from 86 per cent. to 100 per cent., Fig. 1) is permissible, without exceeding the limiting safe rise of 100°C. This requires an increase of 9 per cent. in field excitation (Fig. 3); and results in a rise of 130°C. and a voltage drop across the field winding of 117 per cent. This would require an exciter voltage of approximately 150-volts on the basis of 125-volt excitation.

These examples illustrate the point already made, that a low temperature rise guarantee for the armature is not in itself a guarantee of operating margin; that the only way in which this margin can be surely obtained is for the purchaser to draw his specifications for the maximum rating desired. Obviously, at this maximum rating the maximum safe temperature rise may be used.

After all is said, the demand for low temperature guarantees is due to scepticism as to the real safety of the limiting temperature claimed for the insulating materials. Operating engineers may safely leave this question with the designers. In this particular field of design, assumed limits are being continually exceeded and extended. New designs are, from necessity, based on an experimental study of materials and on an analysis of constructions and of complex phenomena involved in the operation of the generator to a greater extent than on direct experience with similar machines. On no other basis could sizes of high-speed units have been increased in single steps from 10,000 kva. to 20,000 kva. or from 35,000 kva. to 50,000 kva. Under these conditions, the guarantees made in the contract are really of secondary importance as compared with the ability and experience of the designers. The situation is quite different from that existing with smaller medium-speed machines where the temperature and other guarantees are, in many cases, the operator's principal safeguard. With these large turbine units, each one representing an investment of several hundred thousand dollars, the designer must be conservative; chances cannot knowingly be taken. Whether the temperature rise guarantee is 100°C. or 50°C., or, if in the future it should become 150°C., the engineering public may rest assured that, everything considered, it is conservative. Those responsible for the fulfilment of contracts cannot afford to have it otherwise.

REPORT ON HIGH-SPEED TELEGRAPHY.

At the end of 1913 a Committee was appointed by the Postmaster-General to consider the question of high-speed telegraphy. As announced in our last issue, the report of this Committee has now been published.

The opening pages of the report deal with the subject in general terms and gives brief particulars of some of the systems which have been investigated during the last 30 years.

The committee considered it desirable to institute a series of tests designed to show as accurately as possible the best results which the various competing systems could produce under identical conditions. Unfortunately the outbreak of war in August, 1914, cut short these tests after the first of the series had been completed.

The committee held 28 meetings, and received evidence from the Creed-Bille Telegraph Co. (twice), Mr. Donald Murray (twice), Mr. John Gell, the Western Electric Co. of America, the Eastern Telegraph Co., Mr. Newlands, Controller of the Central Telegraph Office, two witnesses representing the provincial press, Messrs. Siemens Bros., and the Automatic Telephone Mfg. Co. Of the various witnesses Mr. Newlands and Mr. Ryan, assistant electrician in chief to the Eastern Telegraph Co., gave evidence at the request of the committee owing to their wide experience of the supervision of telegraph work. The representatives of the press gave evidence at their own request, and their evidence, as being that of customers of the Post Office, is in a special category.

After setting out the advantages and disadvantages of the various systems, the following conclusions are given:—

(i.) Systems on the multiplex principle are definitely superior to the automatic high-speed systems on the large majority of main circuits for ordinary inland commercial telegraph work.

(ii.) The extension of systematic Wheatstone working should be discontinued, and the question of displacing it by multiplex circuits taken up gradually.

(iii.) Of the multiplex systems at present available the Western Electric has given the best results. We recommend that a number of quadruple duplex installations of this apparatus be ordered. We think seven or eight such sets should suffice, as although present conditions favour the rapid application of systems with the greatest output, it is desirable to avoid too great a dislocation of working, and to allow time as far as possible for other makers to demonstrate their capabilities.

(iv.) Page or column-printing is preferable to tape-printing on the busiest routes, and the Western Electric Co.'s page-printing on a continuous roll of paper, cut off after each message, is quite satisfactory. Mr. Murray's system, with a separate sheet for each message, has been given a trial on his Manchester multiplex, but a fuller trial of his improved method will be necessary. We do not think it desirable that either page or column printing should be adopted throughout the service to the exclusion of tape-printing.

(v.) The five unit alphabet as a code for printing telegraphy is better than the Morse code, news traffic and submarine cable communications being left out of account.

(vi.) The application of type keyboard signalling instruments to the present Baudot circuits is desirable.

(vii.) Creed receiving apparatus can most profitably be used in the Post Office service for news work.

(viii.) The application of printing methods to the less important circuits should be kept steadily in view, and early trials of the one-way and two-way installations of the Western Electric and of the light line printer of the Automatic Telephone Mfg. Co. should be made. We are impressed with the possibility of two-way working with one operator at each end, both to signal their messages simultaneously to the other end and then both to gum the tape. An hourly load can be carried in this way equivalent to the average Morse load with two operators at each end, and having the additional advantage of printing the telegrams.

(ix.) The introduction of multiplex methods for news work will call for serious consideration in the near future.

(x.) The application of multiplex systems to give simultaneous communication on one wire between each one of three or possibly more offices should be kept in view as multiplex methods are extended.

(xi.) The pay and prospects of officers selected to be "leading operators" of multiplex circuits should be reconsidered.

The report bears the following signatures: Cecil Norton (chairman), J. Gavey, John Lee, W. M. Mordey, A. M. Ogilvie, W. Slingo, A. B. Walkley, and G. O. Wood (secretary).

A number of appendixes are attached giving some further details of apparatus and showing the nature of the proposed tests.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

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THE COOLING OF ELECTRICAL MACHINERY.

Many an hour may be profitably spent in studying the patent specifications dealing with the ventilation and cooling of electrical machinery. Given the best materials of their respective kinds and tolerably good design, electrical and mechanical, the design of a commercial dynamo machine is first and foremost a thermal problem. The attempts to solve this problem are to be found in patent specifications innumerable. Some of the methods that have been proposed are good in so far as advantage is taken of elementary thermal laws; others are bad because the faith of the inventor in himself appears to be greater than his knowledge of the laws of heat transmission.

As long as outputs per unit volume of material remained small it mattered little whether the cooling surface was well arranged or otherwise, because the allowable load was limited by other considerations. And, as in the case of heating surface in boiler experiments half a century previously, it was found that mere cooling surface had little or no effect on the performance of the machine. The so-called ventilating ducts in the armature of a small motor may be given as an example. Although such ducts are still very largely used, it is the experience of some of the most successful designers that the ducts may be omitted without affecting the measurable temperature rise. By providing a fan on a given armature it was found that the output could be greatly increased for the same rise of temperature. As an example may be mentioned one of a line of industrial motors. A certain frame without fan was rated at 40 H.P. at 600 revs. per min. the temperature rise being 65° F. The same frame with fan ventilation was rated at 60 H.P. at 620 revs. per min., the temperature rise being 60° F.

Several methods of cooling enclosed machines have been proposed. In one of these the same volume of air is passed repeatedly through the machine, and through an external cooling device formed in the foundations. Air is drawn in at one end of the machine and expelled at the other, the circulation being completed between staggered ribs formed in the box-shaped foundation plate. In this manner the heat is transmitted to the surrounding foundation. The ribs may be hollow, and air or water may flow through them. Another method is to fit a radiator, consisting of thin metal tubes, to trunk openings in the end covers of the machine. A fan fitted on the armature shaft causes a circulation of air through the machine and through the radiating tubes, and the arrangement is such that the air impinges on the thin vertical tubes, giving maximum cooling.

In regard to all these methods it is evident that neither of them can be regarded as a means of materially increasing the output of a given frame, because the difference in temperature of the machine and the cooling air is but small, as also is the difference between the temperature of the cooling air and the external air. Although we are prepared to admit that the addition of a radiator to a totally enclosed machine may result in a rating approaching that of a ventilated machine of given frame, we are, nevertheless, of the opinion that much greater differences of temperature will be necessary before it is possible to make any considerable increase in the rating.

Greater differences of temperature imply either an increase in the allowable temperature of the machine or a decrease in the temperature of the air surrounding the radiator. With materials as they are, no great increase in the allowable temperature can be expected. It follows, therefore, that before any great increase of output for a given frame can be obtained insulating materials will have to be improved so that the working temperature may be increased to about 250°C., or the temperature of the cooling medium will have to be decreased. Whilst it may be found profitable to adopt the latter method in the case of a machine of large output, it certainly will not pay in the case of a small machine.

It is with the high-speed machine of large output that the designer is seriously handicapped. As turbo-alternators go in these days, 15,000 k.v.a. is a machine of medium size. In such a machine the total loss is about 545 kw., and an enormous volume of cooling air is required for carrying away the heat due to this loss. According to Mr. B. G. LAMME, a simple approximate rule for determining the quantity of cooling air required is that an expenditure of 1 kw. in one minute will raise the temperature of 100 cubic ft. of air 18°C. Therefore, for a temperature rise of the outgoing air of 20°C. above that of the incoming air a loss of 545 kw. will necessitate a supply of ventilating air of approximately 50,000 cubic ft. per minute. Mr. LAMME states that air velocities as high as 5,000 ft. to 6,000 ft. per minute are common, while in some cases a velocity of more than 10,000 ft. per minute has been required in certain constricted sections of the air path inside the machines. To provide these large volumes of air, in addition to the gap method of ventilation, the circumferential and axial systems have been used.

If the ventilation of the small turbo-alternator was a difficult problem, it will be seen how much greater is the difficulty of cooling a machine of small volume in which the loss is from 1,000 kw. to 1,500 kw. Just as it was found impracticable to rely on natural methods of cooling in the case of a transformer, so, we imagine, will it be found impracticable to use air cooling for turbo-alternators of large output.

Indeed, recent patents foreshadow the adoption of forced cooling in such cases. In one method liquid is passed through one or more spiral ducts in the rotor by a pump mounted on an extension of the armature shaft. The liquid enters and leaves through concentric passages connected to the ducts by cross passages, and communicating with one another through tanks. Other longitudinal ducts extending through the rotor teeth at the bottom of the slots may be provided. Two or more spiral ducts may traverse the rotor and be connected at the ends by annular chambers formed in the rotor; or cooling liquid may enter one duct, and, passing through this, may enter the second duct at the opposite end, then passing back through the shaft to the pump.

In another method water or other liquid is introduced by a stationary pipe into an axial duct formed in the rotor, and after traversing this duct the liquid flows through radial holes into a series of pipes embedded in the rotor body. The liquid returns through these pipes towards the inlet end of the rotor, then flows radially inwards and out to an exhaust chamber through the space between the stationary pipe and the bore of the rotor spindle.

The fact that makers of repute are turning their attention to forced methods of cooling will, we hope, be attended by the same measure of success as that which attended the introduction of forced methods of cooling transformers. It may be that the air-blast method will still continue to be used for machines of small output ; but the objections to this method for the cooling of large transformers apply with equal force to the cooling of large alternators. Given a satisfactory forced system of cooling, and provided that, as our experience increases, higher working temperatures will be allowed than at present, it is likely that the future will see a greatly increased output per unit volume of machine.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(*Continued from page 522.*)

XIV. SPEED VARIATION WITH CHANGE OF LOAD IN ROTARY BALANCERS.

An expression will now be determined for the change in the speed of the set as unbalancing takes place. For a given armature winding, the speed is proportional to e/φ under all circumstances. The ratio of the unbalanced speed to the balanced speed is thus $e_3\varphi_0/\varphi_3 e_0$, or $e_4\varphi_0/\varphi_4 e_0$.
These ratios are the same as—

$$\frac{C_3R+2qV/100}{1-A}\cdot\frac{1}{e_0}\cdot\frac{\varphi_0}{\varphi_3},\text{ and }\frac{A}{1-A}(C_3R+2qV/100)\frac{1}{e_0}\cdot\frac{\varphi_0}{\varphi_4},$$

and these, combined by adding numerator to numerator and denominator to denominator, give the ratio as

$$\frac{1+A}{1-A}\cdot\frac{\varphi_0}{\varphi_3+\varphi_4}\cdot\frac{C_3R+2qV/100}{e_0},$$

which is

$$\frac{1+A}{1-A}\cdot\frac{\varphi_0}{\varphi_3+\varphi_4}\cdot\frac{C_3(R+2BV/100)}{e_0}.$$

This ratio may be differently expressed, starting from a different relation. For $e_3\varphi_0/\varphi_3e_0=e_4\varphi_0/\varphi_4e_0$, and either of these is equal to $(e_3+e_4)\varphi_0/(\varphi_3+\varphi_4)e_0$, and therefore to $\{2\varphi_0/(\varphi_3+\varphi_4)\}(1/e_0)(e_3+e_4)/2$. Analyse $(e_3+e_4)/2$.

$$(e_3+e_1)/2=V-CR-\frac{V_3}{2}\left\{\frac{R}{R_3}\cdot\frac{\varphi_3-\varphi_4}{\varphi_3+\varphi_4}\right\}$$

$$=V-CR-V\left\{\frac{\varphi_3-(\varphi_3-\varphi_1)CR/2V}{(\varphi_3+\varphi_4)+(R/R_3)(\varphi_3^2+\varphi_4^2)/(\varphi_3+\varphi_4)}\right\}\left\{\frac{R}{R_3}\cdot\frac{\varphi_3-\varphi_4}{\varphi_3+\varphi_4}\right\}$$

$$=V-CR-V\left\{\frac{\varphi_3(\varphi_3-\varphi_4)-(\varphi_3-\varphi_4)^2CR/2V}{(\varphi_3+\varphi_4)^2R_3/R+(\varphi_3^2+\varphi_4^2)}\right\}$$

$$=[V\{(\varphi_3+\varphi_4)^2R_3/R+(\varphi_3^2+\varphi_4^2)-(\varphi_3^2-\varphi_3\varphi_4)\}+CR(\varphi_3-\varphi_4)^2/2 \\ -CR\{(\varphi_3+\varphi_4)^2R_3/R+(\varphi_3^2+\varphi_1^2)\}]/\{(\varphi_3+\varphi_4)^2R_3/R \\ +(\varphi_3^2+\varphi_4^2)\},$$

which, after simplification, reduces to

$$(e_3+e_4)/2=\frac{V\{R_3/R+\varphi_4(\varphi_3+\varphi_4)\}-CR\{R_3/R+\frac{1}{2}\}}{R_3/R+(\varphi_3^2+\varphi_4^2)/(\varphi_3+\varphi_4)^2}.$$

The ratio of unbalanced speed to balanced speed is, therefore,

$$\{2\varphi_0/(\varphi_3+\varphi_1)\}(1/e_0)\frac{V\{R_3/R+\varphi_4(\varphi_3+\varphi_4)\}-CR\{R_3/R+\frac{1}{2}\}}{R_3/R+(\varphi_3^2+\varphi_4^2)/(\varphi_3+\varphi_4)^2},$$

which is equal to

$$\{2\varphi_0/(\varphi_3+\varphi_4)\}(1/e_0)\frac{V\{R_3/R+A/(1+A)\}-CR\{R_3/R+\frac{1}{2}\}}{R_3/R+(1+A^2)/(1+A)^2},$$

which is generally similar to the other expression, but contains R_3 instead of C_3. The physical meaning of this expression will be discussed later, in connection with a particular case, but it is clear that for normal loads, when φ_3 and φ_4 are not very different from each other, and A is, therefore, not very different from unity, the ratio of unbalanced speed to balanced speed is also not very different from unity, so long as $\varphi_3+\varphi_4$ is not very different from $2\varphi_0$, which is also generally the case for normal loads. Therefore, the balancer quickly settles to new conditions, and the disturbance of the system due to switching on load is a more or less momentary one. If the fields be set for a given value of A, and the superposed torques do not immediately balance each other, the set will adjust itself, by changing its speed, until not only e_4/e_3 is correct, but also e_4 and e_3 are individually just right to allow currents to pass which will give balanced torques. When that state is reached, q will have a definite value, dependent, in a way already indicated, on the condition of the system at the time considered.

XV. EFFICIENCY OF SYSTEM WITH ROTARY BALANCER ; TREATMENT OF BALANCER AS MOTOR-GENERATOR ; RATING OF BALANCERS.

When a rotary balancer is used, the efficiency of the whole system is high, this being the ratio of the out of balance load to the output required from the mains to produce it, so that $\eta=V_3C_3/(2VC_2+\text{shunt field loss})$. If R_S be the resistance of each field winding, $V_3^2/R_S+V_4^2/R_S$ is the total field loss, and

this is $(V^2/R_S)\left\{\left(1+\frac{q}{100}\right)^2+\left(1-\frac{q}{100}\right)^2\right\}$,

or $(2V^2/R_S)\left\{1+\left(\frac{q}{100}\right)^2\right\}$, or $2VC_{S0}\left\{1+\left(\frac{q}{100}\right)^2\right\}$.

Thus

$$\eta=V_3C_3/2V[C_2+C_{S0}\{1+(q/100)^2\}],$$

$$=(1+q/100)VC_3/2V[C_6+C+C_{S0}\{1+(q/100)^2\}]$$

$$=\frac{1}{\frac{200}{(100+q)C_3}[C_6+C+C_{S0}\{1+(q/100)^2\}]},$$

$$=\frac{1}{\frac{200}{100+q}\left[\frac{1}{1+A}+\frac{1}{C_3}\left\{C+C_{S0}\{1+(q/100)^2\}\right\}\right]}.$$

This can also be expressed by a relation of resistances, thus,

$$\eta=\frac{1}{\frac{200}{100+q}\left[\frac{1}{1+A}+\frac{100}{100+q}\cdot\frac{R_3}{R}\left(1-\frac{e_0}{V}\right)+\frac{100^2+q^2}{100^2+100q}\cdot\frac{R_3}{R_S}\right]}$$

Note that R is assumed to contain the resistance of all the windings which carry a main current, namely, series and interpole and armature windings, as well as the brush contact resistance, about which certain precautions have already been mentioned. If the series winding is coupled in the middle wire, as is often done, instead of being directly in series with the armature, some equivalent amount must be added to R, bearing in mind that C_2 is approximately half of C_3. As regards the value of the efficiency in actual percentage, as the values given in Fig. 13 are rather misleading, because R has been chosen purposely high in order to get some of the curves in later sections to show certain characteristics sharply, consider for the present case a small set arranged for level compounding, with A adjusted to 0·85, say, and with C about 5 per cent. of C_2 at full load and C_{S0} about equal to C. Then, as C_2 is approximately $C_3/2$, $C=C_{S0}-0{\cdot}05C_2=0{\cdot}025C_3$. Hence, $\eta=0{\cdot}5/\{(1/1{\cdot}85)+0{\cdot}025+0{\cdot}025\}=0{\cdot}5/0{\cdot}59=85$ per cent. at full load. As it is only in a small set that C and C_{S0} are as high as 5 per cent. of the full-load current of the machine, this shows that a relatively high value can be obtained for the efficiency of the whole system. The value thus calculated is for the out of balance part only ; if there be in addition a balanced part of the load, coming from the mains at 100 per cent. efficiency, the total efficiency will be still higher.

When C_5 becomes greater numerically than C, so that C_1 may be considered as a current generated by the armature and sent round the local out of balance circuit to make up, with C_2, the required value of C_3, then the two machines are capable of being considered as an ordinary motor-generator set. It may easily be shown that the input to the motor armature, less all the losses in the two armatures, is just equal to the output of the generator armature. The losses are C_1^2R and C_2^2R for copper and brush contact loss, and e_3C and e_4C for core, friction, windage and brush friction. The input to the motor armature is V_4C_2. Thus the set is a simple motor-generator if $V_4C_2-C_1^2R-C_2^2R-e_3C-e_4C$ is equal to the generator output $-V_3C_1$, which has a negative sign, since C_1 is opposite in direction to C_2.

Remembering that $e_4C_6=-e_3C_5$,

$$\begin{aligned}V_4C_2-C_1^2R-C_2^2R-e_3C-e_4C&=e_4C_2+C_2^2R-C_1^2R-C_2^2R\\&\qquad-e_3C-e_4C,\\&=e_4C_6+e_4C-C_1^2R-e_3C-e_4C,\\&=-e_3C_5-C_1^2R-e_3C,\\&=-e_3C_1-C_1^2R,\\&=-C_1(e_3+C_1R)=-V_3C_1,\end{aligned}$$

which is the generator output. Hence what was stated above is true; but, as there are times when both machines are running as motors, the treatment as a motor-generator is not so universal as the method developed previously. The efficiency of the set itself, which must be clearly distinguished from the efficiency of the system as a whole, is $-V_3C_1/[V_4C_2+2VC_{s0}\{1+q/100)^2\}]$. It is not specially important to know this efficiency as a rule; what is important is that it should be reasonably high, so that the system as a whole may be as efficient as possible.

In settling the size of the machines to be used to form a rotary balancer, it is necessary to remember that for maximum out of balance conditions with, say, level compounding, one armature carries considerably more current than the other. The value of A for level or over compounding is always <1; hence C_6 is always a greater number of amperes than C_5. The current in the right-hand armature is $C+C_6$, while that in the other armature is $C+C_5$; but C_5 is opposite in direction to C under usual circumstances, so that $C+C_5$ is numerically less than C_5 when the armature is generating. Hence, as C_2 is $>C_6$ and C_6 is $>C_5$ and C_5 is $>C_1$, considered numerically merely, C_2 is certainly greater than C_1. As each is of the general order of $C_3/2$, and as the average voltage on each side is V, a first approximation to the rating is to take the output as $VC_3/2$; but there must be sufficient margin in the armature winding to carry the larger current also. As regards speed, owing to the machines having to act as differentially wound compound-wound motors, as will be more fully described later, the full field strength of the machines, which would be used, say, if they were wound as standard shunt-wound motors, cannot be obtained, and the speed must be reckoned as of the order of 10 per cent. higher than would be given by the same armature generating $C_3/2$ amperes at V volts in a normal field. Thus with, say, a 10 per cent. increase for margin in current, and 10 per cent. for the weak field, the frame size will come out about one-fifth larger than would be required for a machine of output $VC_3/2$ with normal full field strength, designed to run at the same speed as is chosen for the balancer. Interpoles are usually advantageous, as they give the set a great overload capacity, and enable it to stand up to sudden rushes of current excellently. Care should always be taken to specify clearly what a balancer is required to do, and the best way of doing this is simply to say how many amperes in the middle wire the balancer has to deal with. To give the out of balance load as a percentage of the full load of the main generator is confusing, because it is never certain whether the reference is to the current output of the generator or to the kilowatt output of the generator, the latter involving just twice as many middle wire amperes as the former. Thus, in a 500-volt 500 kw. generator, 10 per cent. of the current is 100 amperes in the middle wire, or 25 kw. out of balance load, while 10 per cent. of the kilowatt is 50 kw. or 200 amperes in the middle wire. This uncertainty cannot occur if C_3 is given in amperes.

XVI. General Performance Curves of Rotary Balancers with Level Compounding.

Using the numerical values given in Fig. 13, it is possible to construct representative curves showing the whole course of events in a balancer over its entire range of working. The fixed data are: $2V=500$, $R=1\Omega$, $C=5$ amperes, $e_0=215$ volts, and the variables are all the rest of the quantities. But these variables are not independent of each other, and if B be fixed for any case then everything can be plotted in curves against C_3, except the actual values of the individual fluxes, as it is only the ratio of fluxes that is dependent on C_3. Four typical cases will be considered, namely, those for $B=+1/10$, $B=0$, $B=-1/10$, and $B=-1/5$.

Starting from C_3 as the independent variable, q is known because $q=BC_3$; V_3 and V_4 are known from q and V; R_3 is known from V_3 and C_3; A is known from B, C_3, e_0/V and R; e_3 and e_4 are known individually from A, C_3, R, B and V; C_5 and C_6 are known from C_3 and A; C_1 and C_2 are known from C_5, C_6 and C; and φ_4/φ_3 is known from A. The ratio of unbalanced to balanced speed is $\{C_3(R+2BV/100)\}(1/e_0)\{(1+A)/(1-A)\}\{\varphi_0/(\varphi_3+\varphi_4)\}$. The relation of $\varphi_3+\varphi_4$ to φ_0 is not known, unless the magnetisation curve of the machines is known, but $\{C_3(R+2BV/100)\}(1/e_0)\{(1+A)/(1-A)\}$ is definitely known, and can be plotted against C_3, to be used as a multiplier of $\varphi_0/(\varphi_3+\varphi_4)$, when the latter is known. To each value of C_3 there correspond two values of A, because of the $\pm$ sign of the square root in the expression for A. In all cases in the practical region, when compounding is reasonably good, the expression under the square root is a diminishing one as C_3 increases numerically in the positive or negative direction, and becomes zero for two definite values of C_3, one positive and one negative. At these values of C_3 all the quantities dependent on A turn backwards, as each of them also has two values for each value of C_3, and these two points are where the two sets of values meet. The curves for A, e_3, e_4, C_5, C_6, C_1, C_2, and the speed change multiplier, therefore, all have limiting turning values at these two values of C_3. The quantities V, V_3, V_4 and C_3, which are not dependent on A, do not turn back at these points; but as A, and all the quantities dependent on A, become imaginary after these points are passed, it follows that, although there are mathematical solutions for them at values of C_3 which lie outside the limits, these solutions have no physical meaning. The meaning of the turning point is that for values of C_3 greater than the limit there are no real values of e_3, e_4 and the rest, which will make it possible to maintain the compounding denoted by B, which is the specified constant for the curve. In the particular numerical example chosen, $B=-1/5$ gives the greatest undercompounding at which A has a turning value. Beyond that, A never becomes imaginary, but these cases are outside the region of practice, so that, while extremely interesting from a mathematical point of view, they have no bearing on the present subject. The condition $B=-1/5$, as will be shown, represents the case where $e_3=e_4$ always, that is, where the shunt windings are in series across the mains and not connected to the middle wire, and no series winding is acting. With the shunts connected to the middle wire and crossed, and acting without series, e_4 is always less than e_3, and this leads to values of B nearer zero. This is the scheme of field connections adopted in actual balancers, with or without the addition of series windings to give still better compounding of the system.

The turning value is when

$$(100e_0/V)^2-\{2B\,.\,100R/V+(100R/V)^2\}C_3^2=0,$$

or when
$$\begin{aligned}C_3^2&=(e_0/V)^2/(2BR/100V+R^2/V^2)\\&=e_0^2/(R^2+2BVR/100),\end{aligned}$$

that is, when

$$C_3=\pm e_0/\{R^2+0\,.\,02BVR\}^{\frac{1}{2}}=\pm 215/\{1+5B\}^{\frac{1}{2}}.$$

For $B=+0{\cdot}1$, 0, $-0{\cdot}1$ and $-0{\cdot}2$ respectively, the turning points are at $C_3=\pm 215/\sqrt{1{\cdot}5}$ or $\sqrt{1{\cdot}0}$ or $\sqrt{0{\cdot}5}$ or $\sqrt{0}$ $=\pm 200{\cdot}01$, ± 215, $\pm 316{\cdot}18$ and $\pm\infty$ respectively.

In Fig. 14, curves are shown for the case $B=0$, for the whole range from $C_3=-215$ to $C_3=+215$. The practical meaning of negative values of C_3 has already been pointed out to be that C_3 has changed over to the other side of the system, and the curves on the two sides of the vertical axis are like each other in shape, but refer to e_3 on one side and e_4 on the other at corresponding parts; a similar relation holds good between the curves for C_5 and C_6, and between these for other pairs of quantities. A, for any value of C_3, is the reciprocal of A for $-C_3$ of the same numerical value, as would be expected from the physical meaning of the curves.

For, A for C_3

$$=\frac{-BC_3\pm\sqrt{[(100e_0/V)^2-\{2B\,.\,100R/V-(100R/V)^2\}C_3^2]}}{+BC_3+100e_0/V+100C_3R/V},$$

and A for $-C_3$

$$=\frac{+BC_3\pm\sqrt{[(100e_0/V)^2-\{2B\,.\,100R/V+(100R/V)^2\}C_3^2]}}{-BC_3+100e_0/V-100C_3R/V},$$

and the product of these is unity. This is perfectly general for any value of B, as is also the symmetry about the vertical axis.

C_5 for any value of C_3 is equal to C_6 for the same numerical value of $-C_3$, for C_5 would then be $-A_{C3}C_3/(1+A_{C3})$, and C_6 would be $-C_3/(1+A_{-C3})$; and these are equal if $A_{C3}/(1+A_{C3})=1/(1+A_{-C3})$, which is true if $1/(1+1/A_{C3})=1/(1+A_{-C3})$, and this is the case since $A^{C}{}_{3}\times A_{-C3}=1$.

Also e_3 for any value of C_3 is equal to e_4 for the same numerical value of $-C_3$, for e_3 is then equal to $\{C_3/(1-A_{3C})\}(R+2BV/100)$ and e_4 is equal to $\{-C_3A_{-C3}/(1-A_{-C3})\}(R+2BV/100)$, and these are equal if $1/(1-A_{C3})=-A_{-C3}/(1-A_{-C3})$, which is true if $1-A_{C3}=1-1/A_{-C3}$; and this is, as before, the case. C_1 and C_2 are clearly symmetrical about the vertical axis if C_5 and C_6 are so. The speed change multiplier curve is symmetrical in itself about the same axis, for $\{C_3(R+2BV/100)/e_0\}\{(1+A_{C3})/(1-A^{C}{}_{3})\}$ and $-\{C_3(R+2BV/100)/e_0\}\{(1+A_{-C3})/(1-A_{-C3})\}$ are its values for two equal and opposite values of C_3. These are equal, because if $1/A_{c3}$ be inserted in the second expression instead of A_{-c3} it becomes

$$-\{C_3(R+2BV/100)/e_0\}\{(1+1/A_{C3})/(1-1/A_{C3})\}$$

$$=-\{C_3(R+2BV/100)/e_0\}\{(A_{C3}+1)/(A_{C3}-1)\},$$

which is the same as the first expression.

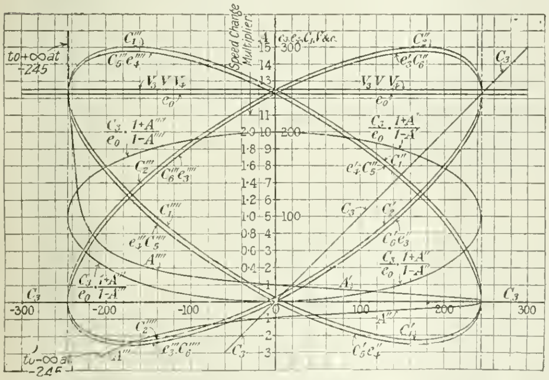

FIG. 14.—REPRESENTATIVE CURVES FOR ROTARY BALANCER WITH $B=0$.

This general symmetry of corresponding variables is a mathematical representation of the fact that the balancer consists of two identical machines, and is, therefore, symmetrically reversible in regard to its function in the system.

For the present, the question of actual speed change is not fully investigated; this will be done in the later section which is concerned with the means of producing the flux necessary to make the balancer give the specified compounding of the system. The quantity by which $\varphi_0/(\varphi_3+\varphi_4)$ must be multiplied in order to give the actual speed change is, however, plotted in Fig. 14, as it has a perfectly definite value dependent on C_3. The complete set of values from which these curves have been plotted is of no special interest, and is, therefore, not given in full, but a few typical points may be tabulated, say the four which correspond to $C_3=\pm200$. All the values are worked out from expressions already given, and evidences of symmetry are obvious in the various columns containing corresponding pairs of values.

C_3	q	V_3	V_4	A	e_3	e_4	C_5	C_6	C_1	C_2	V_3 $=e_3+C_1R$	V_4 $=e_4+C_2R$	Speed change multiplier.
+200	0	250	250	+0·318	+293	+93	−48	+152	−43	+157	250	250	1·575
+200	0	250	250	−0·318	+152	−48	+93	+293	+98	+298	250	250	0·425
−200	0	250	250	−3·144	−48	+152	+293	+93	+298	+98	250	250	0·425
−200	0	250	250	+3·144	+93	+293	+152	−48	+157	−43	250	250	1·575

All other values are calculated on exactly similar lines. As R has been chosen 1 ohm, the curves for E.M.F.s and currents coincide in some cases, but they are clearly lettered in Fig. 14, so that the course of each can be followed. Starting with $e_3=e_4=e_0$ and increasing C_3 in the positive direction, e_3 increases and e_4 diminishes. Very soon e_3 is $> V$, and the loaded side generates current. This happens when C_1 falls below the zero line. Whenever the E.M.F. and corresponding total current of the armature are on the same side of the zero line in the diagram, the armature is motoring, and when they are on opposite sides it is generating. The difference between C_2 and C_6 or C_1 and C_5 is put down as 5 amperes throughout, on the assumption that C is constant, although, as has already been said, this cannot be true under all circumstances. But for the working part of the diagram, which is probably under 100 amperes each side of zero, the error is small, and in any case the curves are qualitatively correct throughout. At the turning point, when $C_3=245$, e_3 is again equal to e_0, and C_5 is zero; e_4 is zero, and C_6 is 245; the torques due to C_5 and C_6 are, therefore, still balanced; C_1 is 5 and C_2 is 250. Both machines are motoring to the extent of the hypothetical, and in this case fictitious, 5 amperes and the remaining 245 amperes of C_2 are simply being carried round in zero field. After that, e_4 is reversed, and C_5 becomes a generating current, flowing in the same direction as before, while C_5 is reversed, and, with the unchanged direction of e_2, becomes a motoring current; the torques are still balanced as before. All quantities in the first stage are marked with one dash, e'_3, C'_5, and so on; in the second stage, from 245 back to zero, they have two dashes. The sections with three and four dashes represent negative values of C_3, and exactly the same process is gone through, so that it need not be further described. It must be clearly understood that this curve does not represent necessarily what goes on in practice on heavy overloads in a balancer wound for level compounding on ordinary loads; it merely shows what values of A must be produced in order to keep $B=0$, and how the other dependent variables alter in consequence. When C_3 is zero, C''_5 and C''_6 are each 245 and C''_1 and C''_2 are each 250. This means that the armatures are acting merely as dead resistances, as 500 volts will just send 250 amperes through the 2 ohms of the armatures in series. This is an impossible practical condition, as the armatures would burn up, but it shows how the curve covers the whole cycle of changes that can possibly be thought of as going on. The practical range of the set is probably about one-third of the region marked with single dashes on the positive side, and the same amount of the region with four dashes on the negative side.

(To be continued.)

Utilisation of Water Power in Russia.—It appears that the Russian Ministry of Communications has prepared a bill to empower the Government to declare any waterfall or area of water suitable for the production of water-power as being of national importance, and to take possession thereof. According to the "Board of Trade Journal," Russian law has not hitherto had any bearing on the utilisation of water-power on a large scale, and the issue of certificates for its use has depended mainly on the consent of private owners.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

For the reason that every citizen is directly interested in the monetary system of his country, I should like to conclude my contributions to THE ELECTRICIAN on the above subject by an exposure of the proposed florin system. Theoretically correct and superficially right, yet creating difficulties where none exist, it may, unless promptly disowned, deal the movement for the decimalisation of our currency such a stunning blow as to paralyse it for a century.

There is a great gulf between the question of the adoption of a decimal coinage and that of the introduction of the metric system. In a change of currency there can be no moderation. The change must be drastic and obligatory, and take effect on a stated day. A change in our systems of weights and measures might be partial, optional or compulsory, as those directly interested might advise. Thus the more important question is undoubtedly that of the coinage. Should a change be made that failed to gain impetus quickly, return would have to be made to the old order. A greater blow to commerce it would be difficult to conceive. This is the age of electricity.

Among the many platitudes with which the advocates of the florin introduce their proposal there is none more artless than the statement that "*our* (italics mine) florin is the 10th part of a sovereign." But the 10th part of a sovereign is two shillings, not a florin. A distinction with a difference so potential that to disregard it would bring about so many misunderstandings as to congest the Courts of Justice for a considerable time. It is recorded of the British that they call a spade a spade, and one certainly cannot imagine a Briton accidentally calling a two shilling piece a florin. Is it possible that he could do so with aforethought? Examine the question in the light of history and world-wide experience.

As a measure of value our present shilling is over 400 years old. Just think of it. The sovereign has not yet reached its centenary, while the two shilling piece, given the meaningless and consequently unpopular name of a florin, did not appear until 1849. Thus history teaches us two important facts. First, that both the sovereign and the florin are merely multiples of the shilling; and secondly that the shilling has always been the unit of our present system. Its very centre and pivot. Thus, £. s. d. We know from experience that it is so regarded throughout the civilised world. We cannot depose it if we would. Withdraw it and the florin would still remain the two shilling piece, not only at home, but also abroad. In desperation withdraw the sovereign also, and still the shilling would be with us in spirit for several generations at least. High Finance may unsettle the mind of a business man, but *it cannot rob him of his subconscious memory.* It may lead him to consult a stockbroker and an actuary to determine the simple question of depreciation, for to high finance simplicity is anathema; but it can never make him say two florins 50 for five "bob."

Picture a system of coinage in operation in which the unit or principal coin was referred to in multiples of one of its auxiliaries. That is to say, the number two spoken to indicate the number one, yet such is the florin proposal. How would it be possible under such a system to deal quickly? Obviously it would be impossible. Even ordinary transactions would be difficult. One would never be sure of the term used. The whole business world would be jumpy and nervous. Foreign dealing would soon become so difficult as to cease entirely. That is the cheerful prospect placed before the people of this nation in order to placate the unreasoned opposition of the higher mathematics to the desired reform of our currency.

To continue the exposure of such a crude proposal as the florin scheme of decimals would appear like unto killing a sparrow with a trench mortar. But owing to the subtlety of the scheme, and the serious position it has created by giving rise to the assumption that fundamental difficulties exist which prevent the adoption of the only popular unit, it must be fought to a finish.

We are told that by the florin scheme the expression of sterling in florins and cents can be done at sight. Test it for yourself and prove the statement. Take the Stock Exchange official list and a big stores price list and make the conversions at sight—if you can. But who wants to convert sterling into two-shilling pieces when single shillings are in the pocket? In all seriousness, no one but a prosy academician. Suppose that you are a skilled mathematician, and the conversion is truly simple, the resulting figures convey no meaning to the mind until they in turn are converted into shillings, and with the shilling in perpetual contiguity, thinking in florins could never be attained even by the educated. But there are credit transactions as well as those for ready money, consequently with the florin system there would be two measures of value, one for the shop (the shilling) and another for the counting house (the florin), one for the teller and another for the ledger clerk, one for the bid at an auction and another to record that bid. Imagine the resultant confusion.

Add to this the further fact that our military men will be returning from countries where the principal gold coin, just as here, divided by 10 gives 2, and that the measure of value of the florin is absolutely at variance to that to which they have by now become accustomed. Those of us interested in the reform of our currency may well ask where we are being led.

I trust that I have been sufficiently explicit to effectively demonstrate to all unprejudiced business men that the florin scheme for the decimalisation of our coinage is impossible. As herein shown, it is based upon theory and devoid of imagination. It has brought the question of this great reform to the parting of the ways. To support the florin scheme is to follow the direct road to disaster, for it must be remembered that first impressions are hard to eradicate, and therefore there could be nothing more dangerous than to put forward a scheme absolutely incomprehensible to the man in the street for the mere sake of pandering to the vanity of the higher mathematics.

London, Jan. 27. G. O. PARSONS.

TO THE EDITORS OF THE ELECTRICIAN.

Your contributor, Mr. John Johnston, in his "Plea for the Pound," as published in your issue of the 26th inst., suggests the possibility of a decimal system of British coinage involving the use of four cash columns instead of our existing three for £ s. d.

This would be a retrograde step, and it is important we should bear in mind that one of the advantages rightly claimed for a decimal system of coinage is that any amount of money may be expressed in two columns—*e.g.*, dollars and cents, francs and centimes, &c.

The adoption of our sovereign as the basis of a British decimal system would mean that our smallest coin—value 0·24d. in present currency—would be expressed by three figures after the decimal point, thus £·001; whereas, taking the florin as the basis, the same coin would be expressed by two figures only, thus florin 0·01.

The following table shows the full set of 10 coins which would suffice to place our existing currency on a decimal basis, and they could alternatively be expressed either in terms of £ and mils or in florins and cents, as shown in the left-hand and right-hand tables respectively.

Cash entry.		Equivalent value of each decimal coin expressed in present currency.	Cash entry.	
£	Mils.		Florins.	Cents.
1	000	Sovereign	10	00
...	500	Half sovereign	5	00
...	100	Florin	1	00
...	050	Shilling	...	50
...	025	Sixpence	...	25
...	010	2·4 pence	...	10
...	005	1·2 ,,	...	05
...	004	0·96 ,,	...	04
...	002	0·48 ,,	...	02
...	001	0·24 ,,	...	01

Assuming that it is agreed the sovereign should be retained, it would appear that we must select one or other of the above alternative methods of expressing cash values.

I should, however, prefer that Mr. Johnston, Mr. Turnbull, Mr. Parsons and your other contributors would, for the time being, dismiss from their minds the details incidental to the placing of our existing system on a decimal basis, and join with us in urging the Government to adopt the decimal basis, leaving to them all such questions as the precise names and values of coins which such a rearrangement would involve.

Manchester, Jan. 29. Harry Allcock.

SHOULD REVIEWS OF BOOKS BE SIGNED?

TO THE EDITORS OF THE ELECTRICIAN.

I have read with interest Prof. Kapp's letter in your issue of November 17 last. Readers naturally expect in journals of high reputation and recognised standing an unbiassed review of a publication and not mere platitudes. On many occasions I have noticed that a book which has been strongly and adversely criticised in The Electrician has been favourably reviewed in other electrical journals, both in England and America, these last reviews, mostly unsigned, being "mere literary hack work." During the last six years, I have never purchased any book unless same has been favourably reviewed in The Electrician.

That "hack" reviews occasionally do appear even in The Electrician will be evident if I refer you to your issue of April 14, 1916. Take the unsigned review of Prof. Langsdorff's "Principles of Direct Current," here the first 14 lines relate to the genesis of the book, and the next 26 lines are copied *verbatim* from the author's preface. Evidently a review does not mean a mere extract from the author's preface.

Mr. Ashton, in his letter in your issue of December 1, 1916, mentions that the many "Germanisms" Prof. Kapp's book contains make it unsuitable for British students. I always thought science was international, and it will be idle to belittle the wonderful achievements of the Germans in electrical engineering. Every one knows what the science owes to men like Kapp, Steinmetz and Arnold, to name only a few.

If Prof. Kapp's books are to be banned simply because a few symbols bear German origins, or are puzzling to British students, what about Steinmetz's classical writings, where new symbols, new methods of analysis and even new conceptions are introduced? Take, for instance, Steinmetz's definition of current, voltage, inductance and capacity, as given in Fig. 5 of his "Transient Electric Phenomena." Is this book to be similarly banned because such conceptions are entirely foreign to ordinary British teachers?

Cossipore, Calcutta, Jan. 3. H. M. Mitra.

DUPLEXING THE SQUIER SYSTEM OF TELEGRAPHY.

TO THE EDITORS OF THE ELECTRICIAN.

I am quite at a loss to understand Mr. Cohen's reply in your issue of January 19th to my letter to you of November 17th.

If I had, as Mr. Cohen suggests, merely drawn attention to Stone's well-known use of the LC loop in wireless as an anticipation of the "new" methods of duplexing, then the whole of Mr. Cohen's letter has point.

As, however, I pointed out that Stone advocated this same loop circuit for preventing outgoing signals affecting receivers on an alternating current system of *land line* telegraphy as early as 1912, it is difficult for me to see where the new departure claimed by Mr. Cohen is to be found.

To sum up: in alternating current line telegraphy, two-way (duplex), four way (quadruplex), &c., &c., the use of resonant loop circuits in series with the receivers to exclude the transmitting frequencies and, also, the use of the same type loop circuits in the transmitters to prevent the latter wasting their energies in each other's circuits is due to John Stone, and is described in his patents for alternating current line telegraphy and his Franklin Institute Paper to which I referred in my previous letter.

Croydon, Jan. 30. H. H. Harrison.

PRINCIPLES INVOLVED IN COMPUTING THE DEPRECIATION OF PLANT.

The following is an account of the discussion on Messrs. Gill and Cook's Paper on this subject before the Birmingham Local Section of the Institution of Electrical Engineers. The abstract of the Paper was concluded in our last issue.

Mr. Henry M. Sayers said that some people might think it a little strange that the authors had put together the return on capital and provision for depreciation. This was, however, a correct view. The plant from the accountant's standpoint was a debtor to the proprietor or contributor under two heads. The first was that of return on capital—*i.e.*, profits, whether dividends or interest; the second was that of return of capital in such measure as to maintain the value of the undertaking by adequate renewal, or reduction of capital liability. There was some difficulty in calculating the economic life of plant. The sinking fund method of accumulating renewals and improvements funds, as advocated by the authors, was undoubtedly the sound and equitable one, and was the one which he had always adopted in calculations. With reference to the distinction between maintenance and renewals, there seemed to be no dividing line in principle. It was, however, convenient as equalising charges in successive periods to draw the line at the life corresponding to the accounting period, whether one year or any other period adopted. Then renewals of any portions of the plant having a life period not exceeding the accounting period were charged as maintenance, while those of longer life were provided for from the renewal fund. This avoided anomalous differences between the periodic accounts.

Mr. T. Plummer said the Paper had apparently been written to show the superiority and greater accuracy of the sinking fund over the straight line method of computing the depreciation allowance for plant, and the authors had made out an exceedingly strong case for the employment of sinking fund calculations in the preparation of ordinary commercial accounts. Mr. Gill had, however, mentioned in his introductory remarks that the Paper was not intended to relate to the accounts prepared by municipalities working on borrowed money, and possibly the same applied to a concern run by the State, as the telegraph and telephone systems. Anyhow, for the purpose of "considering the financial results of the working by the State of the telephone system of the country," the Postmaster-General appointed in 1913 a strong committee of accounting, actuarial and engineering experts, and in preparing the statement of accounts for presentation to Parliament they assessed "depreciation on the basis of the estimated effective life of the plant." The method followed was on the straight line basis of equal annual instalments on an equated life of plant of 20 years (as estimated by the Engineer-in-Chief of the Post Office), due regard being paid to residual values. Nodoubt this decision was arrived at, as against the sinking fund method, to conform with the usual practice of annual accounting for Government departments, each year's votes being entirely independent and to fit in with the system of Parliamentary control. Referring to the "Constant Maintenance Cost" section of the Paper, it was not his experience that the maintenance cost of telegraph and telephone plant was constant throughout its life. In the case of line plant, the maintenance cost was at a minimum for the first few years, then, as time went on, arms required straightening and wedging, wires got slack, and had to be regulated; insulators, binders, stays got loose and had to be tightened up; all this having no connection with mere renewals in the sense of plant replacement. Again, a switchboard multiple gave comparatively little trouble when new, but when it approached the end of its effective life, the jacks got worn and further troubles arose in the removal of faults in a large multiple field which considerably added to the maintenance cost.

Councillor E. C. R. Marks said the authors had demonstrated the advantages of the sinking fund method of providing for depreciation of plant. The particular method adopted was not, however, of such prime importance as the need for making the provision adequate. Engineers, like other people, were in danger of overlooking the needs of to-morrow by their anxieties of to-day. If they could keep the concern running now they were apt to pay too little attention to the avoidance of a funeral for their successors. Engineers were well acquainted with the principle of the indestructability of energy and of matter. They could never command the confidence of those who financed their undertakings unless they recognised the theory of the indestructability of capital and made due provision for wasting assets. It was not always easy to estimate the physical life of a plant. It was always difficult to estimate its economic life, but it was the engineer's duty to do it, just as it was the duty of the medical adviser of an insurance company to estimate the life of an applicant for a life insurance or an annuity policy. When he had done so the actuaries, accountants and the like would soon fix up the annual premium required. That was not the doctor's job. Neither was it the engineer's job to settle just how the money set aside to maintain capital intact was to be dealt with. He had quite enough to do to keep his own end up.

Mr. F. J. Moffett said in the section headed "Constant Maintenance Cost" it was stated that the renewal of each part, as it was required in turn, was provided for by the fund established on the basis of the equated physical life. It was, therefore, clear that an equated life, arranged for all the plant, provided money for the renewal of every part. He would be glad to know whether the authors proposed that a physical life should be fixed for every component part of an individual machine, and that from these separate physical lives an equated life for the whole machine should be arrived at in order to calculate the renewals fund. It appeared to him that a much simpler and more satisfactory arrangement would be that the renewal of all parts such as brushes, bearings, &c., which wore out in a relatively short period, should be charged to maintenance. It would be a comparatively easy matter to estimate the annual cost of such renewals and add this amount to the ordinary maintenance cost.

Dr. C. C. **Garrard** said this Paper brought home the necessity in modern times of accurate cost-keeping. It was rather surprising to find, even among business men, a very vague idea as to what an engineering or manufacturing cost was. It was very often confounded with an estimate and was regarded as a variable quantity which could be altered at will depending upon the method of calculation used. This view was, however, entirely wrong. The cost which had been incurred in making a certain article or in carrying out a certain operation was a fixed and unalterable amount.. The cost which would be incurred in repeating the work might well be different; once a job, however, was completed its cost for that occasion was fixed. It might be difficult to find out what the actual cost was, but the value although unknown was essentially a fixed quantity. All proper systems of keeping costs aimed at arriving as nearly as possible at the correct figure. This question of cost-keeping was as important in a manufacturing works as it was in an electric supply station or telephone system. A works which had not a proper cost-keeping system as a basis for its official accounts was in the same position as that of a retail shop-keeper who did not know what he had given for his stock.

ANNUAL REPORT OF THE B.E.A.M.A.

The annual report of the Council of the British Electrical and Allied Manufacturers' Association for the year 1916 has been issued.

The report states that the year which has just closed finds members more seriously engaged in the business of war than was considered probable in January, 1916; but the Empire is undoubtedly more confident of the final result and more determined than ever to see it through in a way that will secure proper safeguards for our civilisation and industrial future. The electrical and allied industries yield place to none in supporting that determination, and will continue to place their best service at the disposal of the authorities.

Export Trade.—A present anxiety is in regard to our export trade, the development of which has been considerably hampered by abnormal manufacturing conditions created by the necessities of war. Practically all the works of members are "controlled," and it has not been possible to supply the demands of established overseas trade connections, a considerable volume of trade in our Overseas Dominions as well as in neutral markets being diverted into the hands of American, Japanese and other competing manufacturers. It is believed this lost ground will be speedily regained when British manufacturers are again in a position to re-enter it and the Empire's purchasers realise what home producers have sacrificed in the common cause. Meanwhile, the Overseas Committees (appointed by the Council) in India, South Africa and Australia continue to use every endeavour to foster in their respective territories those co-operative principles which have been beneficial at home. The Australia Overseas Committee has been successful not only in drawing up general conditions of contract for electrical and engineering work, but in obtaining for them the official approval of the Electrical Association of Australia. As that association comprises in its membership many of the important buying engineers in the Commonwealth, including the engineers of Government departments and municipalties, there is little doubt that the conditions will in time become the recognised standard for all public contracts. They have already been adopted by several important public bodies. Progress is being made in the same direction in India and South Africa. An energetic Overseas Committee, recently formed in Buenos Ayres, keeps in touch with representatives in Rio de Janeiro (Brazil), where, it is hoped, a separate committee may soon be formed. A small committee has also just been formed in Moscow, from which useful work is anticipated. The experience gained with the Overseas Committees has shown the desirability of broadening the basis of their constitution, and steps are being taken to enlarge their scope and to make it possible to establish committees in other countries. In addition to the work of the Overseas Committees, useful reports have been received (and circulated to members) from correspondents in Rio de Janeiro (Brazil), Rosario (Argentina), China, France, various parts of Australia and South Africa, &c.

The Council has decided to publish special editions of the "Journal" in the Russian, Spanish and Portuguese languages, provided adequate advertising support is received from members.

Export Rules.—The Council has issued in handy form a set of British export standardisation rules for electrical machinery and transformers (excluding traction motors). The text of these has been settled as far as possible in accordance with present international standards and after agreement with the sections of the association mainly interested. It is believed that these rules will, if energetically circulated, tend to displace those issued by other countries for use abroad. Translations into French, Spanish, Italian, Russian and Portuguese will shortly be available.

The association is frequently approached by various Government departments for information. Members of the Council have discussed with the Foreign Trade department matters surrounding overseas trade, and the latter department from time to time furnishes advance information of use to members which is duly circulated.

Trade Propaganda.—Under direction of the Association's Trade Committee, formed at the end of 1915, propaganda work was undertaken with the object of impressing on public opinion at home the indispensability of a powerful and prosperous engineering industry, both in war and peace. Although at the beginning of this campaign an enormous production of munitions was the most conspicuous industrial feature throughout the country, it was not at that time yet realised how much the future safety and economic progress of the nation and the Empire depend on the magnitude and variety, the efficient organisation and the technical advancement of British engineering. On behalf of the committee, Mr. T. C. Elder delivered lectures before large audiences in Birmingham, Manchester, Glasgow, Newcastle, Liverpool and Nottingham, and organised a successful meeting at the Mansion House on Sept. 20. At the same time a large number of pictorial leaflets and reprinted reports of the meetings has been distributed, the total publicity effect of which cannot be precisely estimated. The committee has, however, reason to believe that the mission thus undertaken by the electrical and allied industries has been warmly approved by other branches of engineering.

Electrical Industry after the War.—The Council appointed certain of its members to appear and give evidence before the committee appointed by the Board of Trade "to consider the position of the electrical trade after the war, with special relation to international competition." Evidence was given on the folllowing subjects: (1) Restrictions of imports by a scientifically devised tariff; (2) the spending of public money, raised on the security of rates and taxes, in the interests of British industry; (3) railway and shipping handicaps on British industry; (4) the need for a ministry of commerce and industry; (5) education in its relation to industry; (6) the need for standardisation and the co-operation of Government departments with British manufacturers in this connection; (7) the abolition of legislative handicaps on the electrical and allied industries; (8) the need for the co-operation of finance and industry; and (9) amendments in the laws relating to patents, trade marks, &c. It is understood that those specific recommendations to which the Association attach the greatest importance are likely to be adopted by the committee and warmly commended to the Government.

Import Restrictions.—As members are aware, the shortage of ships has necessitated the prohibition of many imports, and the prohibiting regulations fell heavily for a time on the electrical industry among others. Representations made by the Council to the proper department, showing that the import of certain insulating materials was an urgent, if temporary, necessity, resulted in the Association being granted a licence to import, for the benefit of the industry at large those materials for which there was urgent need.

Scholarships, &c.—The turbine section of the Association has resolved to establish, at various university industrial centres throughout the kingdom, scholarships for the promotion of the practical study of steam problems especially as related to turbine work. Similar endowments of scholarship in other branches of industry are now, or will shortly be, under consideration. The Association's General Committee for Research, created at the invitation of the Privy Council Advisory Committee, has established working sub-committees to deal with the improvement of insulating materials, the corrosion of condenser tubes, special waterproof insulation for machines, magnet steel, problems of switching and arcing, turbine blading; and certain applications for grants-in-aid of research have already been lodged, while others are in preparation. Meanwhile the preliminary investigations, aimed at ascertaining the most urgent subject matters for further work, are being conducted. It was hoped that certain researches could have been conducted jointly with the Institution of Electrical Engineers, but this has not so far been found practicable.

Standards.—The Association is represented on the British National Committee of the International Electrotechnical Commission, and on the Engineering Standards' Committee on its Sectional Electrical Committee and its sub-committees and panels established under the following titles: Standardisation, rules for electrical machinery, prime movers for electrical plant, electrical symbols, electrical accessories, heating and cooking apparatus, motor starters, ammeters and voltmeters, electricity meters, plugs, switches, fuses and lampholders. The Association is also represented on the committees of the Institution of Electrical Engineers dealing with wiring rules and with marine (other than Admiralty) work, and on the Electric Vehicle Committee. The Standardisation Committee continues its co-operation with the Engineering Standards' Committee in the preparation and revision of the new British Standardisation Rules, and has prepared detailed recommendations for the revision of the Engineering Standards' Committee's Report No. 72. The report gives some particulars of other work done by the committee, and this includes the following subjects: Motor starters, under which a specification has been prepared to serve as the basis for the E.S.C. rules now in preparation; transformers for meters and instruments, under which a specification has been prepared for incorporation in the revised E.S.C. specification for meters and instruments; graphical symbols, under which the recommendations made have been very fully adopted in the new E.S.C. draft rules; switchgear symbols, under which the section of the Association's rules dealing with this subject has been revised and considerably enlarged; marine generating sets, under which a joint committee has been established to deal with the standardisation of electric generating sets for marine purposes; ammeters and voltmeters, being a revision of E.S.C. Report 49, which is now well in progress (the recommendations from this Association receiving full consideration) in the revised draft of which the proposed specification for transformers for use with these instruments is being embodied; electricity meters (E.S.C.

37), under which recommendations have been made to the E.S.C. covering a proposed revision of this specification; accessories, under which recommendations are being prepared for the assistance of the E.S.C. in the standardisation of lamp-sockets and other details; I.E.E. wiring rules, under which recommendations have been transmitted to the Institution regarding desirable amendments in the present (seventh) edition of the wiring rules. The Council adopted Engineering Standard's Committee's Specification No. 74, being a specification of a standard electric-vehicle charging plug, prepared by the Electric Vehicle Committee.

Conditions of Sale and Contract.—The Council, by an issue (Feb. 1, 1916) entitled "Instructions to Members for the Use of Conditions of Sale and Contract," amended and consolidated all previous instructions on this subject. Little opposition to the Association's conditions has been encountered during the year, thus bearing added testimony to their reasonableness. Fifty-six different purchasers raised questions which were amicably settled with the assistance of the industrial solicitor. Of these, 46 came from municipal and 10 from industrial purchasers. Many were merely repetitions of a question previously settled with the same purchaser.

Trade During the War.—The Council successfully protested against circular instructions issued by the Mines Department to their inspectors, stating that where British firms had difficulty (owing to "control") in supplying machinery, such machinery could be obtained from America.

Excess Profits.—The Council appointed witnesses to prepare a case for submission to the Commissioners of Inland Revenue in favour of increasing the standard percentage of profits under the Finance Act (No. 2), 1915. As a result of the Council's efforts the standard percentage was raised by 1 per cent.

Loans for Storage Batteries.—During the year the Council, at the request of the accumulator section, was successful in obtaining from the L.G. Board, extensions of the loan periods for storage batteries from seven to 10 years, and five to seven years, in certain cases respectively. The same section was similarly successful in obtaining a desired revision of the battery specification issued by the War Office.

Legislation, &c.—The Incorporated Association of Electric Power Companies has invited the co-operation of the Association in drafting a new electric lighting bill.

The growth and progress during the year of various bodies formed to foster British and Empire industry has been noted with much interest and sympathy. The British Empire Producers' Organisation, whose efforts extend into many Overseas Dominions, has already received the Council's support. Another, the Federation of British Industries, formed primarily to watch over the industrial interests of this country, has the Council's cordial sympathy. The growth of the Association has rendered advisable the creation of some co-ordinating body composed of members closely connected with the work of the sections, and the Council welcomes the proposed establishment of a sectional committee or board composed of such members and reporting to the Council. It is hoped by this means to concentrate efforts in matters common to all sections.

Cross-tendering Agreements.—The system of tendering embodied in the agreements known as cross-tendering agreements continues to find favour among members, but has not been extended during the year. The association has in operation the following such agreements: (1) Steam engine builders and dynamo makers; (2) Diesel engine builders and dynamo makers; (3) steam engine builders; (4) turbine makers; (5) condenser makers.

Membership.—The number of members on the register at the end of the year (Dec. 31) was 144. Thirty firms were admitted to membership during the year, and one resigned.

THE PROVINCIAL ELECTRIC SUPPLY COMMITTEE OF GREAT BRITAIN.

This Committee has been formed with the principal object of providing a central and representative body to afford a ready means of co-operation in protecting and furthering the financial, commercial and legislative interests of provincial electric supply companies working under provisional orders.

The Executive Committee consists of the following:—

H. B. Renwick (chairman)	Bournemouth & Poole Electricity Supply Co. and other provincial companies.
Sir J. S. Harmood Banner, M.P.	Midland Electric Corpn. for Power Distribution.
F. E. Gripper	Edmundson's Electricity Corpn.
G. W. Spencer Hawes	Reading Electric Supply Co. and other provincial companies.
J. Atkinson Hosker	County of Dorset Electric Supply Co. and other provincial companies.
W. L. Madgen	British Electrical Federation.
Sir Henry C. Mance	Oxford Electric Co.
R. P. Sloan	Newcastle-upon-Tyne Electric Supply Co.
J. G. B. Stone	Electric Supply Corpn.
J. C. Wigham	Urban Electric Supply Co.

There will also be a General Committee, on which each of the provincial companies subscribing will be represented by one director.

The Committee proposes to direct particular attention to the following matters:—

1. To organise and arrange for united action in protecting common interests as and when occasion arises and such united action is necessary and desirable.
2. To afford the readiest means for considering such questions as rating, income tax, assessments, excess profits tax, emergency and other legislation, rates of supply, fiscal and other matters generally affecting the companies' interests.
3. To prepare, collect and distribute amongst the members statistics or other information of common interest, and to print and issue other literary matters for the use of members desiring to avail themselves of the facilities offered.
4. To afford facilities for intercourse between the directors of the companies represented on the Committee with a view to the consideration of any questions affecting the common interests.
5. To watch over the interests of the companies and take any steps expedient with a view to correcting misstatements that may appear in the public press.
6. To assist in the compilation of official statistics and information on a uniform basis where such is desirable and to the benefit of the companies.
7. To appoint sub-committees to deal with any special matters arising, and generally to initiate, organise and carry out any work having for its object the protection or furtherance of the interests of the companies.

We refer to this new organisation in our Editorial Notes.

LEGAL INTELLIGENCE.

Electric Lighting Plant Valuation.

The raetable valuation of the Clones Electric Lighting Co. recently came, by way of appeal from the Commissioner of Valuation, before his Honour Judge Johnston at the Court of Quarter Sessions. In giving judgment, Judge JOHNSTON said the company was incorporated in 1913, and began supply on Aug. 13 of that year. The capital was £2,500, and there was an overdraft of some £1,300. In 1915 a valuation of £25 was placed on the company's electric lighting station, and nothing on the mains, poles and easements. This year the valuation had been increased to £100—namely, £20 on the building and £80 on the rest of the undertaking. The ground of appeal was "that the said valuation is excessive and ought to be reduced." It had been proved that there was a very considerable loss in the company's trading for the period ended Nov. 30, 1914; but in the following year a handsome profit was made, and it is on that profit that the valuation appealed from is based. The Clones undertaking consisted for rating purposes of the power station and lands on which it stands, the mains and the land which is occupied by them, and the posts and wires suspended therefrom and attached by bolts and brackets to convenient roofs and chimneys; but not the meters and fittings in the houses of the company's customers. The first question raised by the appeal was whether the 112 H.P. gas engine and the 40 H.P. oil engine should be included as part of the rateable hereditament. Sec. 7 of the Valuation Act, 1860, provides that "in making the valuation of any mill or manufactory, or building erected or used for any such purpose, the Commissioner of Valuation shall in each case value the water or other motive power thereof, but shall not take into account the value of any machinery therein, save only such as shall be erected and used for the production of motive power." In England a long series of decisions had established the proposition that, although machinery may not be part of the freehold, "it yet must be taken into account to increase the amount of the rate which is exacted from the tenant." That was to say, machinery which was on the premises for the purpose of making, and which did make them fit and proper for the particular purpose for which they were used, was regarded as part of the freehold for rating purposes. (Tyne Boiler Works *v.* Longbenton Overseers.) It was probable that the law was the same in Ireland until in 1836 it was altered by statute (sec. 13 of 6 & 7 Wm. IV., c. 84), which provided for the valuation of flour, corn, flax and other mills, enacted that the water-power of such mills should be valued also, but only so far as it might be actually used, "and that such valuation shall not extend to or include the value of any machinery contained within such mill." That was followed by similar provisions in sec. 42 of 9 & 10 Vict., c. 110 and sec. 13 of the Valuation Act, 1852; and in 1855 it was held in M'Master's case that, by reason of those provisions, five steam engines, a water wheel and certain twisting and flax-cutting and other machines, all fixed more or less to the freehold, were not rateable. In 1860 all those provisions were repealed, and sec. 7 of the Act of that year provided that for the future "the water and other motive power" of all mills and manufactories should be valued with the buildings, but that any machinery therein should not be taken into account, save "such as shall be erected and used for the production of motive power." Blackburn, J. (in Reg. *v.* Lee), said that there were three classes of things that a trading tenant might bring on to his premises; Things moveable, such as office furniture; things so attached to the freehold as to become part of it; and things which, though capable of being removed, were intended to remain permanently connected with the premises, and were essential for their working. The first class was not rateable either in England or Ireland; the second class was rateable in both places (that, he thought, was the effect of the judgment of Lefroy, C. J., in M'Master's case); the third class was rateable in England but not in Ireland, except in so far as it was machinery for the production of motive power. In the present case there could be no doubt that the power station of the appellants was a manufactory, that the two engines had been erected and used for the production of motive power, and that the Commissioner of Valuation was entitled to include them as part of the rateable hereditament; but he was further of opinion that the accumulators, dynamos, switchboard and belting must be regarded as tenant's fixtures, and not rateable. From one point of view the dynamos might be described as machinery for the production of motive power; but, in my opinion, the motive power to which sec. 7 referred was that which was "produced" on the premises for the purpose of carrying on the business or trade of the undertaking, and not motive power which was manufactured there for the purpose of sale to the public. It was pointed out by Gibson, J., in Armstrong v. Commissioner of Valuation (1905), 2 I.R., 474—a case of great importance, which decides that, with certain exceptions, the law as to valuation for rating purposes was the same in Ireland as in England—that all hereditaments for which no specific mode of valuation was prescribed by sec. 11 of the Valuation Act, 1852, including such undertakings as collieries, brickfields, electric and gas lighting and the like, must be valued according to the principle set out in sec. 64 of the Poor Law (Ireland) Act, 1838; that was to say, on an estimate "of the rent at which, one year with another, the same might in their actual state be reasonably expected to let from year to year, the probable annual average cost of the repairs, insurance and other expenses (if any) necessary to maintain the hereditaments in their actual state, and all rates, taxes and public charges (if any), except tithes, being paid by the tenant." After quoting dicta of Lord Halsbury, Mr. Justice Andrews and of Lord Kyllachy, his Honour said it was obvious that in the case of undertakings such as those of gas and electric lighting and water supplying—"cases of monopoly or quasi-monopoly, monopoly associated with the particular lands," as described by Lord Kyllachy in the Oakbank case—direct evidence of letting value was seldom, if ever, available, and accordingly it had been the practice for a long time to arrive at the letting value by ascertaining the gross revenue of the undertaking and making certain deductions therefrom, called landlord's deductions and tenant's deductions. It was scarcely contested in the present case that the ascertainment of revenue was the proper method of arriving at the letting value; but it was argued on behalf of the appellants that the losses incurred by the company in 1914, when the undertaking was struggling into life, should be brought into the account of the profits of 1915. He did not agree with that contention. The ascertainment of the profits was merely a means to an end, and not the end itself. The letting value of the hereditament as it stood was to be ascertained, and not the soundness or unsoundness of the company which carried on the undertaking, and to ascertain the letting value the profit for the last preceding year was the best criterion. In the Charing Cross Electricity Supply Co. v. City of London Union the Court of Quarter Sessions held that the case must proceed on the basis of the previous year's profits; but the Court allowed evidence to be gone into as to the general results of the working of the company in the current year in order to discover what was the prospect of a successful business being carried on by the company. He allowed evidence to be given of the meter readings during the current year (there being at the date of the hearing in October last no balance-sheet for 1916 in existence), and he was satisfied from that evidence that the undertaking was in a thoroughly sound financial condition, and that it had probably been an advantage to the appellants to have had the year 1915 adopted as the test period rather than the current year. In arriving at that conclusion he had taken into account the evidence adduced on behalf of appellants as to the recent rise in the rate of wages and salaries and in the price of coal, oil, wire and accessories; but he had also taken into account the fact that the company, not being a philanthropic corporation, had increased the price of their current by 1d. per unit. Having ascertained the gross revenue at the date of the valuation, the valuing authority must then differentiate between the portion of that revenue which ought to go to the tenant as trader in the shape of interest on tenant's or trader's capital and legitimate trading profits, and the portion that ought to go to the landlord as owner of the rateable hereditament in the shape of rent. In a case like the present, where the trader was both landlord and tenant, it was necessary to consider what portion of the total capital of the company had been sunk in the rateable hereditament and what portion had been expended upon non-rateable machinery and chattels and used as working capital for trading purposes; and that brought him to the third question in the case. The capital of the company was £2,500, but there was an overdraft for over £1,300, and appellants contended that the interest payable to the bank on that overdraft should be included amongst the deductions to be made from the gross revenue in order to arrive at the letting value of the undertaking. He could not yield to that contention in the form in which it was put. That sum of £1,300 must be looked upon as part of the capital of the company expended for the purposes of the undertaking when it was still in its initial stages. From the point of view of those who made the advances those two sums, £2,500 and £1,300, had at one time a book-keeping existence, but for rating purposes they no longer existed, and could not be taken into account. In so far as the total capital was sunk in the rateable undertaking—the buildings and works, the mains, the poles and wire and the engines—[illegible] it had become part and parcel of the hereditament that was to be rated. On the other hand, in so far as the capital was used as tenant's capital, it now existed only in the form of non-rateable machinery and chattels. The appellants were entitled to a deduction amounting to 15 per cent. (which seemed to him to be ample) on the present value of such machinery and chattels to cover interest and trade risks and profits. It was decided in R. v. North Staffordshire Railway Co. that that percentage deduction must be calculated, not upon the cost price of the machinery and chattels, but on the depreciated value that they might have at the time when the valuation was made, and that the amount to be allowed was entirely a question of fact in each particular case. The appellants were entitled also to a percentage deduction in respect of their working capital. Acting on the principle of the North Staffordshire case, and taking all the evidence into account, he agreed with the Commissioner that the appellants should be allowed credit for a floating or working capital of £200, but he thought that a 10 per cent. reduction (namely £20) would amply compensate them in respect of it. The other items of tenants' capital allowed by the Commissioner were £218, being the present value of the meters and lamps, and £182 for stores; but for the reasons that he had already expressed he thought that that allowance was not enough. The Commissioner had followed the English practice, and included the whole of the machinery as part of the rateable hereditament, forgetting the important difference in the law which was brought about by sec. 7 of the Irish Act of 1860. To the sums which had been allowed there must be added sums of £78, £2, £164 and £294, being the present value of the switchboard, shafting, dynamos and accumulators respectively, all of which in his opinion were non-rateable machinery. Allowing a sum of 15 per cent. in respect of the machinery and 10 per cent. in respect of working capital, he fixed the "tenant's allowances" at £160, instead of £93; but the "landlord's allowances" must be reduced to a sum of £42, instead of £65, on account of the transfer of that machinery from one class of allowances to another. Adopting all the rest of the Commissioner's figures, accepting 8s. in the £ or thereabouts as the urban rating, and taking into account the other circumstances proved in the case, he fixed £75 as the valuation of the whole undertaking, of which £25 would be apportioned to the buildings and engines and £50 to the mains, poles and easements. The appellants claimed also to be entitled to deduct from the gross profits the rent that they paid for the land on which the power station stood. If that land were rated as a separate hereditament in the hands of the landlord they would be entitled to such a deduction; but as it was not so rated that part of appellants' claim failed. If they had redeemed the rent by an expenditure of capital, such expenditure would be treated as landlord's capital, and would not carry with it any allowance. The rent represented the cash equivalent of part of, or rather of the appellants' interest in, the rateable hereditament, and therefore cannot be deducted from the gross revenue. He had admitted the evidence of Mr. Potts (appellants' valuer), and he had used it roughly for testing the reasonableness of the result that he arrived at by another process. It was expressly decided in Edinburgh Parish Council v. Edinburgh Assessor (S F. 521) that in the case of an electric lighting undertaking the proper basis of valuation was the revenue, and not the structural cost method. The shortcomings in Mr. Potts's evidence demonstrate very clearly the inapplicability of that class of evidence to an undertaking which was a monopoly or a quasi-monopoly, and which consisted in part of substantial incorporeal rights.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

16,113 Trent. Watt-meters and like instruments for the measurement of electrical power.

17,691 International Electric Co., Roose & Le Noir. Electric signalling. (Addition to 3,520/15.)

17,753 Tilney & Jensen. Control of electrical measuring instruments.

18,115 Wilson & Rodgers. Alloy for arc welding. (16/6/15.)

1916 Specifications.

365 Lovelace, R. E. H., and Edison & Swan United Electric Light Co. Electric indicators. (8/1/16.) 102,629.

1,597 Betheno, J., and Girardeau, E. Radiotelegraphy. (2/2/15.) 100,058.

Relates to high power radiotelegraphic apparatus, in which an auxiliary excitation circuit connected inductively or directly with the main circuit is used, this circuit comprising a condenser connected in parallel with the main condenser, through an inductance and a resistance, both adjustable, arranged in series so that the discharge in the intermediate circuit takes place approximately at the moment when the charge of the main condenser is at a maximum.

2,541 Pike, R. D. Arc light carbons and methods of manufacturing the same. (21/2/16.) 102,645.

2,697 Je[illegible], W. A., and Stewart, H. J. S. Automatic electric fog signals. (23/2/16.) 102,649.

3,922 Western Electric Co. & Ha[illegible], J. G. Automatically operating switch for machine switching telephone systems and the like. (16/3/16.) 102,655.

4,683 Henley's Telegraph Works Co., W. T., and Judge, E. E. Quick-break electric coupling members. (30/3/16.) 102,6[illegible]2.

6,491 Laidlaw, E. A., and Grinsted, W. H. Telephone systems. (5/5/16.) 102,680.

7,614 H[illegible], W. (Bryant Electric Co.) Electric lamp sockets. (9/5/16.) 102,682.

11,740 Landis & Gyr Soc. Anon. Prepayment electricity meters. (18/9/15.) 101,535.

14,416 Giles, G. Electric condensers. (13/10/15.) 101,801.

14,745 Fairholme, E. G., and Clarke, A. D. Apparatus for electrocuting animals. (17/10/16.) 102,704.

16,[illegible]3 B.T.-H. Co. (G.E. Co.) Wireless signalling systems. (19/10/15). (Divided application on 14,769/15.) 102,709.

Relates to a wireless transmitting system having a number of parallel paths, each containing an incandescent cathode discharge relay and a resistance in series, for controlling the amount of energy delivered to the antenna from a source of high [illegible] the [illegible] of the relays being varied in succession.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Registration of Business Names. Under sec. 15 of the Registration of Business Names Act, 1916, an office has been opened at 39, Russell-square, London, W.C., for the registration of firms and persons whose principal places of business are situated in England and Wales, and the Registrar-General has been nominated by the Board of Trade registrar for the purposes of the Act.

The particulars required for registration must be furnished on the forms prescribed by the Board of Trade, which will be obtainable at the principal post offices. The registration fee (5s.) will be paid by affixing a 5s. postage stamp at the spot indicated on the form Separate forms will be provided for individuals, firms and corporations.

All communications should be addressed to: The Registrar of Business Names, 39, Russell-square, London, W.C.

* * * *

The War Loan. During the past week there were many additional subscribers to the War Loan, and these included several electrical engineering firms. Among the large subscribers we notice the following:—

Babcock & Wilcox (£500,000); Brisbane Electric Tramways Investment Co. (£108,400); Brunner, Mond & Co. (£750,000); British L. M. Ericsson Mfg. Co. (£30,000): Denny, Mott & Dickson (£25,000); Brown Bros. (£20,000); British Ever Ready Co. (£10,000, new).

* * * *

Copper Scrap. The Minister of Munitions again calls the attention of persons who have copper scrap in their possession to the Order published on Jan. 2, and reminds them that the penalties provided by law will be enforced in all cases where returns of such material are not made as directed in the Order.

The Order includes all scrap copper other than such as is specifically excepted, and applies to such articles as old copper, calico printers rollers, old copper plates used in printing, and other similar forms of copper, as well as to turnings, swarf, &c. All returns should be made within seven days after the close of each month.

The buying prices for scrap copper set out in the schedule to the Order published on Jan. 2 are net, and include the cost of packages, which must be provided by the seller. Delivery must be made f.o.r. to the nearest station unless otherwise arranged with the Ministry of Munitions. Consignors must themselves arrange with the consignees for the return of their packages.

* * * *

Tramway Materials. There is great difficulty in obtaining materials for the maintenance and renewal of tramway tracks, rolling stock, &c., and the Ministry of Munitions have received numerous applications for priority certificates for the manufacture of tramcars and of materials required for tramway maintenance.

The Ministry considers that before issuing certificates every effort should be made to supply the applicants with materials and vehicles which other tranway umdertakings may have at their disposal. Tramway associations are accordingly requested to obtain from their constituent undertakings details of materials and vehicles which they can dispose of. Steps are accordingly to be taken in this direction, but it is doubtful whether much surplus stock or tramway material will be found in this way.

* * * *

Imperial Trade and Cable Communication. The report of the Dominions Royal Commission which was appointed in February, 1913, is now ready, and will be published in a few days.

Interim reports dealing with the resources of Australia, New Zealand, South Africa and Newfoundland have been issued, and an interim report dealing with Canada is to be issued. The final report will deal with various matters connected with the development of the Empire's resources. Cable communications will, it is reported, receive full consideration. The proposed construction of an "All-Red Cable" from the United Kingdom to Canada and across Canada to Australia will be considered. Suggestions will also be made regarding the unification or closer co-ordination of the official statistical systems of the Empire, a better organised system of commercial intelligence, an expansion of the consular service and the employment of trade commissioners, and industrial and other exhibitions.

* * * *

Local Authorities & Income Tax. Local authorities are now responsible for so many public services and run so many trading departments that the incidence of income tax is of considerable importance to them. Some years ago Leeds Corporation brought a test case to justify their claim to pool all their services and undertakings for income tax assessment purposes, and though they failed in the House of Lords they succeeded in establishing a partia pooling to the extent of the services secured on each separate rate fund being treated as a separate undertaking.

The effect of this may be seen from the recent report of the borough treasurer of West Ham Corporation on the result of the negotiations for income-tax adjustment with the Inland Revenue Authorities, covering a period of ten years up to April 5, 1916. The borough treasurer has been able to effect a settlement, with the result that there is a saving in tax over the above period of £11,033—viz., £6,083 for the District Fund and £4,950 for the Borough Fund. Further reductions in the tax payable in respect of trading for supplies to the council's own services, depreciation and new method of assessment in pursuance of sect. 13 of the Finance Act, 1914, have amounted to £1,385.

The thanks of the Council have been voted to the Institute of Municipal Treasurers and Accountants for assistance given in connection with the case.

* * * *

Electrically-driven Textile Mills. Some members of the Bradford Textile Society were recently shown over the Showers Mill, Frizinghall, by permission of the proprietors, Messrs. H. Longbottom & Co.

The mill, which has been practically completed, is sufficiently advanced to allow the weaving machinery to be operated, has been built to accommodate 269 looms and subsidiary machinery. The predominant feature is the fact that the whole of the power is supplied by electricity applied on the "individual drive" system, each loom being driven by a separate electric motor. The complete absence of overhead shafting and belting from the weaving sheds enables them to be perfectly lighted, and owing to this and the careful arrangement of the mill in other respects, there is little left from a hygienic point of view to be desired. Dr. John F. Crowley, of Messrs. Siemens Bros. Dynamo Works (who supplied and installed the electrical plant), gave a description of the electrical plant and explained its advantages to the members. Dr. Crowley pointed out the progress of the use of individual drive by electric power. The first individual drive plant was installed at Keighley, when 100 looms were provided with motors. In June, 1910, his firm put down a set for 800 looms at the Wellfield Mill, Bolton. This installation had proved the advantages of the individual drive, inasmuch as on the plain looms there had been an increased production by as much as 10 and 12 per cent., and on the Jacquard looms 25 per cent. The next installation was at the mill of Messrs. Ward & Henry Holroyd, where 100 looms were provided with electric motors. The biggest development in the district came when Mr. Longbottom decided to use electric motors. He placed the whole thing in the contractors' hands, with the sole stipulation that they had to do a first-class job. The individual drive has made little progress in Yorkshire as compared with Lancashire, but in the course of six years 9,000 motors had been installed for this purpose. Among the advantages of the individual drive were the absence of overhead shafting, the ease with which weaving could be supervised and the cleanliness of the shed that resulted from the use of electric power. But from a commercial point of view the vital fact was the uniformity of speed which could be obtained. They would be surprised what extraordinary variations there were in power in the revolution of a loom shaft. If an electrical engineer were told that for every revolution the power would vary in such and such a way he could almost always provide a motor which would deal with that regular series of variations. If a number of looms were put on one shaft the electrical engineer could not be told what was going to happen, and therefore he could not design a motor to meet the unknown conditions. The consequence was that with individual drive the speed could always be kept up to the possible maximum; that form of drive enabled the loom to keep nearer to the proper speed for such textile machinery than any other. Saving of time was also effected when starting and stopping the loom, and there was a far smaller percentage of breakages, due to the steadiness of the drive.

Dr. Crowley submitted that for the bulk of the Yorkshire manufactures the gear drive was undoubtedly the proper type. For looms there was none which could possibly equal that drive. Gear drive was 7 per cent. more efficient than corresponding belt drive. Chain drive was too liable to snap to be of any practical utility. The reason for the slow progress made in the adoption of the individual drive had been the fact that up to eight years ago a motor built to the size required for looms had an efficiency of about 67 per cent. Motors now built for the driving of looms had an efficiency of from 85 to 88 per cent. on the 1½ H.P. size. The increase in efficiency obtained represented one of the finest things done by electrical engineers in recent times. He said Germany was certainly very much in advance of us in certain directions, but in textile work there was no comparison whatever. Germany was years behind this country in the organisation and the running of her textile factories, except in the poorer classes of work, which she had made peculiarly her own. In calico printing, however, the Germans had us beaten very badly, and he ascribed that very largely to the use of the electric drive to an extent altogether unknown in this country.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 20, 1917, *to* Jan. 27, 1917.

IMPORTS.

London.—*U.S.A.:* Telephone material, £1,063, elec. machinery, £1,764; wire and cable, £3,331; elec. carbons, £255; glow lamps, £1,021; unenumerated, £10,187. *Japan:* Elec. glow lamps, £137; unenumerated, £1,597. *France:* Elec. carbons, £105; unenumerated, £700. *Switzerland:* Elec. carbons, £2,020; glow lamps, £31; unenumerated, £553. *Canada:* Unenumerated, £3,823. *Holland:* Glow lamps, £5,783; unenumerated, £125. *Sweden:* Unenumerated, £670. *Denmark:* Unenumerated, £542.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £64; unenumerated, £276. *Melbourne:* Wire and cable, £236; Elec. machinery, £78; unenumerated, £1,174. *Sydney:* Elec. machinery, £84; wire and cable, £3,692; unenumerated, £673. *Wellington:* Wire and cable, £2,214; unenumerated, £706. *Adelaide:* Elec. lamps, 1,000 n.o.; wire and cable, £54; unenumerated, £168. *Brisbane:* Unenumerated, £29. *Perth:* Unenumerated, £77. *Dunedin:* Elec. machinery, £67; wire and cable, £49; unenumerated, £23. *Newcastle:* Wire and cable, £861. *Christchurch:* Wire and cable, £2,503; elec. machinery, £158; unenumerated, £14. *Hamilton:* Elec. machinery, £16. *Gisborne:* Unenumerated, £18. *Launceston:* Wire and cable, £2,675; elec. machinery, £775. *Sydney:* Elec. machinery, £558; unenumerated, £838. *Timaru:* Unenumerated, £11. *Oamaru:* Unenumerated, £200.

Africa.—*Cape Town:* Unenumerated, £72. *Port Elizabeth:* Unenumerated, £134. *East London:* Unenumerated, £107. *Mauritius:* Unenumerated, £134. *Napier:* Unenumerated, £13. *Durban:* Elec. machinery, £71; unenumerated, £163.

Egypt.—*Alexandria:* Elec. lamps, 3,400 n.o. *Suez:* Elec. machinery, £33. *Aden:* Unenumerated, £10.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Wire and cable, £160; elec. lamps, 1,350 n.o.; unenumerated, £27. *Calcutta:* Elec. lamps, 16,020 n.o.; wire and cable, £333; elec. machinery, £2,487; unenumerated, £1,285. *Madras:* Elec. machinery, £231; unenumerated, £88. *Ceylon:* Unenumerated, £23. *Singapore:* Elec. machinery, £279; unenumerated, £465. *Medan:* Unenumerated, £18. *Bangkok:* Unenumerated, £24. *Kilindini:* Unenumerated, £288. *Karachi:* Unenumerated, £41. *Sourabaya:* Unenumerated, £2,197. *Samarang:* Unenumerated, £90.

Japan.—*Yokohama:* Unenumerated, £76.

China.—*Hongkong:* Unenumerated, £64. *Shanghai:* Wire and cable, £215.

U.S.A.—*New York:* Elec. machinery, £208; telegraph material, £120; unenumerated, £130.

Java.—*Batavia:* Elec. machinery, £781; wire and cable, £10; unenumerated, £135.

South and Central America.—*Buenos Ayres:* Elec. lamps, 3,200 no.; wire and cable, £1,067; unenumerated, £728. *Valparaiso:* Telegraph material, £23; unenumerated, £46. *Santos:* Unenumerated, £15. *Monte Video:* Unenumerated, £42. *Pelotas:* Wire and cable, £507. *Pernambuco:* Unenumerated, £20. *Port Alegre:* Unenumerated, £17.

Holland.—*Amsterdam:* Wire and cable, £944; unenumerated, £92. *Rotterdam:* Wire and cable, £1,204; unenumerated, £34.

France.—*Paris:* Elec. machinery, £214; unenumerated, £1,273. *Dieppe:* Unenumerated, £873. *Calais:* Unenumerated, £169. *Havre:* Elec. machinery, £134; unenumerated, £717. *Bordeaux:* Unenumerated, £506. *Honfleur:* Elec. machinery, £488. *Rouen:* Unenumerated, £410.

Spain.—*Bilbao:* Wire and cable, £30. *Seville:* Unenumerated, £247.

Canada.—*Toronto:* Unenumerated, £24.

Malta.—Unenumerated, £25.

Russia.—*Petrograd:* Elec. machinery, £1,561; unenumerated, £1,365.

Denmark.—*Copenhagen:* Wire and cable, £148.

Finland.—*Tammerfors:* Wire and cable, £332.

FOREIGN GOODS (duty paid and free).

Amsterdam: Unenumerated, £125. *Melbourne:* Elec. meters, £252. *Bilbao:* Unenumerated, £75. *Bombay:* Unenumerated, £19. *Bordeaux:* Unenumerated, £36. *Calcutta:* Unenumerated, £30. *Copenhagen:* Unenumerated, £235. *Dieppe:* Unenumerated, £125. *Paris:* Unenumerated, £119. *Pernambuco:* Unenumerated, £73. *Sourabaya:* Unenumerated, £10. *Kobe:* Unenumerated, £32. *Helsingfors:* Unenumerated, £22. *Madras:* Unenumerated, £12. *New York:* Unenumerated, £242. *Port Elizabeth:* Unenumerated £26.

IN TRANSIT.

Hongkong: Elec. lamps £545. *Durban:* Elec. lamps, £1,320. *Calcutta:* Elec. lamps £1,600.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The partnership between Richard, Frederick, Christopher and Charles Attwater, trading as Attwater & Sons, india rubber merchants, and as the British Rubber Co., Preston, has been dissolved, so far as regards Charles Attwater. Debts by Messrs. Richard, Frederick and Christopher Attwater, who continue the businesses under the same titles.

The offices of the British Empire Producers' Organisation are now at Kingsway House, Kingsway, London, W.C. Telegraphic address: "Frohtic Westcent London"; telephone: "Gerrard 713."

Sale of Shares by Tender.—The Public Trustee announces that he will shortly offer for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Particulars and forms of tender will be issued at an early date. Intending tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., in writing.

The Public Trustee invites tenders for the purchase of the whole or any part of 3,679 A shares of £10 each (fully paid) and 1,200 B shares of £10 each (fully paid) of the Tudor Accumulator Co. (Ltd.) which are vested in him as custodian by an order of the Board of Trade. Tenders must be delivered to the Public Trustee, Kingsway, London, W.C., on or before Monday, Feb. 26, and not Feb. 5, as previously advertised. *Further particulars are given in an advertisement.*

Plant Wanted.—Messrs. John M. Henderson & Co., King's Works, Aberdeen, require electric generating plant of 400 kw. to 650 kw., with either gas engines and suction plant, steam turbine or engines, with boilers, condensers, &c.

Names of Permanent Magnet Makers Wanted.—An advertiser requires the names of makers of permanent magnets for small moving coil recording instruments, or suppliers of steel suitable for making same.

ELECTRICITY SUPPLY.

EXTENSIONS.

Coventry.—A plot of land is to be purchased as a site for a substation.

Dublin.—At the last meeting of the Corporation a resolution was passed authorising the borrowing of sums amounting to £100,000 for extensions of the electric supply undertaking, &c.

Replying to a vote of thanks for his conduct in the chair during the past year, Councillor Jas. J. O'Neill, Chairman of the Lighting Committee, said it was a matter of public congratulation that, despite restrictions and increased cost of material, they were able during the last year to pay off £32,000 of capital, £24,000 in interest, and make a net profit of nearly £9,000.

Dundalk.—An inquiry was held last week into the application of the Urban Council for sanction to borrow £5,000 for extensions of the electric supply undertaking.

Falkirk.—A company proposes to erect works in the district provided it can obtain a sufficient supply of electric current, but in order to give the desired supply the erection of new electricity works by the Corporation would be necessary.. A committee has been formed to inquire into the subject and to report.

Islington (London).—It was reported to the Council last week that there was an overdrawn balance of £10,850 on the electricity account.

Unexercised sanctions to borrow for mains and plant extensions represented £7,940, and application has been made for sanction to borrow £5,499 for mains, meters, &c. In order to reduce the overdraft the Council has decided to raise from their bankers a sum not exceeding £13,439 at the rate of 5 per cent. per annum.

It is proposed to lay an additional feeder main to the Belle Isle district, at an estimated cost of £4,000.

Keighley.—The Electricity Committee recommend the Council to apply for sanction to a loan of £2,000 in order to lay an extra-high-tension cable to provide a supply of electrical energy for power in certain streets.

Sheffield.—Another Greaves-Etchells electric steel-melting furnace has been installed at the works of Walter Spencer & Co., and is now running regularly and satisfactorily. It has a capacity of three tons.

Walthamstow.—It will not be possible to erect the steel chimney provided for in the extension scheme, and tenders are to be invited for the construction of a brick chimney. The L.G. Board have sanctioned the borrowing of sums amounting to £18,790 in connection with the extensions at the generating station, &c.

Weymouth.—The Council have authorised an expenditure of £500 on extensions of mains, &c.

Whitehaven.—The question of extending the electric supply mains to Kells is being considered by the Water and Lighting Committee.

GENERAL.

Hornsey.—Repairs in the crank shaft of one of the engines at the generating station are to be carried out at a cost of £300.

Lambeth (London).—The General Purposes Committee have considered the question of their option in March, 1918, of re-purchasing the undertaking of the South London Electric Supply Corpn.

Notice in writing of intention to exercise the option must be given to the corporation before March 16, 1917, but the General Purposes Committee recommend that as the present time is inopportune notice to exercise the option be not given. The Council has also the option of re-purchasing the undertaking on March 16, 1928.

Liverpool.—At last week's meeting of the Council Mr. Chas. Wilson sought to extend the area of the proposed increase of street lighting by means of shaded incandescent electric lamps.

The town clerk (Mr. E. R. Pickmere) said he understood that the lighting was to be further improved with the approval of the head constable and the military authorities.

Long-distance Radiotelegraphic Communication.—It is announced that wireless telegraphic communication will be established next week between Spain and the United States, the Philippines, Japan and China.

TRACTION NOTES.

Blackburn.—The Tramways Committee propose to increase car fares on all sections but one in the town.

There will be no return tickets on any section, and workmen will have to pay the single fare each way. The increases are made on account of the advances in wages and high cost of material.

Brighton.—Last week the Council adopted a report of the Works Committee recommending the purchase of two motor vehicles for street watering and general haulage at £2,050.

Croydon.—The Tramways Committee have decided to renew the trolley wire from the "Swan" to Purley terminus at a cost of about £800.

Dublin.—The Corporation have resolved to utilise the local tramway system for the conveyance of refuse, &c.

London-Watford Electric Railway.—The electric line from Euston to Watford is nearing completion, and an important development of London suburban traffic will take place next month, when the L. & N.W. Railway Co.'s electric trains will run over the Bakerloo line to the Elephant and Castle. This will enable travellers to the West End to alight at Piccadilly-circus, instead of having to make the journey from Euston by taxi or 'bus.

Salford.—The Tramways Committee have decided to shorten the penny stages on all routes, the result being an increase of a halfpenny on all fares on journeys exceeding 2 miles.

The decision of the Committee on Production (Sir Geo. Askwith, Sir D. Harrel and Sir George S. Gibb) on the strike of tramway employees in consequence of the appointment of female inspectors has been received. The Committee state: "Having given careful consideration to the statements and arguments submitted, find that under the conditions arranged by the Corporation and as a temporary and supplementary measure during the war the objection raised by the union to the employment of female inspectors has not been established."

Walthamstow.—Owing to the shortage of motor men the tramway service between Stratford and Chingford has been temporarily suspended.

The Council has decided to give preferential employment on the tramways to discharged soldiers.

EMPIRE NOTES.

Australasia.—The Melbourne Tramway Board recently issued a writ against the Melbourne Tramway & Omnibus Co., claiming £250,000 damages for alleged breaches of covenants made by defendant with the Melbourne Tramway Trust. There is a clause in the agreement stipulating that the company shall maintain and renew the roadway between the tramways and the roadway 18 in. outside of the rails, and maintain, repair and renew the tramways until the end of the lease. These obligations were to be performed to the satisfaction of the Trust, and the contention is that these have not been carried out.

Melbourne City Council recently adopted proposals of the Electric Supply Committee for raising the standard of efficiency amongst the employés of the electrical engineer's department. The proposals were: (*a*) A system of apprenticeship, with provision for technical training: (*b*) a system of travelling scholarships, whereby the most promising of the junior engineering staff may be able to gain experience in the workshops of the best British electrical manufacturers. It is proposed to restrict the entrance of boys into the department to those who have completed a course at one of the junior technical schools. The number of apprentices required each year by the electric supply department is about eight. These will be chosen by the city electrical engineer from boys nominated by the junior technical schools. Two each per annum will be chosen from the Melbourne and Swinburne schools, and one each from the Brunswick, Prahran, Collingwood and Footscray schools. The age of entry is not to exceed 16 years, and the period of apprenticeship will be five years, and during the first three years apprentices are to attend the electrical engineering or other suitable classes at the Working Men's College or Swinburne Technical College. The Council will pay the fees. There is also a proposal for travelling scholarships, with the object of creating facilities whereby junior technical officers of the department might obtain special training in the works and drawing offices of some of the important manufacturing electrical firms in Great Britain. One member will be sent each year to Great Britain for two years' experience. It is recommended that the Council provide the successful officer with £50 for his return fare, and an allowance of £1 per week during his absence. Those chosen will be required to give a guarantee that they will return to Melbourne at the end of the term of two years.

In the course of the arbitration proceedings before Mr. Justice Cussens to determine the price to be paid to the Melbourne Tramway & Omnibus Co. to the Tramway Board for properties not included in that surrendered on the expiration of the company's lease, the question of future electrification of the lines has arisen, in connection with the value of existing rolling stock. Mr. Alex. Cameron, chairman of the Prahran & Malvern Tramways Trust, stated that the electric tramways in the suburbs of Melbourne were approximately 105 miles (equivalent) single track. The difficulties arising through use of both the electric and cable systems were serious. The Trust's cars in the summer time frequently discharged passengers who were unable to get on to the cable trams going to the beach in one direction, or to the city in the other. He did not think the two systems would be continued beyond the next 10 years, as through traffic would be demanded. No doubt any further tramways would be electric. The cable system was too costly to extend into less densely populated areas. Also the speed of the cable system was less. He doubted if the cable cars would have any residual value for electric purposes. For thinly-populated areas the electric system was the best, but in the city itself the cable system answered requirements. He would like to see a loop of electric tramcars put around the centre of the city, as that would obviate the necessity of having any service in the main streets within that area. There was room on St. Kilda-road to lay down an electric tramway, and in that way their suburban services could be brought right into the city. The process of converting the cable lines would be gradual, electricity steadily superseding cable haulage.

Mr. G. Smith Duncan, civil engineer, who designed and supervised the construction of the cable system, said that the cable tramway system was cheaper to work than the electric. The working cost of the electric system in Sydney was 30 per cent. more than the Melbourne cable tramways in 1910.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" recently stated that the town of Dolores (Province of Buenos Ayres) had been in darkness for a week, the local electric lighting company having cut off the current owing to non-payment by the municipal authorities of the public lighting bill.

The Municipality of Chascomus (Province of Buenas Aires) propose to establish electric supply works capable of supplying current to 200 public lamps of 600 c. p.

It is stated that the Anglo-Argentine Tramways Co.'s underground railway in Buenos Ayres, which reached the third anniversary of its opening on Dec. 2 last, continues to be one of the outstanding beneficial features of the metropolitan movement of Buenos Ayres.

Brazil.—"Wileman's Brazilian Review" (Rio de Janeiro) state that the Caldas region, in which zirkite (zirconia) deposits occur, is mountainous plateau, measuring about 20 miles by 15 miles, partly in the State of Minas Geraes and partly in the State of Sao Paulo, about 130 miles north of Sao Paulo.

Several large outcrops of the ore occur on the extreme westerly edge of the plateau, one or two isolated boulders weighing as much as 30 tons. No extensive development work has yet been attempted, but deposits have been traced for 15 miles between Cascata and Caldas, and, if surface indications are of any significance, the deposits are of vast extent.

Chili.—Permission has been granted to Don Maximo Bastian to instal electric lighting and power systems with overhead lines in the towns of Huasco and Freirina, and with underground cables in Vallenar.

Ecuador.—A decree has been issued authorising the Municipality of Quito to grant one or more contracts for the construction of electric tramways from that city to any town or towns in the canton, the concessionaire to hand over to the Municipality 5 per cent. of the gross receipts from the undertaking during the first five years of operation, and thereafter the percentage to is be increased by 2 per cent. for each five-year period. The concession to be for 30 years.

Italy.—A consular report states that there is a market in Taranto for goods which can be supplied by British merchants in substitution for imports from the Central Powers.

Before the war the Germans and Austrians had a firm hold on the Italian market as far as foreign goods were concerned. They had captured the market by superior trade organisation, and their willingness to grant credits, and by reason of geographical position, freight facilities on German railways, and, possibly, political subvention. Local traders expect 90 to 20 days' credit, and accounts are more easily collected by a traveller than by post. British goods are rare and costly in the district due to middlemen's profits. Cost of transport and the state of Italian exchange (which would mean an increase of over 25 per cent. on prices in currency) are difficulties at present. Suppliers should quote metric weights and measures and prices in Italian money at 25 lire gold to the £, plus the *aggio* for the day as published by the Italian Government for the purpose of custom house payments.

Manchuria.—Local British firms are of opinion that imports into Harbin from the United Kingdom have increased during the war.

But the increase is not commensurate with the increase in imports from Japan and the United States. This is attributable partly to the fact that in many cases British goods come from Hong Kong and through treaty ports in China and not direct from the United Kingdom. In some cases prior to the war British goods were purchased through Hamburg. Japan and America have advantages in greater stability of prices, better shipping facilities and punctuality. Amongst British goods in which the increases have been greatest are electric bulbs, galvanised iron sheets and black sheets. Japanese competition is severe. Direct dealings with non-British local merchants are not recommended. Harbin is the distributing centre for the whole of Northern Manchuria, and at present is also a considerable purchasing centre for European Russia. There is a constant demand for electrical fittings, machinery, ironmongery, wire, oils and paints. The urgent demand brought about by the war has, for the time being at least, practically abolished the long-credit system.

Paraguay.—On Dec. 11 last a general strike commenced in Asuncion.

The strike was declared by the Paraguayan Regional Workmen's Union owing to a question between carpenters and their employers not having been settled. The tram service stopped working in the morning, and the power house stopped generating current at 3.30 p.m. owing to the workmen having joined the strike. The railways staffs also joined the movement. The inmates of the prisons were taken to the power house for the purpose of providing current for lighting the city. Printers, bricklayers and bakers also joined the movement.

Russia.—The Ministry of Communications has prepared a Bill for the notification of centres of water power from waterfalls, or stretches of water suitable for the supply of such centres, of national or public importance.

The Duma is impressed with the necessity for the organisation and development of the water-power resources of Russia, and desires to have legislation on the subject. Up to the present permits to make use of water-power have been in the nature of certificates for works that the Ministry of Communications considered would not interfere with navigation rather than of concessions. These certificates were only issued after consulting the local owners of water frontages. The present Bill proposes to empower the Government to declare any waterfall or stretch of water capable of being used as a source of water-power as being of national importance, and to take possession of such source of power, either for direct Government use or with a view to granting concessions for its use

Mr. L. D. Wilgress, Canadian Trade Commissioner, states that the following, amongst other goods, are in great demand on the Siberian market: Tools of all kinds, electric light fittings and hand pumps. The prospects for the supply of machinery, &c., in connection with construction or equipment of railways, grain elevators, refrigerators, railway car shops, flour mills, leather and other factories, ironworks and coal and other mines warrant careful study on the part of manufacturers and contractors.

Russian Trade.—Owing to the special importance of establishing commercial connections on a firm basis between the allied countries, and with the object of ousting German intervention and competition, the Russo-British Chamber of Commerce, at Petrograd, takes this opportunity of requesting all British firms wishing to trade with Russia now or after the war to send their catalogues and price lists (not less than 10 copies) to the Chamber.

The catalogues will be placed in the special library of the Chamber (at 4, Gorochovaia, Petrograd), and will be distributed to Russian merchants interested in the development of their trade connections with England.

"Engineering" reports that at a recent meeting of the Russian Special Committee for Fighting against German Preponderance means were discussed for ousting the German influence of the following companies: Siemens-Schuckert, Siemens & Halske, Allgemeine Elektricitäts Gesellschaft, the Elektro Peredatscha, and the St. Petersburg Company for Electric Lighting of 1886. The representative of the Minister for Commerce proposed three measures for the attainment of this end—viz., liquidation, purchase by the State, or participation of the Government in the companies by exercising the requisite control. The Committee pronounced in favour of the first measure and of liquidating all five companies, including the Petersburg Company of 1886. A detailed plan for liquidation will be worked out by the liquidating boards which were to be appointed, but the Committee has already drawn up some general regulations. According to these, all shares not issued to a distinct person have to be exchanged for shares issued to a named person; the owners of the present shares have the right to record their shares with a view to such exchange, but such exchange can only be granted to persons with regard to whom there can be no suspicion as to German capital being implicated. The other shares (that is, the shares held by Germans or in which German capital is interested) will be purchased by the Russian State at their nominal value. These shares will then either remain in the possession of the State, whereby it will become directly interested in the different concerns, or they will be sold by the State. According to the plan, the liquidation of all the five companies should be completed by July 1, 1917.

Spain.—A concession for the construction and working of a tramway for goods traffic from the station of Miravalles (on the Castejon Bilbao railway) into the town, has been granted to Chavarri, Petrement & Co.

Uruguay.—Statistics published in the "Journal" of the British Chamber of Commerce in Uruguay show that the total imports into that country in 1915 were valued at 34,979,639 pesos (£7,131,123).

The three largest contributors were Argentina 7,373,843 pesos (£1,566,912), United States 7,270,980 pesos (£1,545,084), United Kingdom 6,851,113 pesos (£1,455,861). Amongst the classes of goods imported were electrical goods 230,708 pesos (£49,025) and raw material and machinery for industries 6,605,162 pesos (£1,403,660).

MISCELLANEOUS NOTES.

Alien Enemy Patents.—The Paterson Engineering Co. has applied for a licence under the Ornstein Patents Nos. 3,666 and 10,374 of 1914, for "Process and apparatus for sterilising water" and "Apparatus for treating water with gas."

Breach of Factory Regulations.—Before the Buxton magistrates last week the Buxton Lime Firms Co. (Ltd.) was charged with having failed, in two instances, to comply with the electricity regulations made by the Home Office under the Factory and Workshops Act.

In September last a man named Bennett was found lying dead on an iron pipe which contained a cable used for lighting purposes by defendant company. If the pipe had been properly earthed in accordance with the regulations death would not have occurred.

For the defence, Dr. Eastham submitted that the case was misconceived. The man had to climb up a 4 ft. 6 in. wall, and had gone a yard or two up the embankment. It was not a thoroughfare. The pipe was placed in an inaccessible place, and his clients thought it was in such a position that no one could get to it, and no one's duties took him there. He submitted that the company were not responsible for contributing to this man's death.

The Bench were unanimous in the first case, and imposed a fine of £10. The second case would be dismissed on payment of costs.

Callender's Hospital and Distress Fund.—The report of this fund for the year ended Dec. 31, 1916, states that the continuance of the war has caused many more of the old members to leave in order to serve King and country, and women are doing their best to fill the gap.

Subscriptions have been well maintained. Donations to the funds included £50 from Callender's Cable & Construction Co., £5. 5s. from Mr. T. O. Callender, and £2. 2s. each from Mrs. E. C. Drake, Sir J. Fortescue Flannery and Messrs. C. H. McEuen, A. R. Kibblewhite, J. S. Pollock, J. Varley, P. Walker and J. C. A. Ward. The penny weekly subscriptions realised £287. 19s. 7d. Awards to hospitals (varying from £73. 10s. to £3. 3s.) amounted to £281. 8s., and grants to members to £62. 16s. 2d. in addition to 233 hospital letters, 10 letters for home nursing, and 10 convalescent home letters.

Electric Light Switching Exams.—The latest phase of this activity of Messrs. A. P. Lundberg & Sons takes the form of "Batch Exams.," which anyone can enter without fee at any time, and on the results of which certificates are awarded.

We have received a copy of a "Batch-Exams." leaflet, which has been issued by the firm. It gives full particulars regarding the "Batch" idea, and contains a set of preliminary grade problems which the recipient can start working without delay. Those interested should communicate with the firm at 477-489, Liverpool-road, London, N.

Enemy Firms Wound Up.—The Controller of Krupka & Jacoby (Ltd.) has applied for a release. Objections to Board of Trade by Feb. 7.

Claims against Radium Limited, 93, Mortimer-street, W., are to be sent by Feb. 24 to Controller, Mr. C. N. Beeby, 66, Basinghall-street, E.C.

Fraudulent Use of Electricity.—At Rugby last month, Hugh L. Smith, engineer, was summoned by the Urban Council for feloniously using electricity between Aug. 1 and Oct. 15, 1916.

In November, 1913, defendant (it was said) applied to have the electric current installed at his house for power and heating purposes only, but when an official visited the premises on Oct. 16 last he found wiring for lighting purposes had been put up in practically every room, and that lamps of 60 c.p. or 80 c.p. were in use, also that in an attic used as a workshop there was a lamp of 300 c.p. The charges for current for heating and power are respectively 1½d. and 2d. per unit, against 4½d. per unit for lighting. It was also found that behind a picture in the hall consumer's cable had been bared for 1½ in. and prepared for making ready connections: that the seal of the fuse box had been broken, the Council's fuses taken away and others of a stronger and different make put in, by which means it was possible to get a great amount of current without it passing through the meter.

Defendant pleaded guilty to the charge, but said the large lamps were used only for warming the rooms in the day time.

A fine of £10 and costs was imposed, the Chairman (Mr. T. A. Wise) remarking that he was sorry to find a man in defendant's position guilty of such a mean fraud.

Inquest.—The inquest on the tramway conductress who was killed in the recent tramcar collision at Wyke, Bradford, was concluded last week.

The jury found that the brakes of the runaway car were in working order, but were not applied, and that there was neglect, but not of a criminal and culpable nature. A more practical tuition of conductresses in the application of brakes was also recommended. The Corporation have accepted responsibility for the accident, and promised reasonable compensation.

The Coroner suggested that a practical lesson might be given the conductresses on the rails as well as in the school.

Mr. C. J. SPENCER (tramways manager) said he did not know how the system of training could be materially altered. The work was so simple in regard to the working of the brakes that he did not see how anything further could be done. After all, they came in the end to the human element, and no amount of instruction would be of any avail with some people in certain emergencies. He would see, however, if any arrangement could be made to give some practical instruction.

TENDERS INVITED.

Boiler, Coal Bunker, Conveyor, &c.

The Electricity Committee of Harrogate Corporation invite tenders for the supply and erection of a by-product Steam Boiler, Overhead Coal Bunker, Coal Conveyor and Structural Steel Work. Specifications from the borough electrical engineer, Mr. George Wilkinson, M.I.E.E., M.I.M.E., to whom tenders are to be sent by March 5. *See also an advertisement.*

Telephone Materials, &c.

Tenders are invited up to March 28 for the supply and delivery to the Postmaster-General's Department, State of South Australia, of Telephones, Telephone Parts, Cords, Line Material, Creed Tape, &c. Specifications, tender forms, &c., can be obtained at the Commonwealth Offices, London. *See also an advertisement.*

Arc Lamp Carbons.

Tenders are invited for the supply of 699,000 Arc Lamp Carbons to the City of Melbourne. Tender forms, Specifications and conditions of tender can be obtained from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Billiter-square Buildings, London, E.C., to whom tenders are to be delivered by noon Feb. 14. *See also an advertisement.*

Automatic Telephone Exchange.

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Specification and conditions of contract from the offices of the High Commissioner, 32, Victoria-street, London, S.W., where tenders must be lodged by noon March 8.

Turbo-Alternators, Dynamos, Switchboards, Motors, &c.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of Melbourne electricity works. Tender forms from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Agents for the City Council, Billiter-square-buildings, London, E.C.; tenders to Chairman, Electric Supply Committee, Town Hall, Melbourne, by noon March 5.

Public Lighting.

Banbridge Urban Council want tenders by 7.30 p.m. Feb. 3 for Public Lighting (gas or electric).

Electric Cranes.

Tenders are required until Feb. 12 for the supply of six 4-ton Electric Travelling Portal Jib Cranes for Durban Harbour. Specifications from Secretary to Tender Board, S. African Railways Headquarter's Offices, Johannesburg, or from the High Commissioner for South Africa, 32, Victoria-street, London, S.W., at which addresses tenders will be received.

Train Lighting Cells.

The South African Railways Administration require tenders for the supply of 3,420 Train Lighting Cells, the approximate requirements for the year ending Feb. 28, 1918 (Tender No. 756). A revised drawing of the cells required may be inspected at the Railway Stores at Cape Town, Port Elizabeth, East London, and Durban and at the office of the Chief Railway Storekeeper, Park Station Chambers, Johannesburg. A copy of the drawing may be obtained from the Stores Offices on payment of 10s. 6d., to be refunded on receipt of tender.

Electric Tipping Wagon.

Tenders are required by 10 a.m. Feb. 9 for the supply of an Electric Tipping Wagon for the Manchester electricity department. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Wiring, &c.

Tenders are wanted by Feb. 21 for Electricians' Work at the War Hospital and the Merton Banks Sanatorium, Keighley. Forms of tender from Mr. J. N. Clarkson, 10, North street, Keighley.

Railway Stores.

The Midland Railway Co. Northern Counties Committee (Ireland) want tenders by Feb. 8 for 12 months' supply of Telegraph Ironwork, Wire Batteries, Electric Lamps, Carbons, Castings, Metals, Ironmongery, &c. Forms of tender from the Stores Supt., York-road Station, Belfast.

Lamp Holders, &c.

The Commissioners of H.M. Works, &c., require tenders (from manufacturers) by 11 a.m. Feb. 6 for Electric Lamp Holders, &c. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W.

Electrical and General Stores.

Battersea (London) Council require tenders by noon Feb. 6 for supply of Various Stores and Materials for their electricity department. Forms of tender from the Engineer, Lombard-road, Battersea, S.W.

Bermondsey (London) Guardians require tenders by 6 p.m. Feb. 22 for 12 months' supply of Electric Lamps, Ironmongery, &c. Forms of tender from the Clerk, 283, Tooley-street, S.E.

Pembroke (co. Dublin) Council require tenders by Feb. 5 for 12 months' Electrical Supplies, Ironmongery, &c. Specification from the Town Hall, Ballsbridge, co. Dublin.

Cheltenham Guardians want tenders by Feb. 14 for 12 months' supply of Electric Light Fittings, Castings, Ironmongery, Rubber Goods, &c. Forms of tender from the Borough Engineer.

Tramway Materials and Stores.

The Tramways Committee of Manchester Corporation invite tenders for the supply of Materials and Stores, including Motor and Controller Parts, Resistances, Coils, Trolley Poles, &c., Lamps, Switches, Bells, Insulation Material, Carbons, Overhead Equipment, Cable, Wire, Oils, Paints, Ironmongery, Bolts, Screws, Axles, Tyres, Castings, &c. Schedules from the general manager, Mr. J. M. McElroy. Tenders to Chairman of Tramways Committee, 55, Piccadilly, Manchester, by Feb. 13.

Halifax tramways department require tenders by Feb. 12 for 12 months' supply of lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor-Bronze Wire, Brake Blocks, Trolley and Overhead Line Materials, Castings, Oils, &c.

Yarmouth Council want tenders by noon Feb. 6 for supply of various Stores to the Tramway Department. Forms of tender, &c., from the Manager.

Salford Corporation Tramways Department require tenders by Feb. 12 for 12 months' supply of miscellaneous Stores. Particulars from the Manager, 32, Blackfriars-street, Salford.

Croydon Council require tenders by 10 a.m. Feb. 19 for the supply of General Stores to the Tramways Department for three, six and twelve months. Forms of tender, &c., from the Tramways Manager.

TENDERS RECEIVED AND ACCEPTED

Cape Town.—The tender of E. A. Shaw & Co. has been accepted for wiring Victoria Court Flats, £800.

Islington (London).—The Lighting Committee reported to the Council last week that, in view of the present circumstances, they considered it inadvisable to advertise for tenders for annual stores.

The present contractors had been communicated with in order to ascertain whether they were prepared to continue their contracts, and it was reported that where a sliding scale governed by the market price was inserted in the contracts the contractors were prepared to continue on existing conditions, but in other cases increased prices were asked for, and it was thought that under the circumstances it would be advisable to accept same in the majority of cases.

The Council authorised the Committee to arrange for the continuation of contracts where they were satisfied that this could be done upon satisfactory terms. The existing contractors and materials supplied are:—

Dick's Asbestos Co. and J. Gibb & Co., engine-room stores; A. F. Goodwin & Co., arc lamp globes; Vacuum Oil Co., oils and lubricants; British Electric Transformer Co. and Sheepbridge Coal & Iron Co., transformers and cast-iron tanks; Basilica Mfg. Co. and Pryke & Palmer, steel, iron, tools, belting, rope, &c.; Young & Sons, Turner & Lisney, J. Knowles & Co. and Doulton & Co., earthenware pipes, insulators, &c.; Chamberlain & Hookham and British Westinghouse Elec. & Mfg. Co., electricity meters; British Insulated & Helsby Cables, cable; A. F. Goodwin & Co., Cryselco Co. and Edison-Swan Electric Co., electrical sundries, lamps, brushes, arc lamp parts, &c.; Geipel & Co., arc lamp carbons; Callender's Cable & Construction Co., W. Lucy & Co., Sykes & Sugden, J. Gibb & Co., Dussek Bitumen Co., W. T. Henley's Telegraph Works Co. and India Rubber & Gutta Percha & Telegraph Works Co., cable terminal boxes, &c.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Department, Sydney.—Western Electric Co., 30,000 jointing sleeves at 15s. 9d. per 100.

Western Australia Government Tender Board.—Chas. Atkins & Co., a.-c. motors and converters, six at £26 13s. each, four at £42 12s. each, four at £35 16s. each, four at £73 19s. each, and five at £60 each: J. R. W. Gardam, a.-c. motors and converters, one at £36 5s. and ten at £41 10s. each; Elder, Shenton & Co., a.-c. motors and converters, four at £31 each, five at £28 16s. each, four at £23 15s. each, and three at £22 5s. each; Denny Bros., a.-c. motors and converters, seven at £20 5s. each, and two at £24 15s. each.

Victorian Railway Commissioners.—Australian General Electric Co., signal lighting transformers for power signalling, £2 11s. each, and half-watt lamps, lanterns and globes, at schedule rates.

Postmaster-General's Dept., Melbourne.—Western Electric Co., 2,000 jointing sleeves, 9s. 8d. per 100; 4,000 ditto, 11s. 9d. per 100; 2,000 ditto, £1. 6s. 6d. per 100; 2,000 ditto, 14s. 3d. per 100; 1,500,000 ditto, (paper), 3s. 3d. per 1,000; Firebrick Insulator & Pottery Co., 50,000 porcelain insulators, 6⅝d. each.

Postmaster-General's Dept., Brisbane.—Edison Swan Electric Co., 15 Edison Lelande cells, 9s. each; 50 ditto, 15s. 4d. each; 10 porcelain jars, 4s. 11d. each; 600 oxide plates, 2s. 0⅛d. each; 250 pairs zincs, 1s. 8d. per pair; 450 pairs ditto, 3s. 1¼d. per pair; Brisbane Electrical Co., 10,000 corks for Meidinger cells, 1d. each; Noyes Bros., 10 porcelain jars, 2s. 6d. each.

Postmaster-General's Dept., Adelaide.—W. T. Henley's Telegraph Works Co., 5,580 yds. cable, £708 per mile; British Insulated & Helsby Cables, 550 yds. cable, £1,034 per mile.

New Zealand Government Contracts.—The N.Z. Public Stores Tender Board has accepted the following tenders:—

P. R. Baillie & Co., 10,500 telephone cords, £1,145; B. L. Donne, 4,000 switchboard plugs, £558, and 1,000 extension bells, £406.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Stepney (London).—The accounts of the electricity supply undertaking for the year ended March 31 last show gross capital expenditure £645,041 (increase £44,697), of which £520,164 is outstanding.

Revenue was £104,531 (compared with £93,637 in previous year), and working and general expenses were £69,237 (£48,508), leaving gross profit £35,294 (£45,129). After meeting capital charges, &c., the net deficit was £5,864 (against net profit £10,702). The maximum supply generated was 9,874 kw. (7,756 kw.), units generated were 27,827,158 (21,923,856), sold in Stepney 18,916,612 (17,194,300), public bulk supply 6,055,279 (1,562,707); total 24,971,891 (18,757,007). Average income was 1·150d. (1·211d.) per unit sold, works and administrative cost was 0·649d. (0·584d.), and interest and sinking fund absorbed 0·406d. (0·440d.) The engineer and manager (Mr. W. C. P. Tapper) says in his report the extension of the Limehouse generating station has been completed and 10,000 kw. of the 15,000 kw. of plant for which the extension was designed has been installed, making the plant capacity 17,720 kw. The all-round advance in costs (coal being the chief item) has prevented any improvement upon the estimated deficit, and as no increase was made in charges the deficit was £5,864 to be taken from reserve. An increase of 15 per cent. was made in the charges for current at the end of the financial year, and further advances have been found necessary since. Nearly £10,000 additional capital charges were incurred in connection with the capital expenditure on the Limehouse extension. Wages increased £1,900 and revenue from private and public lighting (less cost of generation) decreased £3,260. But for the abnormal conditions due to the war, the financial result would have exceeded the best obtained in previous years. The supply and maintenance of motors meets with continued success and the profit from this was over £1,100. The Ministry of Munitions has certified the undertaking, and issued over 160 war service badges to employees, of whom five were recently debadged. At the end of the report is a roll of honour containing the names of 60 members of the staff who are serving or have served in H.M. Forces during the war; of whom we regret that eight have been killed or have died on active service.

Tynemouth.—The accounts of the electricity department for the year ended March 31 last show total capital expenditure £97,695 (increase £521), of which £55,708 is outstanding.

Revenue was £14,369 (compared with £16,026 in previous year), and working and general expenses were £15,653 (£15,802), interest, sinking fund, loan instalments and apparatus bought out of revenue amounted to £6,512 (£6,190), the net result being a deficit of £513 (compared with a profit of £738). Working and general costs were 1·055d. (1·020d.) per unit sold, and total costs, including financial charges, sinking funds and capital expenditure out of revenue, were 1·897d. (1·813d.). Kelvins sold were [illegible] (1,809,811). Maximum demand was 1,160 kw.

Mr. C. Turnbull (borough electrical engineer) says in his report there has been no real deficit, but an actual profit of £5,998. This has been expended in interest, sinking fund and redemption and in capital expenditure out of revenue. The balance of £513 has been met from funds in hand and the sum of £1,311 still remains from past profits. The gross profit (£5,998) is over 10 per cent. on the capital outstanding at the beginning of the year. During the winter, the demand for current from the bulk supply company became so great that the department had to run its steam plant. This performed its work with every satisfaction, but with temporary running the costs were naturally high. Applications for connection during the year were restricted by war conditions, and as time goes on it will be more and more difficult to put in wiring, as men are called up for the Army. The electric motor has achieved an unassailable place in the engineering works. Modern factories are equipped throughout with motors and indeed the present immense output of munitions could not have been produced without the electric motor. Demand for motor load is growing rapidly in Tynemouth.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

BRITISH SWITCHGEAR (LTD.) (145,352)—Private company. Reg. Jan. 25, capital £40,300 in £1 shares (40,000 preference), to carry on the business of manufacturers and dealers in electrical switchboards and other electrical and mechanical machinery and apparatus, &c., and to enter into an agreement with Brook, Hirst & Co. (Ltd.) and Erskine, Heap & Co. (Ltd.). First directors are J. A. Hirst (nominee of Brook, Hirst & Co.), J. M. Scott Maxwell (nominee of Electric Control, Ltd.), A. Erskine (nominee of Erskine, Heap & Co.) and H. C. Siddeley. Secretary: C. H. Siddeley.

MORTGAGES AND CHARGES.

BRITISH MINIATURE ELECTRIC VEHICLES (LTD.)—Particulars of £3,000 debentures created Jan. 17, 1917, have been filed, amount of present issue being £1,000. Property charged: Company's undertaking and property, present and future. No trustees.

MERRYLEES & CO. (LTD.)—Notice of appointment of P. S. Booth, Exchange-chambers, Liverpool, as receiver on Jan. 15, 1917, under powers contained in debentures for £2,500 dated Nov. 30, 1914, has been filed.

CITY NOTES.

MEMORANDA (Jan. 31).—Bank rate 5½ per cent. (since Jan. 18, 1917) Consols, 52. Stocks and Shares Ticket Day, Feb. 8. Pay Day Feb. 9 Price of Silver, 37 5/16d.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—The revenue for 1916 was £64,567. 7s. 10d. and the expenses were £34,341. 5s. 4d., leaving £30,226. 2s. 6d. After paying rent of Rochester Corporation lines (£3,743. 12s.) and interest on debentures, &c. (£2,589 12s. 9d.), transferring £6,000 to reserve for depreciation and £2,000 to maintenance reserve account and writing off £1,632 1s. 3d. for investments, and adding £3,150. 4s. 3d. brought forward, the balance is £17,401. 0s. 9d. Of this amount £2,940 has been paid for the interim dividend at rate of 5 per cent. per annum on the preference share capital and £3,180 for the interim dividend of 3 per cent. on the ordinary share capital for the June half-year, and the directors recommend payment of final dividends at rate of 5 per cent. per annum on the preference share capital and of 4 per cent. on the ordinary share capital, making, with interim dividend 7 per cent. for the year. The 10 per cent. of net profits payable to the directors after payment of 5 per cent. dividend on the ordinary share capital for the year amounts to £307 1s. 8d., leaving £3,793. 19s. 1d. for revenue new account. There is an increase of £3,650 in the revenue and £2,111 in the expenses compared with the receipts and expenses for 1915. It has again been impossible, owing to shortage of labour and difficulty in obtaining materials, to maintain the track and rolling stock in the usual state of repair, and £2,000 has been added to maintainance reserve account in order to make some provisions for repairs after the war.

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.)—The accounts for 1916 show that the amount available for division is £91,194. 5s. 11d. Interim dividends, amounting to £24,960, were paid in August, leaving £66,234. 5s. 11d. Out of this sum it is recommended that a dividend at rate of 6 per cent per annum, (less tax) be paid on the preference shares for the half-year ending Dec. 31, and that a final dividend at rate of 5 per cent. per annum (less tax) be paid on the ordinary shares for the same half year; that £20,000 be set aside for renewals of rail and £7,000 be added to general reserve, leaving £13,359. 5s. 11d. to carry forward.

METROPOLITAN RAILWAY CO.—A dividend at rate of 1 per cent. has been declared on the ordinary stock for the past half-year (making 1 per cent. for the year), carrying forward about £14,500, after placing £20,000 to general renewals fund.

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NOTES.

The Purchase of Coal.

A BULLETIN recently issued by the Bureau of Mines shows that the purchase of coal on a scientific basis is making considerable headway in the United States. By "scientific basis" we mean under specifications depending on the heating value of the coal, its content of ash and of moisture, and other considerations, rather than upon the reputation or trade name of the coal. It appears that the plan was first adopted by the U.S. Government about 10 years ago. Since then the plan, modified in form, but the same in principle has been gradually adopted until, at present, of the coal used by the Government more than half is purchased under specifications. A laboratory is maintained at the Bureau of Mines where samples representing deliveries of coal purchased under specifications are analysed and tested. At this laboratory it is said that more than 1,200 samples have been dealt with in a month. With the complete equipment and the efficient technical staff employed, the analytical work has been so perfected that the analyses and heating-value tests of the samples received are as accurate as may be reasonably expected in laboratory work of this nature. We venture to think that if it is advantageous for the State to purchase coal to specification, it is of equal advantage to the individual so to do. Many of the largest coal users in the country already buy coal on this plan but we should like to see the method more widely adopted, not only by the large consumers but also by the medium and small consumers. Wide adoption of the plan would make it possible to establish a central laboratory where the tests could be made accurately and economically. Only those who have actually done the work know how difficult it is to obtain consistent results in the testing of fuels, and the central laboratory would get rid of the difficulty. The bulletin mentioned deals authoritatively and exhaustively with the methods of sampling delivered coal, and, in addition, typical specifications are given for the purchase of coal.

Fuses on Short Circuit.

IT is well recognised that the object of the fuse on an electric circuit is two-fold, firstly to prevent overloading of the circuit, and secondly, to prevent damage to the wiring through short circuits. On ordinary networks the fuse is called upon mainly to play the part of protector against overloading and against the milder forms of short circuit; but it is nevertheless realised that every fuse should be capable of standing what is termed a "dead short circuit." The fuse takes a certain time to act—this, in fact, being one of its virtues—but owing to this characteristic the current that is carried before actual fusion occurs may be very high under certain conditions, and a state of affairs may be reached in which a small variation in the time constant of the circuit and other factors may make a very considerable difference in the maximum current. This seems to be the explanation of the effects observed by Mr. SYDNEY W. BAYNES, the Chief Electrical Engineer of the St. Pancras Borough Council. Mr. BAYNES has found that service fuses have been much less satisfactory during recent years—in fact, since the advent of the steam turbine. The currents that may arise on dead short circuits through a 5-ampere or 10-ampere fuse have now become very heavy, this being partly due, possibly, to the fact that a momentary overload has a less mechanical effect on a steam turbine than on a reciprocating engine, and partly, no doubt, due to the fact that the reactance of the turbo-generator is much less. On another page we publish an interesting photograph showing the effects obtained. Mr. BAYNES has found that owing to the very heavy currents that may result there is a tendency for the arc to flash to any earthed metal in the immediate vicinity of the fuse, and consequently he favours fuses of the cartridge type. For this reason he has now adopted concrete service boxes for all services on the St. Pancras network. We shall be interested to hear whether other engineers have experienced similar difficulties, as the question is one of distinct importance to those engaged in electricity supply.

The South African Market.

NOT without reason American electrical engineers appear to attach a great deal of importance to the South African market. We are not referring to the small things in the business so much as to the large, as it is the latter which go to make up the bulk of engineering work in a country like South Africa. It is largely the fault of home firms that their rivals have secured so much of the trade in the past. In pre-war days they allowed experts on the engineering requirements of South Africa to sell themselves to German firms, and these experts, in order to secure the means of livelihood, had to do work which was directly opposed to the interests of engineering firms at home. In recent years several informative Papers dealing with electrical engineering on the Rand have been read before the engineering institutions. Of these, Mr. RIDER's Paper, read before the Institution of Electrical Engineers, and Mr. BERNARD PRICE's Paper, read before the South African Institute of Electrical Engineers, give a very good idea of the kind of engineering that is insisted upon by the mine owners. Although Mr. RIDER's Paper was read some years ago, many of his criticisms apply with equal force at the present time. One would think that it would be to the best interests of British engineering for home firms, or their Associations, closely to study the ever-increasing requirements of the South African market with a view to securing a fair share of the orders for big things—preferably the things that are of record size—as these are good advertisements for the firms undertaking their manufacture.

* * *

"A Master Weapon" (?)

IN dealing with the peculiar position in which the people of the United States find themselves, the "Observer" remarks: "If the enemy persists in this policy of universal piracy and murder, the United States, in concert with the Allies, could adopt a resolution vigorously debarring Germany and the Central League from the markets of the world for a term of years—seven, ten, or more. If that were done in a way to show that it was decreed in thorough earnest, Germany would be deserted by her Allies before the end of this year. Prussian principles could no longer hold out the faintest hope for the future. Before long nothing but surrender at discretion would be left for the common enemy of mankind. We trust that President WILSON will seriously consider the use of this bloodless but terrific weapon of economic compulsion. Its use by the Allies can be made formidable if we are hardened enough; its reinforcement by America would be crushing." In the early days of the war we heard a good deal about schemes of this kind, and it is schemes such as these which tend to make the people of this country continue to live in a fool's paradise. As long as German hardware can be obtained at a less price than Birmingham hardware the people of the earth will pocket their patriotism in order to save their cash. It is more than probable that the terrific weapon of economic compulsion will necessitate the doing of things by ourselves which it were better for us not to do, and one of these things is trading with the enemy. We hope that we are to have an indemnity. Had we rigorously to debar Germany and the Central League from the markets of the world for a term of years we should automatically make it impossible for them to pay such an indemnity, because had we to take all they possess we should not have a sufficient sum to pay interest on the capital invested and to make good the damage that has been done during the past two-and a half years. The use of this "terrific weapon" would mean that we should have to pay back the war loan by taxing ourselves, and this does not strike us as being particularly good business. In the past nations have been put into slavery for crimes less grievous than those committed by our enemies. In the present nations whose only sin is that they wish to live peaceably are put into slavery. Is it too much to hope that in the future it may be possible for entire nations to be put into slavery? This at least would be a fit punishment for the common enemy of mankind.

* * *

Platinum Production in 1916.—Last year the production of platinum in the Urals was seriously affected partly on account of the scarcity of labour and partly on account of the difficulty of obtaining mechanical equipment. It is estimated that during 1916 the production of platinum was 3,600 lb. to 4,300 lb., or one-third of the normal.

"Faraday House Journal."—The "Faraday House Journal" for the Lent Term contains some interesting notes on electrical engineering by Dr. Alexander Russell, dealing with the Circular on Standards for Electric Service, issued by the Bureau of Standards; also a short article by Mr. L. Romero on "The Transmission of Power between Two Alternating-current Power Stations." Some account is given of Dr. Russell's Kelvin Lecture and Mr. J. K. Stothert's Address to the Scottish Local Section. The "Journal" is naturally largely concerned with the doings of Faradians at the Front, and contains the inevitable Roll of Honour of those old students who have fallen in the cause of liberty.

War Lighting in Manchester.—A deputation, consisting of the Chairman of the Gas & Electric Committees, the Deputy Chairman of the Watch Committee, the Chairman of the Tramway Committee and the chief electrical engineer to the City of Manchester, has recently been making a tour of various provincial towns, with that of inspecting the lighting conditions. While no formal report from the deputation has yet been published, it is generally considered that Manchester is not unfortunate in its present lighting, which compares favourably with that of many adjacent cities. For example, in Manchester, 20 per cent. of the lamps are still lighted, while in four towns in the East Midlands only 4 per cent. are lighted, and even these are extinguished in the course of the evening.

Electric Lifts in Ships.—At a meeting of the Belfast Association of Engineers held on January 18th a Paper on "Electric Lifts on Land and Shipboard," by Mr. C. G. Major, was read by Mr. P. H. Stevens. The installation of electric lifts on ships presents special difficulties, owing to the pitching and rolling of the vessel. The guides, for example, must be specially stiffened and yet, since no part of a vessel in motion is absolutely rigid, there must be flexibility and "give." The swinging control cables below the cage are considered to be a nuisance, but the alternatives are even more inconvenient. The fittings inside the well must accordingly be so fixed that the free swinging cable cannot possibly hitch on them, whatever the motion of the ship.

Various Applications of Research.—In a recent address to the Junior Institution of Engineers Mr. A. P. M. Fleming pointed out that the encouragement of research has a direct interest to all sections of the community. Much has been said regarding its value to the manufacturer and the merchant. But it is very important that the manual worker should realise that research is also of benefit to him, by leading to new developments in industry and so promoting continuity of employment. To the financier again, research would often be necessary in analysing the financial possibilities of new schemes, on which past experience gives little guidance. It should also be recognised that not only the manufacturer, the financier and the worker, but the whole community benefit by research. The progress brought about by patient research in illumination, locomotion and hygiene, for example, have been of far-reaching benefit to the community as a whole.

Choosing Employees by Test.—During recent years much has been heard on the scientific use of human material, including the careful selection of men best suited for various classes of manual labour. Some refinements in methods of selection are described by Mr. W. F. Kemble in a recent issue of "Industrial Management." An important point is the discrimination between strength and manual dexterity. A number of devices are proposed for testing the latter quality, such as the time taken to transfer a number of matches from a pan into a series of holes prepared for them. For other classes of work strength of fingers and forearm may be tested with the ergograph, or, again, grip may be tested with a dynamometer. As regards manual dexterity, the shape of the hand and fingers often offers a good guide. It is said that the very finest typists have exceptionally small fingers, and that generally small dimensions tend to quickness and deftness of movement.

Illumination as a Factor in Manufacturing Costs.—In a booklet by Mr. A. S. Hubbard, issued by the Westinghouse

Cooper-Hewitt Co. (Ltd.), it is pointed out that if every operator in a works were given two carbon filament lamps or one tungsten lamp for his own exclusive use, or one arc lamp was provided for each five operators, or one Cooper-Hewitt lamp for each four operators, the cost of current for the entire day would be only about ½d. per operator. Each operator might be paid, on the average, 8s. 4d. per day of 10 hours—*i.e.*, ½d. for three minutes' work. If, therefore, the illumination provided enabled the workman to save only three minutes in the course of the day, it would pay for its cost. The above illustration shows that illumination is in general but a minute fraction of the total cost of manufacture. Any improvement in lighting which enables the worker to execute his job slightly more rapidly or with less imperfections is invariably worth while.

Trench Foot an Electrical Phenomenon (?)—In a recent article by Dr. C. N. Longridge in the *Lancet* it is stated that the sores accompanying "trench foot" have a close resemblance to the tropic sores which accompany certain diseases of the central nervous system. Dr. Longridge applies a theory of Mr. A. E. Baines to explain these effects on an electrical basis. It is suggested that the normal condition of the body involves the constant circulation of currents through the nerves, which operate as insulated cables. When, however, a man is standing continually in water, so that his extremities and a considerable surface of the skin have their electrical resistance enormously diminished, a constant leakage of current takes place. This apparently interferes with the continued action of the "electrical generator" believed to be located either in the brain or the spinal column. Experience has shown that the best safeguard against trench foot is to cover the feet with grease; similarly swimmers on long distances anoint themselves with oil. It has usually been assumed that the beneficial action of this treatment is due to the grease or oil acting as a heat insulator, but according to the theory of Dr. Longridge it is rather its qualities as an electrical insulator that renders such a covering valuable.

OBITUARY.

H. G. Stott.—The death is announced of Mr. Henry Gordon Stott, a well-known Anglo-American electrical engineer.

Deceased was a native of the Orkney Islands, where he was born in 1866. He was educated at the Watson Collegiate School, Edinburgh, and the College of Arts and Sciences, Glasgow. He became assistant electrician on board the c.s. "Minia," and he was identified with the duplexing of the Direct United States Cable Company's main cable. In 1889 he became assistant engineer of the Brush Company's plant at Bournemouth, but in the following year he entered the service of Messrs. R. Hammond & Co. as assistant engineer in connection with the Madrid electricity supply undertaking. In 1891 he entered the service of the Buffalo Light & Power Co., with whom he remained for 10 years. In 1901 he accepted the office of superintendent of motive power of the Interborough Rapid Transit Co., a position which he held at the time of his death. He was President of the American Institute of Electrical Engineers for 1907-8, Vice-president of the American Society of Mechanical Engineers in 1912-14, and a director of the American Society of Civil Engineers in 1911. He was a member of several committees of the American Institute of Electrical Engineers and was a frequent contributor to the electrical press.

PERSONAL.

Our readers will join with us in sympathy with Dr. J. A. Fleming, F.R.S., the Pender Professor of Electrical Engineering at University College, London, upon the death of his wife, which occurred on the 6th inst.

An interesting double wedding took place on Saturday at St. Paul's Church, Onslow-square, London, when Lieut. A. Reginald Courtenay and Mr. Wm. Heartley Dewers married respectively Miss Edith and Miss Winifred Ashworth, the daughters of Dr. J. Henry Ashworth, of Cliftonville. Until June, 1915, Lieut. Courtenay was Acting Manager of the Publicity Department of the General Electric Co.

Capt. Harry Richardson, R.E. (general manager of the Dundee Corporation electricity works), is mentioned in Field-Marshal Sir Douglas Haig's despatch. Capt. Richardson has been at the front for 18 months.

Mr. C. J. Hunt, who until recently was chief contract engineer to Messrs. Bruce Peebles & Co. (Ltd.), Edinburgh, has been appointed chief engineer to the company; and Mr. Wm. Oliver, who has for some time been acting chief estimating engineer (in the absence of Mr. R. Shaw on active service), has been appointed chief contract engineer.

APPOINTMENTS VACANT.

A charge engineer is wanted by Ilford Urban District Council for their electricity works. Salary £120, increasing by annual increments of £10 to £150 per annum. Applications to the engineer and manager, Mr. Arthur H. Shaw, by Feb. 19. *See an advertisement.*

A capable draughtsman, accustomed to switchgear design, is required. *See an advertisement.*

A wireman is required on the temporary staff of the East Sussex County Asylum, Hellingly, with knowledge of three-wire work, motors, &c. Wages 9d. per hour for 54 hour week. Applications to Resident Engineer.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Feb. 9th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S.W. Agenda: "ASpecial Test on the Gravitational Temperature Effect," by Dr. P. E. Shaw and Mr. C. Hayes, B.Sc.; "To Measure Pressure in a High Vacuum by Observation of Logarithmic Decrement," by Dr. P. E. Shaw; and "Note on the Calculation of the Coefficient of Diffusion of a Salt at a Definite Concentration," by Dr. A. Griffiths.

SATURDAY, Feb. 10th.

Birmingham and District Electric Club.

7 p.m. At the Swan Hotel, New-street, Birmingham. Presidential Address by Mr. A. B. Mudie.

MONDAY, Feb. 12th.

Electro-Harmonic Society.

6.15 p.m. Concert at the Holborn Restaurant, Holborn, W.C. Ladies' night.

Newcastle Local Section, Institution of Electrical Engineers.

6.45 p.m. At the Mining Institute, Newcastle. Discussion on "The Metric System," to be introduced by Mr. G. Stoney. F. R.S.

TUESDAY, Feb. 13th.

Manchester Local Section, Institution of Electrical Engineers.

7 p.m. At 17, Albert-square, Manchester. Paper on "Frequency Changers," by Mr. R. Townend.

WEDNESDAY, Feb. 14th.

Association of Engineers-in-Charge.

8 p.m. At St. Bride Institute, Bride-lane, Fleet-street, E.C. Paper on "Galvanising," by Mr. W. E. Sharples.

THURSDAY, Feb. 15th.

Royal Institution.

3 p.m. At Albemarle-street, W. Lecture on "The Mechanism of Chemical Change," by Prof. F. G. Donnan, F.R.S. (Lecture III.)

FRIDAY, Feb. 16th.

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Annual General Meeting.

Scottish Local Section, Institution of Electrical Engineers.

7.30 p.m. At 207, Bath-street, Glasgow. Kelvin Lecture, "Some Aspects of Lord Kelvin's Life and Work," by Dr. A. Russell.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Colonel C. B. Clay, V.D., Commanding.

Orders for the Week.

Officer for the Week.—Platoon Commander L. C. Hughes-Hallett.

Next for Duty. Platoon Commander J. O. Cheadle.

Monday, Feb. 12.—Technical for Platoon No. 9, at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.30 to 8.

Wednesday, Feb. 14.—Instructional Class, 6.15; Platoon Drill, Platoon No. 2.

Thursday, Feb. 15.—Platoon Drill, Platoon Nos. 5 and 6; Ambulance Class by M.O., 6.30.

Friday, Feb. 16.—Technical for Platoon No. 10, Regency-street; Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill, 6.30 to 8.30.

Saturday, Feb. 17.—Commanding Officer's Parade, 2.45, uniform.

Sunday, Feb. 18.—Entrenching at Otford. Parade Victoria (S.E.& C. Railway Booking Office), 8.45 a.m. Uniform, haversacks, water bottles. Midday rations to be carried. Railway vouchers will be provided.

Musketry.—For all Companies, see Notice at Headquaters.

Note. Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

CONSTRUCTION AND LAY-OUT OF HIGH-TENSION EQUIPMENT.*

BY M. M. SAMUELS.

It is the object of this article to review the present status of high-tension developments, and to indicate a few places where improvements are required and feasible from installation and operating standpoints.

Transformer Developments.—Transformers are now being built for very high voltages and ratings for both single and three-phase circuits. To give an approximate idea of the enormous size of modern transformers for an average installation it may be pointed out that the 10,000-kw. three-phase, 6,600-66,000/110,000-volt units which have been installed by the Tennessee Power Company occupy floor space of approximately 20 ft. by 8 ft., are about 19 ft. high and weigh approximately 200,000 lb. Since, as is evident, such apparatus could not be shipped assembled, the tanks had to be riveted together in the field.

Indoor transformers of large rating are always water cooled and no special radiators are required, the tank surface in addition to convection currents in the water being sufficient to carry away the heat generated.

In hydro-electric power houses where a great quantity of water is available at little cost, the cooling water is usually taken from the intake, circulated through the transformers under the force of gravity and discharged into the tail race, so that no elaborate water piping is required. At substations, however, where city water often has to be used, or where the water has to be pumped at great expense, a saving can usually be realised by installing cooling facilities and re-circulating the water through the transformer.

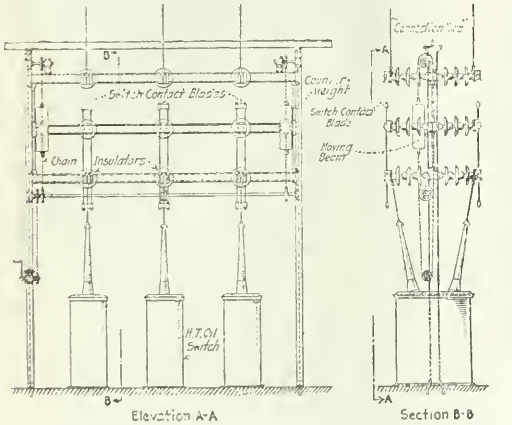

FIG. 1.—BAYONET-TYPE DISCONNECTING SWITCH, REQUIRING SMALL AISLE SPACE.

The arrangement of piping as well as the oil filtering and pumping equipment should be given special consideration when making a preliminary power station or substation layout since the crowding of piping will often cause complications in the high-tension wiring.

In connection with the subject of transformer layout there is one obstacle which station designers encounter for which no remedy can be offered at the present time; *i.e.*, the great variation in the shape of different makes of transformers. While it is always possible to estimate the floor space required by a rotary converter, motor-generator or an oil-switch, it is impossible to do so with transformers, and this may partly explain the awkward arrangement of high-tension apparatus and wiring sometimes observed in high-tension installations.

Reverting to transformer construction, it may be pointed out that bushing troubles have been practically eliminated and tank construction so improved that leakage now occurs only very rarely. High-voltage testing transformers are available at the present time in all test rooms, the highest test pressure used for practical purposes being about 750,000 volts. By installing the transformer and high-tension switching in enclosures and interlocking the compartment door with the low-tension oil-switch of the transformer, the operation of these high-tension tests has been made practically hazardless.

Mounting of Oil-switches.—Next in importance to the transformer as regards rapid development of construction is the oil-switch, there being a new type of switch in practically every new station that is constructed. Low-tension oil-switches differ so much that different 'bus structures have to be used with nearly every type. On the other hand, all modern high-tension oil-switches have approximately the same outside appearance, and there is very little difference in the required floor space. Older types of high-tension oil-switches required concrete or steel foundations in order to raise the terminals above reach. Most recent oil-switches, however, are arranged for pipe or angle-iron mounting, which not only does away with the necessity of a foundation, but permits the tank being lowered easily for repairs or examination. For automatic operation of the older types of high-tension oil-switches, series relays were mounted on high-tension insulators and connected with small auxiliary tripping switches by means of long wooden rods. This rather clumsy and primitive construction is now very seldom used, however, its place having been taken by current transformers. Where the line current has to be measured, as is required in most cases, the meter current transformers are utilised for operating the relays. When metering is not required, bushing-type transformers mounted on the oil-switch terminals are generally employed for operating the relays.

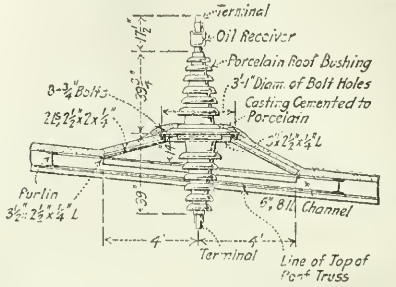

FIG. 2.—CROSS-SECTION OF 120,000-VOLT ROOF BUSHING.

Since a continuous wall or steel member is seldom installed along a line of oil-switches on which to support a control bus, individual circuits usually have to be carried directly from the switchboard to each oil-switch.

Improvements in Disconnecting Switches.—Except in extreme cases, such as for 'bus selection, disconnecting switches are auxiliaries to oil-switches, serving only to isolate the switch when inspection or repairs are necessary. On this account, they may be considered a necessary evil and should not be permitted to have too much influence upon the character and quality of a high-tension layout. All of the old type disconnecting switches, with the exception of the pneumatically operated units, were usually opened and closed by means of a switch hook attached to a hickory stick of suitable length. This method requires an operating aisle which increases in width with the voltage. The space cannot be utilised for any other purpose and is thus wasted. Especially in hydro-electric stations with elaborate substructures, this has called for an enormous expense and has led to the development of many types of disconnecting switches which are operated from the floor by means of a pipe mechanism. Most of these switches are of the pivot type, the centre insulator turning around its pin as an axis and contacts being made at the top as well as at the bottom. Such switches permit a considerable

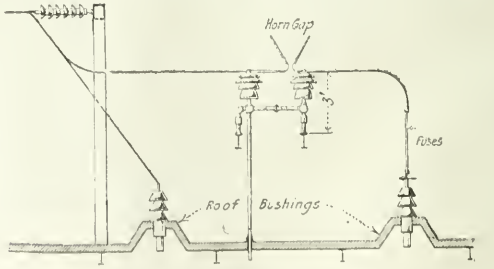

FIG. 3.—ROOF INSTALLATION OF HORN GAPS, OPERATED FROM WITHIN STATION AND CONNECTED THEREWITH THROUGH ROOF BUSHINGS.

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* Abstracted from the Electrical World.

*Clearances for Circuits and Apparatus at Different Voltages.**

Maximum voltage.	Spacing of live parts, in.				Spacing of 'buses, in.				Live parts to ground, in.				Min. spacing of horn gaps, in.	Minimum height of line over horn gap, in.	Floor space required for 3-phase lightning arrester, ft.	Floor space required for 3-phase oil switch, in.		Length of stick for operating knife blade disc switches, ft.	Minimum elevation of knife blade sw's, ft.	Minimum width of operating aisle for knife blade sw's, ft.
	Indoor.		Outdoor.		Indoor.		Outdoor.		Indoor.		Outdoor.					Indoor.	Outdoor.			
	Minimum.	Recommended.	Minimum.	Recommended.	Minimum.	Recommended.	Minimum.	Recommended.	Minimum.	Recommended.	Minimum.	Recommended.								
2,300	2½	4	6	8	6	8	8	12	2	3	4	6	...	...	...	...	...	...	...	...
7,500	4	4½	12	15	9	10	15	18	3	4	5	7	...	...	...	...	...	...	...	...
15,000	5	6½	18	21	10	12	20	24	3½	5	6	8	48	60	5 × 9	...	...	4	7	5½
22,000	7½	9	27	30	12	15	36	39	6	7½	8	10	52	72	5 × 9	26 × 82	...	5	8	6½
35,000	12	15	33	36	18	22	38	41	10	12	11	14	60	84	5 × 11	34 × 86	...	6	10	8
45,000	16	19	42	46	24	27	50	54	14	16	14	17	74	96	9 × 14	40 × 100	40 × 124	8	11	9½
70,000	24	30	60	66	36	42	72	78	21	24	23	26	98	120	11 × 17	48 × 124	48 × 142	12	15	13½
90,000	32	38	72	80	48	54	88	96	27	32	29	34	120	132	13 × 22	60 × 142	60 × 146	14	17	15
110,000	38	48	80	90	60	66	100	110	33	38	40	45	120	144	13 × 25	70 × 180	70 × 184	16	19	17½
140,000	50	60	100	120	72	84	132	144	42	50	45	54	140	180	...	...	...	...	...	...

* Clearances refer to bare conductors. Areas do not include passage-ways. Areas for lightning arresters and oil switches are for estimating purposes. There are switches on the market requiring less space. Areas for lightning arresters include horn gaps over tanks and are for fused arresters. For non-fuse arresters considerably less space is required. Spaces not filled out represent apparatus on which the different manufacturers vary too much to permit obtaining an average or maximum.

saving in the width of the operating aisle, but require more space between the individual switches, since the blades are mounted so that they rotate in the same plane.

In the writer's opinion the best type of disconnecting switch which has been developed so far is shown in Fig. 1. Considering the enormous amount of floor space saved by its use it is hoped that the idea will be further developed and utilised by switch manufacturers.

Methods of Connecting Inside and Outside Equipment.—The problem of bringing a high-tension wire out of a building is similar to bringing one out of a transformer. For the same reason that most transformer high-tension leads are brought out through the top it will be found best to bring high-tension conductors out of power-houses or substations through the roof. In some cases, however, it will be found better to use wall outlets. No fixed rule can be made in this respect, since the method depends on the particular layout, arrangement of buses, disconnecting switches and lightning arresters, being the ruling factors. For pressures of 100,000 volts and higher, the weight of the outlet bushing and its great size as well as the required ground clearance from steel must be taken into consideration when designing the roof. A good example of a 120,000-volt roof outlet cone is shown in Fig. 2. The base casting of the porcelain bushing is bolted to a circularly-bent angle iron which is attached to the roof purlins by radial angle irons. In Fig. 3 is shown another type of roof outlet, and also a roof installation of horn gaps with the operating rod running through the roof slab. It may be pointed out that the roof beams are spaced with due regard to electrical conditions. Both roof and wall outlets are shown in Fig. 4 with the horn gaps mounted on special steel work over the lightning-arrester lean-to. This arrangement is used in a 35,000-volt power house and shows what careful planning can accomplish under the most unfavourable conditions in an old building. Different types of wall outlets are shown in Figs. 5 and 6. The method of setting wall bushings must depend upon the particular conditions, and due consideration must be given to architectural features.

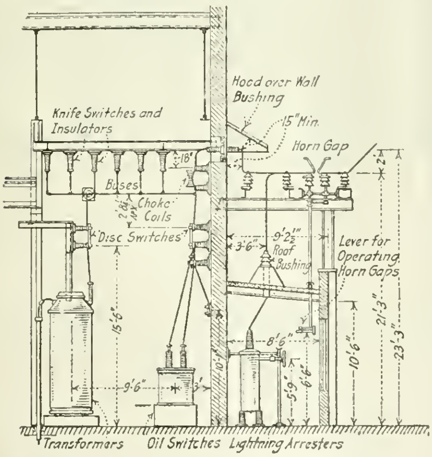

Fig. 4.—Conditions under which both Wall and Roof Bushings were required.

No rules or classifications are possible with reference to high-tension wiring. However, given certain types of apparatus and a wiring scheme, it will generally be easier for a designer to devise a good arrangement with high-tension equipment than it will be to work a low-tension 'bus structure into rather crowded space.

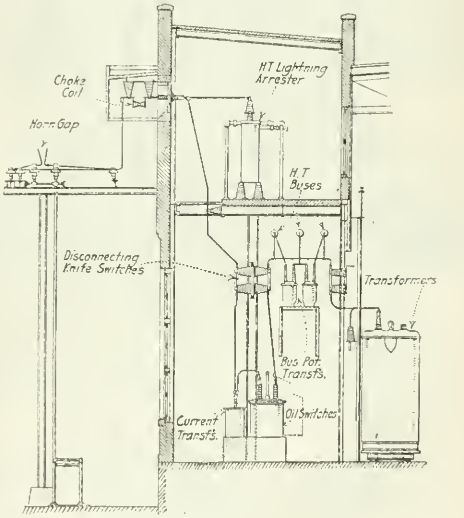

Fig. 5.—Method of Extending 35,000-volt Conductor through Wall.

While loose wiring or strain-insulator units may be suitable on transmission-line towers they are out of place in any station. Only rigid conductors, well supported and properly spaced, should be considered for high-tension station layouts. For this purpose copper pipe or brass pipe is preferable to wire. Minimum and preferable clearances are given in the accompanying table. In this connection it may be pointed out that all energised parts should be out of reach to prevent accidental contact. The 'buses may be arranged either in a horizontal or a vertical plane, it being safe to disregard the arguments advanced that something may accidentally fall across horizontally arranged 'buses, and short-circuit them and that an operator holding a length of pipe may short-circuit vertically arranged 'buses. There is no more chance of a piece of metal falling across horizontal 'buses than there is of a piece of pipe short-circuiting verical 'buses. Choke coils should be located as near the building entrance as practicable and if possible even out of doors, as shown in Fig. 5.

Lighting of high-tension rooms is a difficult problem. Uniform illumination is out of the question, since the lighting units must be placed in accessible positions and therefore must generally be very low. Furthermore, it is difficult to illuminate disconnecting switches and 'buses located at high elevations. Flood-lighting may be suggested as a possible solution of the problem of properly lighting high-tension rooms. Otherwise it is necessary to resort to special reflectors and frosted lamps. Guards should in most cases be provided for incandescent lamps to protect the filaments from static effects.

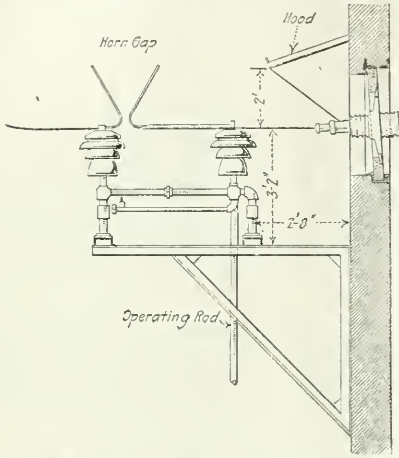

Fig. 6.—Wall-type Bushing for 60,000-volt Installation.

POLE-FINDERS FOR ALTERNATE CURRENT.*

BY DR. A. BRUCKMANN.

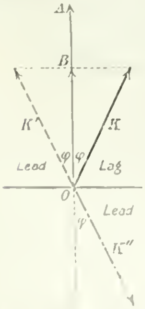

Fig. 1.—Ambiguity in the Position of the Vector.

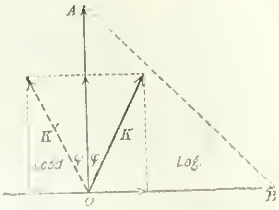

Fig. 2.—No Ambiguity in the Vector.

Continuous-current voltages and currents are merely added or subtracted in order to find the resultant; with alternating current, the direction of the vector is very important. Voltages and currents are generally added geometrically; it is only in the special cases of similarity of phase or opposition of phase that algebraic methods can be used.

Vectorial multiplication has long been capable of execution by measuring instruments, constructed on the dynamometric principle. Such instruments show the geometric resultant or product of two vectors, *i.e.*, either the product of voltage and current in wattmeters, or of currents in ammeters, or of voltages in voltmeters. The usual case is to determine the position of a current vector in relation to one or more voltage vectors. Thus there is usually one current-coil, and one or two voltage coils, as in all wattmeters and instruments for measuring the wattless current. In ammeters and voltmeters, the measurement refers to the square of a current or the square of a voltage. There were scarcely any instruments which measured $E_1 E_2 \cos \varphi$, or $I_1 I_2 \cos \varphi$, *i.e.*, which determined the position of a voltage with reference to another voltage, or of one current referred to another. Generally speaking, to determine the phase of two currents, reference is made to any chosen voltage vector as a sort of datum line by using a wattmeter. On the other hand, an instrument with a fixed and movable voltage coil presents no difficulties of a constructional kind and has a fairly extended range of action. An instrument of this kind ought to be of use in any case where it is desired to determine the phase of voltages without any reference to currents. Such cases are the connecting up of transformers and the determination of phases that are to be joined in parallel. It would be used in conjunction with one or two voltmeters, and then gives the voltage-diagram in relation to that of the network. It could be used by contractors for testing for the proper connections on alternate current, where no great exactitude as to the amount of the phase displacement is required.

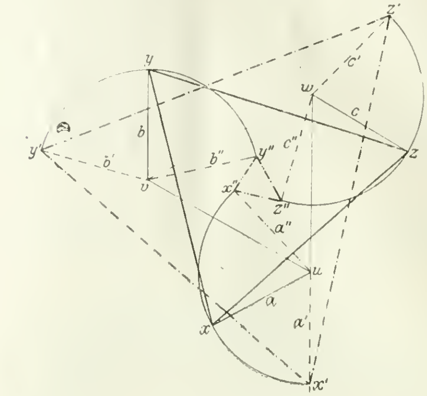

Fig. 3.—Diagram of Induction Regulator. Phases in Proper Sequence.

Scale: 1 mm. = 3 volts.

If a fixed and movable voltage-coil be used, there is generally an ambiguity, which gives rise to questions easily solved by a little consideration. Let us suppose there is such an instrument, and that the needle can be deflected on both sides of the zero. Let us suppose the datum voltage A to be applied to the fixed coil; then let a voltage lagging by the angle φ be applied to the movable coil. This voltage will produce a deflection, proportional to OB (Fig. 1) and this deflection will be in a positive direction; on the other hand, a voltage of the same amount, lagging by $180 - \varphi$, will produce a negative deflection of the same amount. The resultant voltage, therefore, lies without doubt above the horizontal. It is, however, a question whether it lags or leads; for, as shown in Fig. 1, a voltage of the

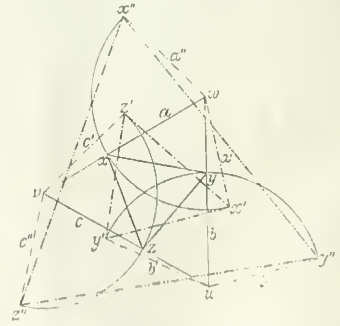

Fig. 4.—Diagram of Induction Regulator. Phases Cyclically Misconnected.

Scale: 1 mm. = 3 volts.

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* Abstract of an article in the Elektrotechnische Zeitschrift, Heft 17, 1916.

same amount, leading by an angle φ, also gives a positive deflection of the magnitude *OB*. In many cases, one knows beforehand whether the voltage lags or leads; but anyhow a second measurement generally puts things right, or an instrument can be used which gives two measurements itself. Let us take an instrument with two fixed voltage coils, and apply the two equal voltages *OA* and *OB*, which may be considered to be derived from the voltage *AB* (*see* Fig. 2) by putting self-induction and resistance in series with it. The position of the vector *K* is then clearly defined. The instrument gives now not only a deflection on each side of zero, but in all four quadrants. *K* gives with *OA* and *OB* a positive deflection above the horizontal; *K′* gives with *OA* a positive, and with *OB* a negative deflection; and *K″* (shown in Fig. 1) would give with *OA* a negative and with *OB* a positive deflection.

An example of such a measurement on an induction regulator may help to explain the matter further. In the present case, in default of a suitable instrument the voltages are not directly referred to the network voltage, but to a current in phase with it and of known constant value. For this purpose an ordinary wattmeter is used, which, with a suitable choice of constants, gives *K* cos φ directly. The induction regulator is excited from the network; it is intended on its secondary side (*a*, *b*, *c*) to regulate the secondary side of a transformer, which is connected on its primary side to the same transformer. The results of the measurements are given in the diagrams in Figs. 3, 4 and 5, on the assumption that the datum voltage vector is drawn vertically upwards. Table I. and Fig. 3 show the results for the properly connected regulator; the measurements in Table II. and Fig. 4 show cyclical misconnections between the transformer and regulator, while Table III. and Fig. 5 shows the effect of two faulty connections. In the second case the regulator controls the voltages *xy*, *yz*, and *zx* only within narrow limits. In the third case the polyphase system is entirely disturbed.

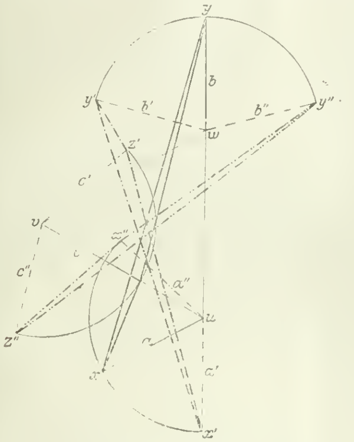

FIG. 5.—DIAGRAM OF INDUCTION REGULATOR. MISCONNECTIONS IN TWO PHASES.
Scale; 1 mm = 3 volts.

Instruments of this construction have been little used; only the synchroscope of the Weston Company belongs to this class; it measures the rotating vector, compounded of two voltage vectors of unequal rotating speed, and becomes similar to the instrument described, if the rotational speeds are equal and a suitably calibrated scale is provided. The instrument also can be used in the graphical construction of voltage diagrams, and has been long used in different forms in the technical school at Hanover.

Table I.

Voltage.	Volts.	*K* cos φ.	Cos φ.	φ in degrees.
xy	72·5	+69·1	0·955	17·0
yz	73·0	−22·0	0·302	72·5
zx	72·5	−48·0	0·662	48·5
x″y″	12·0	+11·0	0·815	35·5
y″z″	12·5	−12·5	0·914	24·0
z″x″	13·7	+1·0	0·073	86·0
x′y′	102·0	+64·0	0·628	51·0
y′z′	102·0	+35·0	0·343	70·0
z′x′	101·0	−98·5	0·975	13·0
uv	49·0	+24·0	0·49	60·5
vw	49·0	+23·0	0·47	62·0
wu	49·0	−17·0	0·96	16·0
a	29·0	−14·0	0·483	61·0
b	29·0	+30·0	1·0	0·0
c	29·0	14·5	0·5	60·0
a″	29·0	+21·2	0·73	43·0
b″	29·0	+7·0	0·242	76·0
c″	29·0	28·0	0·967	14·5
a′	29·0	−29·0	1·0	0·0
b′	29·0	+8·5	0·283	73·5
c′	29·0	+21·0	0·725	43·3

Table II.

Voltage.	Volts.	*K* cos φ.	Cos φ.	φ in degrees.
xy	26·0	4·0	0·154	81·0
yz	26·0	20·5	0·79	37·0
zx	27·0	+25·0	0·962	16·0
x″y″	80·0	61·8	0·773	39·5
y″z″	81·0	11·2	0·138	82·0
z″x″	81·0	74·0	0·914	24·0
x′y′	37·5	10·0	0·267	74·5
y′z′	37·0	+37·0	1·0	0·0
z′x′	...	...	...	...
uv	51·0	+25·0	0·49	60·0
vw	51·0	+24·0	0·47	62·0
wu	50·0	49·0	0·98	11·0
a	29·0	14·0	0·483	61·0
b	30·0	+30·0	1·0	0·0
c	30·0	−15·0	0·5	60·0
a″	29·0	+21·0	0·725	43·5
b″	29·0	+7·0	0·242	76·0
c″	30·0	29·0	0·967	14·5
a′	29·0	29·0	1·0	0·0
b′	29·0	+8·5	0·293	73·0
c′	30·0	+20·5	0·684	47·0

Table III.

Voltage.	Volts.	*K* cos φ.	Cos φ.	φ in degrees.
xy	99·0	+93·0	0·94	20·0
yz	73·5	70·0	0·953	17·5
zx	26·0	−23·0	0·885	27·5
z″y″	64·0	+35·2	0·55	56·5
y″z″	102·0	−60·5	0·593	53·5
z″x″	38·5	+25·0	0·88	28·5
x′y′	95·5	+87·0	0·91	24·5
y′z′	15·2	12·0	0·79	38·0
z′x′	80·6	−75·0	0·93	21·5
uv	49·5	+24·2	0·49	60·5
vw	49·5	+23·0	0·465	62·5
wu	49·5	−48·0	0·97	14·0
a	30·0	−14·0	0·467	62·0
b	30·0	+29·4	0·98	11·5
c	20·0	−15·0	0·5	60·0
a″	30·0	+21·0	0·7	45·5
b″	30·0	+7·0	0·233	76·5
c″	30·0	−28·2	0·94	20·0
a′	30·0	−29·0	0·965	15·0
b′	30·0	−8·0	0·267	74·5
c′	30·0	+20·0	0·666	48·5

THE PARALLEL OPERATION OF STATIC TRANSFORMERS.

BY J. LINDLEY THOMPSON, M.SC., A.M.I.E.E., AND
S. AUSTEN STIGANT, A.AM.I.E.E.

Summary.—The authors deal first with the aspects of voltage ratio, impedance and polarity, as affecting the operation of single phase transformers in parallel. Comparative tables are given showing the effect on loading of varying ratios of resistance and reactance and also of unequal impedances. Formulæ are given to determine the transformer current values and phase angles under these conditions. Polyphase transformers are then treated in a similar manner, but with the inclusion of a study of phase rotation. The "phasing out" of three-phase transformers is described, tables and diagrams being given which show possible voltage measurements obtainable. Results of paralleling dissimilar groups of transformers are described, and in conclusion the effects of position of junctions to 'bus bars or main cables, temperature and power factor are discussed.

The procedure to obtain the satisfactory parallel operation of most types of electrical machinery is necessarily somewhat complicated, and static transformers are no exception to this generality. It is proposed in this article to indicate the methods adopted to secure the best results and to show various effects resulting from incorrect procedure.

When paralleling two or more transformers it is extremely desirable that they should possess the following characteristics :—

1. The same voltage ratios.
2. The same per cent. impedances.
3. The same polarity.
4. The same phase rotation.

As will be seen in the course of the article, (4) only applies to polyphase transformers.

A certain degree of flexibility may be allowed with the second characteristic mentioned, but the voltage ratio, polarity and phase rotation of all transformers in parallel *must* be the same. These points are clearly brought out in the course of the article.

Single-phase Transformers.

The calculations for single-phase transformers are necessarily simpler than those for polyphase transformers, but the considerations with the exception of phase rotation are precisely the same.

1. *Voltage Ratio.*—As stated above, the ratio of two or more transformers operating in parallel *must* be the same. If this is not so, circulating currents will take place in the transformer windings before being connected to their load. As an instance of paralleling transformers of different voltage ratios, we will take two single-phase transformers having the following characteristics :—

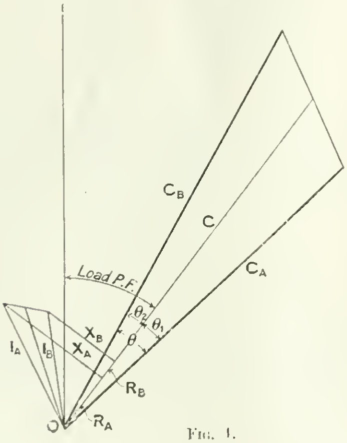

Fig. 1.

Transformer C.—200 k.v.a., 5,000-110 volts, 3½ per cent. impedance.

Transformer D.—350 k.v.a., 5,000-180 volts, 3½ per cent. impedance.

Now as there is a difference of 40 volts between the two low-tension terminal voltages, a current will circulate through the two windings when these are connected in parallel. The value of this current is in direct proportion to the difference in terminal voltages and in inverse proportion to the sum of the impedance volts of the two transformers. Taking, then, the 200 k.v.a. transformer, the percentage full-load current when paralleled will equal

$$\frac{(180-110)\times 100}{\dfrac{(3\cdot5\times 110)}{100}+\left[\dfrac{\dfrac{(3\cdot5\times 180)}{100}}{730}\times 155\right]}=151\cdot5 \text{ per cent.,}$$

and the 350 k.v.a. transformer percentage full load current will equal

$$\frac{200\times 1{,}000\times 180\times 1\cdot515}{110\times 1{,}000\times 350}=96\cdot1 \text{ per cent.,}$$

i.e., transformer C will become overloaded to an extent of 54·5 per cent., while transformer D will become 3·6 per cent. underloaded. It is to be noted that these conditions occur before the transformers are connected up to any external load. The difference in low-tension terminal voltages are taken somewhat high in order to better illustrate the deleterious effect on the transformers. With smaller differences, however, the circulating current set up will prove a decided obstacle to satisfactory operation.

2. *Per cent. Impedance Voltage.*—It has been previously remarked that to obtain satisfactory results from the parallel operation of transformers, certain conditions, inherent in the design, must agree. We will now consider the effects resulting from a departure from one of these conditions, namely, that of the same percentage impedance, both with regard to actual percentages and also the ratio of resistance to reactance drops in both transformers.

Taking first the case of equal per cent. impedances, but unequal ratios of resistances and reactance. Transformer A has a resistance drop of 1·5 per cent., reactance drop of 3 per cent., giving an impedance drop of 3·36 per cent. Transformer B has a resistance drop of 2 per cent., reactance drop of 2·69 per cent., also giving an impedance drop of 3·36 per cent. Now keeping the impedance volts constant throughout and varying the ratios of resistance and reactance values, we can compile a comparative list of current values as given in Table I. The values given may be obtained graphically as indicated in Fig. 1, or by means of the formulæ developed by the authors and given below.

The following conclusions may be drawn then from Table I.

(*a*) That two transformers operating in parallel whose equal percentage impedances are not in phase (*i.e.*, not made up of the same ratio of resistance and reactance drops) will both take a higher and equal full-load current than when operating singly, or the arithmetical sum of the currents in the two transformers will be greater than the line current, the transformers therefore becoming overloaded.

(*b*) That the transformer having the smaller ratio of resistance to reactance will take a "lagging" current with reference to the line current. The other transformer will take a corresponding "leading" current with reference to the line current.

(*c*) That the angles of "lag" and "lead" (with reference

Table I.—*Transformers Having Equal Impedances Consisting of Unequal Ratios of Resistance to Reactance.*

Transformer A. Impedance drop 3·36%				Transformer B. Impedance drop 3·36%.			
		Current.				Current.	
R%	X%	θ_2 or θ_1	Increase %	R%	X%	θ_1 or θ_2	Increase %
1·5	3·0	*Lag 5°	0·45	2·0	2·69	*Lead 5°	0·45
1·0 0·5	3·2 3·32	Lag 9·5° Lag 13·85	1·36 3·06	2·0 2·0	2·69 2·69	Lead 9·5° Lead 13·85°	1·36 3·06
1·5 1·5	3·0 3·0	In phase Lead 4·5	... 0·2985	1·5 1·0	3·0 3·2	In phase Lag 4·5°	... 0·2985
1·0 0·5	3·2 3·32	Lag 4·5 Lag 4·35	0·2985 0·2985	1·5 1·0	3·0 3·2	Lead 4·5 Lead 4·35°	0·2985 0·2985
2·69 3·2	2·0 1·0	Lead 8·45 Lead 18·05°	1·205 5·16	2·0 2·0	2·69 2·69	Lag 8·45° Lag 18·05°	1·205 5·16
1·5 1·5	3·0 3·0	Lag 13·45° Lag 23·05	2·75 8·73	2·69 3·2	2·0 1·0	Lead 13·45 Lead 23·05°	2·75 8·73
2·69 3·2	2·0 1·0	Lag 5 Lag 4·375°	0·45 0·2985	3·0 3·32	1·5 0·5	Lead 5° Lead 4·375°	0·45 0·2985
1·0 0·5	3·2 3·32	Lag 17·95 Lag 31·9	5·0 17·9	2·69 3·2	2·0 1·0	Lead 17·95° Lead 31·9	5·0 17·9
2·235 3·0	2·5 1·5	Lead 12·15° Lead 27·3	2·44 12·75	1·0 0·5	3·2 3·32	Lag 12·15° Lag 27·3°	2·44 12·75

* Lag or lead with reference to the line current.

to the line current) of the transformer currents, *i.e.*, angles θ_1 and θ_2, Fig. 1, are equal.

We will now treat in a similar manner the case of two transformers of unequal per cent. impedances. Table II. gives a list of varying values for two transformers A and B. Arbitrary values of resistance and reactance have been taken for the first pair and then the resistance and reactance values varied as shown in Table II. to obtain different impedances. The current values throughout may be obtained graphically as shown in Fig. 1, or by means of the formulæ developed by the authors and given below.

The following conclusions may be drawn then from Table II.:—

(*a*) That two transformers operating in parallel with unequal percentage impedances will divide the load current in inverse proportion to their impedances.

(*b*) That the transformer having the smaller ratio of resistance to reactance will take a "lagging" current with reference to the line current. The other transformer will take a corresponding "leading" current with reference to the line current.

(*c*) That the angles of "lag" and "lead" of the transformer currents (with reference to the line currents) are inversely proportional to their impedances.

It will be seen then from Tables I. and II. that a certain degree of latitude *may* be allowed in paralleling transformers with unequal impedance and with different ratios of reactance. But if too great a disparity exists between the percentage impedances, then one transformer at least will be seriously overloaded. Apart from the questions of efficiency and regulation, this will inevitably result in a considerable curtailment of the possible life of the transformers.

The equations for obtaining the phase angle difference of the transformer currents with reference to the line current and also the values of the transformer currents, are as follows:—Referring to Fig. 1.

θ=Phase angle difference between transformer currents.

θ_1=Phase angle difference between line current and current in transformer A having the larger percentage impedance and leads or lags the line current according to the ratio R/X.

θ_2=Phase angle difference between line current and current in transformer B having the smaller percentage impedance and lags or leads the line current according to the ratio R/X.

$R_A R_B$=% Resistance drop of transformer A and B respectively.

$X_A X_B$=% Reactance drop of transformer A and B respectively.

I_A=% Impedance drop of transformer A having the larger impedance.

I_B=% Impedance drop of transformer B having the smaller impedance.

C= 50 per cent. line current.

C_A=% Current in transformer A having the larger impedance.

C_B=% Current in transformer B having the smaller impedance.

O= Origin.

Then—

$$\theta=\left(\mathrm{Tan}^{-1}\frac{X_A}{R_A}\right)-\left(\tan^{-1}\frac{X_B}{R_B}\right) \quad . \quad . \quad . \quad . \quad (1)$$

$$\theta_1=\tan^{-1}\frac{I_A\sin.\theta}{I_A\cos.\theta+I_B} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\theta_2=\theta-\theta_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\text{Current in transformer A}=C_A\%=\frac{I_B\,.\,100\,.\,2\,.\cos\theta_1}{I_A\,.\cos.\theta+I_B} \quad (4)$$

$$\text{Current in transformer B}=C_B\%=\frac{I_A\,.\,100\,.\,2\,.\cos.\theta_1}{I_A\,.\cos.\theta+I_B} \quad (5)$$

Table II.—*Transformers Having Unequal Impedances Consisting of Unequal Ratios of Resistance to Reactance.*

Transformer A.					Transformer B.				
			Current.					Current.	
R %	X %	I %	θ_2 or θ_1	Increase or decrease %	R %	X %	I %	θ_1 or θ_2	Increase or decrease %
1·0	2·0	2·236	*Lag 4·85°	Inc. 6·0	1·5	2·0	2·5	*Lead 5·5	Dec. 5·2
1·5	2·0	2·5	Lead 2·7	Inc. 8·3	1·5	2·5	2·92	Lag 3·2°	Dec. 7·25
2·0	2·0	2·828	Lead 8·35°	Inc. 10·0	1·5	3·0	3·36	Lag 10·1°	Dec. 7·4
1·0	1·5	1·804	Lag 1·8°	Inc. 28·0	2·0	2·5	3·2	Lead 3·25°	Dec. 27·9
1·5	1·5	2·12	...	Inc. 25·0	2·5	2·5	3·54	...	Dec. 25·2
2·0	1·5	2·5	Lead 1·1°	Inc. 22·0	3·0	2·5	3·91	Lag 1·8°	Dec. 22·0
2·5	1·0	2·695	Lead 7·85	Dec. 2·9	2·0	1·5	2·5	Lag 7·25°	Inc. 4·8
2·5	1·5	2·92	Lead 7·1°	Dec. 0·9	2·0	2·0	2·828	Lag 6·9°	Inc. 2·3
2·5	2·5	3·54	Lead 3·35	Dec. 5·0	2·0	2·5	3·2	Lag 3·0°	Inc. 5·0

* Lag or lead with reference to the line current.

As a proof of the foregoing reasoning and formulæ, Fig. 2 may be referred to which shows the resultant vector diagram for the impedance drops when correcting for the unbalanced loading. Lay out for transformer A and on the corrected vector C_A, the decreased resistance and reactance drops R_{AR} and X_{AR} due to being underloaded. Treat transformer B in a similar manner, laying off on the vector C_B, the increased resistance and reactance drops R_{BR} and X_{BR} due to being overloaded. Now lay off on the resultant line current vector C values of resistance drop R_R and reactance drop X_R equal to twice the resultant values of the normal drops (obtained from the transformer specifications, viz., R_A, R_B and X_A, X_B) in parallel. We find that the ends of the reactance vectors all join up at the same point, thereby giving coincident and equal impedances I_R. This shows, therefore, that where two circuits operating in parallel have different impedances, the line current divides itself in inverse proportion to the impedances and attains to such a value in each branch that the respective impedance drops become equal. This being the case, there is obviously no tendency for any further circulatory flow of current to take place between the branches of the circuit, there being no difference of impedance voltage to maintain any such flow.

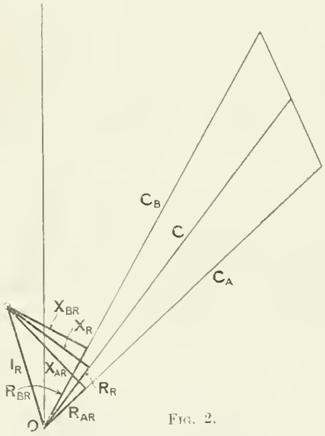

Fig. 2.

All the above reasoning applies as precisely to polyphase as to single-phase transformers.

3. *Polarity.* Before connecting any two or more transformers in parallel, even if their ratios and percentage impedance volts are the same, the correct junction of terminals must be found. This operation is termed "phasing out," and is necessary in order to determine that the two or more transformers are of correct polarity. When the term "polarity" is used in connection with the parallel operation of machinery

it is understood to refer to a certain relation existing between *two or more* units and not to be applied to any single unit considered alone. It can be said then, that two terminals of any pair of transformers have the same polarity when their instantaneous voltages are in phase. That is, if a voltmeter be connected across any two such terminals the pointer will register zero.

The phasing-out of single-phase transformers is simple and needs little explanation as there are only two possible connections one of which must be correct. Fig. 3 shows two transformers X and Y to be phased out. Transformer X is connected across the 'bus bars on both primary and secondary sides. The first operation then as regards transformer Y is to connect its primary winding across the supply bars in a similar manner to transformer X. If the two transformers have the same polarity the corresponding secondary terminals will be at the same potential. In order to ascertain if this is so, connect one terminal of the secondary winding of transformer Y—say, terminal *C'*—to the same 'bus bar as that to which terminal *C* of transformer X is connected. Now measure the voltage across the unconnected terminal *D'* and the 'bus bar corresponding to terminal *D* of transformer X. If this voltage is zero then the transformers have the same polarity and permanent connections can be made. If, on the other hand, the voltage measured be twice the normal secondary voltage of the transformer, then the two units are of opposite polarity. To correct for this opposition it will be necessary to cross-connect the terminals of transformer Y to 'bus bars. That is connect terminal *C'* on to the 'bus bar to which *D* is connected. On measuring the voltage between *D'* and the 'bus bar to which *C* is connected, zero will be indicated, and permanent connections can therefore be made.

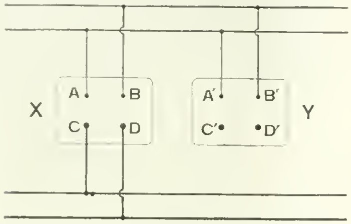

FIG. 3.

4. *Phase Rotation.*—This only exists with polyphase transformers, as will be seen later.

(To be continued.)

FREQUENCY CHANGERS.*

BY R. TOWNEND.

It is proposed in this Paper to consider the questions involved in the use of frequency changers as electrical machines.

Frequency changers may be divided broadly into three classes:—

1. Where the electrical energy is converted electromagnetically by transformer action.

2. Where part of the energy is converted electromagnetically and the remainder converted into mechanical energy, and then, in some cases, back again into electrical energy.

3. Where the energy is converted into mechanical energy, and then again into electrical energy.

The first of these types has been described in a Paper read before the Institution.† It is to the second and particularly the third type that the author proposes to limit this Paper.

The second type usually takes the form of an induction motor mechanically coupled to some form of driving motor. If an E.M.F. is applied to the stator terminals of a slip ring induction motor, the rotor of which cannot rotate, the slip ring voltage is determined by the ratio of the number of turns in the two windings, and its frequency is the same as that of the stator supply. If the rotor is allowed to rotate, its speed being held constant at any desired value, the rotor frequency is equal to—

$$\text{Stator frequency} \times \frac{(\text{Synchronous r.p.m.} - \text{Operating r.p.m.})}{\text{Synchronous r.p.m.}}.$$

If the rotor is rotated in the opposite direction the rotor frequency is

$$\text{Stator frequency} \times \frac{(\text{Synchronous r.p.m.} + \text{Operating r.p.m.})}{\text{Synchronous r.p.m.}}.$$

If we take the case of a supply frequency of 25 cycles, and the rotor is rotated at 140 per cent. of synchronous speed in the opposite direction to the normal, the rotor frequency is $25 + 1{\cdot}4 \times 25 = 60$ cycles, and of the energy taken from the rotor 25/60ths is converted by the transformer action and 35/60ths by generator action, the driving motor supplying the power for the latter portion.

Hence, with this arrangement it is possible to obtain any frequency from zero to a value limited by the maximum safe running speed of the induction motor.

Such a machine appears at first sight to be an almost ideal frequency changer, but its bad inherent voltage regulation has prevented it from being used commercially to any extent, but it is certainly very useful for testing purposes.

The third type of frequency changer consists of an alternating-current motor driving a synchronous alternating-current generator. The motor may be either of the induction or of the synchronous type, the former giving the induction frequency changer, and the latter the synchronous frequency changer.

As the motor and generator are not electrically connected together, each machine can be designed for any desired voltage and number of phases, so effecting a change in both voltage and number of phases, in addition to the change in frequency, if this should be required. Also by controlling the generator voltage by means of an automatic regulator, its pressure can be maintained constant.

MAXIMUM SPEED OF OPERATION.

The number of poles on the motor and the generator must have the same ratio as the motor and generator frequencies (neglecting the slip in the case of the induction frequency changer), and this, of course, determines the maximum speed for which the set can be designed.

In the case of the induction frequency changer the ratio of the two frequencies varies to a small extent with the load.

CHARACTERISTICS OF INDUCTION AND SYNCHRONOUS FREQUENCY CHANGERS.

The adoption of induction or synchronous motors depends upon the conditions governing each case. If it is essential that the ratios of the frequencies should be constant at all loads, that the power factor of the motor should be under the control of the operator, or that the set should be perfectly reversible it is necessary to adopt synchronous frequency changers. In other cases the induction set has advantages, as the paralleling of and load distribution between induction frequency changers are usually simpler than is the case with synchronous sets. Induction sets form a connecting link having the nature of a slipping clutch, whereas synchronous sets have the characteristic of a rigid coupling.

INDUCTION FREQUENCY CHANGERS.

The motor of an induction frequency changer may be of the squirrel-cage or slip-ring type. Starting is effected in the manner ordinarily adopted for induction motors; if of the squirrel-cage type the starting current in the line will be 100 to 150 per cent. of full-load current. In the case of the slip-ring motor the starting current will be 30 to 50 per cent. of normal full-load current.

Synchronising. Where induction frequency changers have to operate in parallel the slip-ring type of motor is preferable, as it enables the generator to be synchronised more easily.

Considering the case where a frequency changer running on no-load has to be paralleled with a similar set carrying full-load, owing to the slip of the induction motor varying directly with the load, the incoming set will be running at a higher speed than the loaded set, and in order that the generators may be safely paralleled it becomes necessary to increase the no-load slip of the incoming set to a value approximately the same as that of the loaded set.

This increased slip may be obtained either by artificially loading the incoming set or by increasing the resistance of the rotor circuits of the motor. If the motor is of the squirrel-cage type it is necessary to adopt the first method. In the case of the slip-ring motor, the second method can be adopted with advantage. An alternative method is to allow the incoming machine to run up to full speed, and when the generator is giving its correct voltage, power is cut off from the motor, and the generators paralleled at the instant the frequency of the incoming generator falls to that of the loaded machine.

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* Abstract of a Paper read last night before the Institution of Electrical Engineers.

† Journal I.E.E. 1914, Vol. LII, p. 700.

Load Distribution.—When two or more sets are operating in parallel the load taken by each will depend upon the full-load slip of the different motors, and if a distribution proportional to their relative capacities is desired, each motor must have the same percentage slip at full-load. With slip-ring motors this can be obtained by means of the external resistance in the rotor circuit, but as this precludes the use of brush-lifting and short-circuiting gear, it is desirable to have the correct slip with the slip-rings short-circuited. With squirrel-cage motors each set must carry a definite proportion of the load, dependent upon its slip at full-load.

Reversibility.—The induction frequency changer can transmit power in the reverse direction—*i.e.*, with the induction machine running as a generator, provided there are synchronous machines running in parallel with it, having a capacity large enough to supply not only the wattless current required to magnetise the induction machine, but also the wattless component of the total load on both the induction and synchronous machines.

When operating as a generator, the induction machine must run above the synchronous speed, and as in the case when motoring, the slip varies with the load, equal slips above and below the synchronous speed corresponding to equal outputs as generator and motor respectively.

In order to obtain the advantages of the induction frequency changer, and at the same time to obtain perfect reversibility, two induction sets may be used; one set having a low-frequency induction machine coupled to a high-frequency synchronous machine, and the other a high-frequency induction machine coupled to a low-frequency synchronous machine.

SYNCHRONOUS FREQUENCY CHANGERS.

The study of the synchronous frequency changer is more interesting than that of the induction type. To investigate their operation it will be necessary to consider how the load on a synchronous machine affects the phase displacement between the terminal and the generated or back E.M.F.

Angular Displacement.—If a synchronous generator is running on no-load, its generated E.M.F. is in phase with the terminal E.M.F., but when loaded these two E.M.F.s may no longer be in phase, due to the resistance and inductance of the windings. This displacement is shown vectorially in Fig. 1 for a load having a power factor of 100 per cent.:—

O A is the terminal E.M.F., and as the load has a power factor of 100 per cent., the current is also in phase with *O A*.

A B is the resistance drop in the windings (in phase with the current).

B C is the inductive E.M.F. (leading 90 deg. with respect to the current).

O C then gives the phase direction of the generated E.M.F., leading with respect to *O A* by the angle a.

Fig. 2 shows a similar diagram for a load having a power factor of 80 per cent. lagging.

In the case of a loaded synchronous motor, the back E.M.F. will lag with respect to the terminal E.M.F. by an angle which we will call β. We see, therefore, that when the frequency changer is loaded, its generator terminal E.M.F. will lag behind its no-load position by an angle of $a+\{(\beta-\beta_1)\sim_G/\sim_M\}$, where β_1 is the no-load value of β, and $\sim_G$ and $\sim_M$ are the respective frequencies of the generator and motor.

In Figs. 1 and 2 the value of *A B* is small compared with *O A*, and has, therefore, very little influence on the angle a, *B C* is approximately proportional to the armature current, and, therefore, where a is small it is approximately proportional to the output of the machine, if the voltage remains constant.

We will now consider the case of a frequency changer converting from 25 to 50 periods, and we will assume that at full load $a=20$ deg. and $\beta=25$ deg. The load on the motor when the set is running light we will take as 10 per cent. of its full-load; then on no load $a=0$ deg. and $\beta_1=2{\cdot}5$ deg. (assuming the angular displacement to be proportional to the load).

Due to the ratio of the frequencies of the motor and generator, the no-load displacement β_1 of 2·5 deg. corresponds to a displacement a of 5 deg. between the actual generator terminal E.M.F., and the generator terminal E.M.F., which would be obtained if $\beta_1=0$—*i.e.*, if the no-load losses were zero. On full load the motor displacement β of 25 deg. corresponds to a generator displacement of 50 deg., and, therefore, the total angular displacement between the no-load and full-load generator voltage is 50 deg. $-$ 5 deg. $+ a = 65$ deg.; that is to say if one set is operating at full load and a similar set has to be paralleled with it, the terminal E.M.F. of the incoming machine will be 65 deg. ahead of that of the loaded machine when the generators should be synchronised, and when this is done the sets will divide the load equally.

If the 50-period machines are synchronised before the 25-period machines the latter will be 34 deg. out of phase when they should be synchronised.

The paralleling of machines when out of phase causes a heavy momentary rush of current and severe mechanical stresses in the stator windings and other parts of the machines, the value of these stresses increasing with the amount by which the voltages are out of phase. To keep these stresses as low as possible it is an advantage to synchronise the high-frequency machines before those of the lower frequency. A still more satisfactory arrangement is to build the frequency changers with either the motor or the generator stators rotatable through a small angle. The stator of the incoming machine can then be rocked round until the generator voltages are in phase, and then rocked in the opposite direction until the set takes the desired load.

Load Distribution.—If two similar frequency changers are operating in parallel, the total load will be divided equally between them, and any change in the excitation of one generator will only alter the power factor at which each generator is operating, the kilowatt output of each machine remaining practically the same as before.

In order to make one generator take more load than the other it is necessary to make the generated E.M.F. of the former lead with respect to the E.M.F. of the latter, and this is accomplished by turning the stator of the former generator through a small angle in a direction against the rotation.

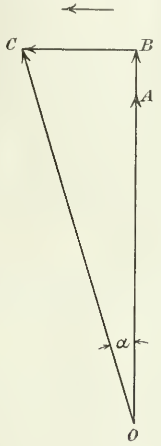

FIG. 1.

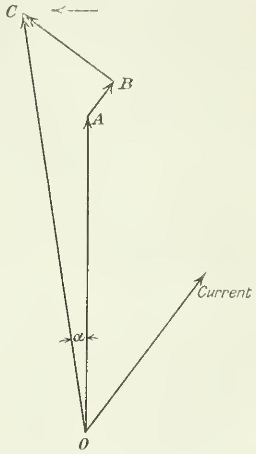

FIG. 2.

It may be mentioned that a division of the load proportional to the normal output of the different sets is usually desirable, as it generally gives the highest overall efficiency.

Design of Machines Required to Operate in Parallel.—When frequency changers have to operate in parallel all the sets should have as nearly as possible the same phase displacement between the motor and generator terminal E.M.F.s at full load, otherwise the load distribution between the different sets will vary with different total loads.

We will consider the case of two sets of equal capacity, one having a total full-load angular displacement of 40 deg. (expressed in terms of the generator displacement) and the other of 60 deg., the sets being adjusted so that their generator voltages are exactly in phase when both machines are running on no load. If the sets are operated at a total load equal to their combined full-load outputs, they will divide the load so that the former set carries approximately three-fifths of the total load (*i.e.*, it operates at 20 per cent. overload), whilst the latter set will carry approximately two-fifths of the total load (*i.e.*, it operates at 80 per cent. of its rated capacity).

In order to make each set operate at full load it will be necessary to move the stator of the overloaded generator approximately 20 electrical degrees forward in the direction of rotation, or the stator of the other generator backward a similar amount.

With this new adjustment, if the total load be reduced to zero, the latter set will reverse, the motor operating as a generator, and the generator as a motor, power being circulated round the two frequency changers.

In addition to the correct electrical design, it is also necessary that frequency changers which have to operate in parallel should be so built that when the motor voltages are in phase the generator voltages are also in phase. This, of course, is easily achieved if either the motor or the generator stator be made rotatable. If fixed stators are adopted the sets can be made exact mechanical duplicates, but to do this involves considerable difficulties. It is therefore advisable to make the sets approximately alike and to provide some means for final adjustment.

In order to ascertain if the generator voltages of two frequency changers are in phase when the motor voltages are in phase, a simple method is to run the motors in parallel, and connect terminal A of one generator to the corresponding terminal A_1 of the other generator. Both generators are then excited to give equal voltages, and the voltage measured between terminals B and B_1, or C and C_1, will indicate the amount by which the generators are out of phase. These voltages can be plotted graphically to obtain the angle through which one generator stator should be rotated to bring the voltage exactly into phase.

An alternative method is to run the two sets with both the motors and generators in parallel, an ammeter being connected in one phase of the generators. Both generators are then excited with approximately normal field current, the excitation of one being then adjusted so that the alternating current flowing between the two generators is a minimum. If the generated voltages are exactly in phase this minimum will be zero.

Starting.—The starting of synchronous frequency changers can be effected either by means of a mechanically-coupled starting motor or by making the synchronous motor, or if desired the generator, self-starting and self-synchronising.

If a separate starting motor is adopted it is usually of the induction type, and may have either a squirrel-cage or a slip-ring rotor. The starting motor is usually built with one pair of poles less than the synchronous motor, and the rotor resistance is adjusted so that the set runs slightly above synchronous speed when the synchronous motor is excited to give normal voltage; the speed is finally adjusted to the correct value by exciting the generator.

If the separate starting motor be dispensed with, and the synchronous motor be made self-starting,* the starting current will be increased, but as the machine is self-synchronising this operation is considerably simplified. During the starting period the synchronous motor operates as an induction motor. If solid steel poles are used the currents induced in the pole faces give sufficient torque to run the machine up to speed.

Starting is effected by an auto-transformer, the initial line current at starting being about 75 to 150 per cent. of full-load current. The slip-rings of the motor should be short-circuited through a resistance during the starting period, in order to prevent a high voltage being induced in the field coils.

Synchronising. When the motors of two identical synchronous frequency changers are running in parallel, the generator voltages will not necessarily be in synchronism, even assuming both sets to be running light.

The author next considers at some length the case of two identical frequency changers converting from 50 to 25 periods, the motors having eight poles and the generators four poles, and continues: It will be found that the chance of obtaining correct synchronism is always greater if the low-frequency machines are synchronised before the high frequency machines, but, as already pointed out, when a set has to be paralleled with one already on load it is an advantage to synchronise the high-frequency machines first, in order to reduce the angle by which the loaded and unloaded machines are out of phase, so reducing the rush of current at the moment of switching in.

Methods of Obtaining Correct Synchronism. In order to obtain correct synchronism of both motors and generators, one of two methods may be adopted:—

(1) Where the motors and generators are synchronised simultaneously.

(2) Where the motors and generators are synchronised separately.

(1) The most satisfactory arrangement is to have a synchroscope fitted with two pointers, one controlled by the high frequency and the other by the low frequency machine. As the machines approach synchronism, the two pointers will rotate at different speeds proportional to the respective slips of the incoming machines controlling them, and the machines should be paralleled when the two pointers simultaneously indicate synchronism.

(2) The motors are first paralleled and the synchroscope connected to the generators; the pointer will remain stationary at a position on the dial indicating the phase difference between the bus bar and the generator voltages. The motor excitation is then reversed, so causing the motor to slip a pole, when the synchroscope pointer immediately takes up a new position. This operation of reversing the motor field current is repeated until the synchroscope indicates synchronism, when the generator can be switched on to the bus bar.

Synchronising Loaded with Unloaded Machines.—It is important to note that when synchronising the generators in the way just described the position taken up by the synchroscope pointer will vary with the output of the loaded machine, due to the angular displacement (due to the load) between the motor and generator 'bus bar voltages as previously explained. This can be taken care of by fitting the synchroscope with a zero mark, which can be moved over a scale graduated in kilowatts output of the running machine. Before synchronising the incoming machine the zero mark is moved to the mark on the scale corresponding to the output of the loaded machine, and when the pointer is opposite the zero mark the incoming machine is in the correct phase for paralleling.

Effect of Interconnecting the Terminal Leads.—The above considerations have been made on the assumption that the connections between the motor and generator stator terminals and the 'bus bars have remained unchanged. With polyphase machines there is, however, the possibility of obtaining a greater number of out-of-phase positions by changing the connections between the stator terminals and the 'bus bars. This additional complication need not be considered when the set is installed and permanently connected up, but it will be seen that in the case of a frequency changer, where neither machine has a rotatable stator, if it is impossible to synchronise the generator correctly, due to faulty machining, &c., the amount by which the voltages are out of phase may be reduced by changing the connections between the stator terminals and the 'bus bars.

The author considers the case of a 10-pole three-phase motor driving a 24-pole three-phase generator, and shows that it is possible to obtain an out-of-phase angle between the generator and 'bus bar voltages which will not be greater than 6 deg.

COMPARISON BETWEEN INDUCTION AND SYNCHRONOUS SETS.

There is very little to be said in the way on comparison between the two types of machines, from the point of view of cost, efficiency, overload capacity, reliability, maintenance and floor space, as in these respects they are practically on an equality. The type to be adopted must, therefore, be determined by the other characteristics of the machines.

It may appear from the foregoing that the difficulty and troubles to be experienced in connection with the operation of synchronous frequency changers are sufficiently great to make it advisable to avoid this type of machine if at all possible. A close consideration of the subject, however, will show that these difficulties are not as real in practice as one would at first expect. If either the motors or the generators are fitted with rotatable stators, the synchronising and load distribution is as simple as with induction frequency changers. If the machines have non-rotatable stators, the difficulty of synchronising depends to a great extent on the ratio of frequency conversion. In this country the most usual frequencies are 25, 40 and 50 cycles, and with these frequencies the chances of obtaining correct synchronism (taking advantage of the effect of reversing the generator excitation) are as follows:

25 to 40 cycles	1 in 5	50 to 25 cycles	1 in 1
40 ,, 25 ,,	1 ,, 2	40 ,, 50 ,,	1 ,, 2
25 ,, 50 ,,	1 ,, 1	50 ,, 40 ,,	1 ,, 5

In any case, the operation of "slipping poles" by reversing the motor excitation is easily carried out, and will quickly bring the generators into the correct phase relation for paralleling.

Taking all the points into consideration, the advantages of the synchronous frequency changer are sufficient to justify its adoption in the majority of cases.

EFFECT OF BRUSH WIDTH ON COMMUTATION.*

BY C. G. LEWIS.

The size of the brushes on direct current-motors and generators is a very important consideration, as the brushes have a very important effect on the commutation.

The commutating zone of a direct-current motor or generator is the zone on the armature surface in which the armature coils are undergoing commutation, and is equal to

$$P_t \frac{C_s + B_1 - k + C_h}{C_s} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where P_t = tooth pitch in inches.
C_s = number of commutator bars per slot.
B_1 = number of commutator bars covered by the brush.
k = a constant depending on the type of winding.
C_h = number of commutator bars which the armature coils are chorded.

In a multiple wound armature which is pitch-wound, commutation of all the coils in a tooth pitch is completed in the space of the number of commutator bars per slot, plus the number of commutator bars covered by the brush minus one. In a two-circuit winding where the number of commutator bars is not divisible by the number of pairs of poles, instead of subtracting one from the number of commutator bars per slot plus the number of bars covered by the brush subtract 0·5 bar in a four-pole machine and 0·66 bar in a six-pole machine and so on. The term k in equation (1) then equals 1 for a multiple-wound machine, 0·5 for a two-circuit, four-pole machine; 0·66 for a two-circuit, six-pole machine, &c. Still assuming three commutator bars per slot, if the winding is chorded one-fourth of a slot, then $C_h = 0{\cdot}75$. The expression

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* "Journal I.E.E.," 1913, Vol. 51, p. 62.

* Abstract of an article in the "Electric Journal."

$$\frac{C_s + B_1 - k + C_h}{C_s}$$

gives the number of tooth pitches it takes for all the conductors for one slot to cut across the slot flux.

The reactance voltage is the voltage generated in the zone of commutation in the coils which are undergoing the process of commutation by the flux, which is produced by the armature magnetomotive force. It is made up of the voltage generated in the short-circuited armature coils by three fluxes the interpolar flux, the flux cut by the end windings of the armature coils and the slot flux. The latter is the flux produced by the magnetomotive force of the armature winding, which extends from the tooth top across the tops of the slot and teeth, the whole of this flux being cut by the conductors undergoing commutation. The expression for the voltage generated in the short-circuited armature coils by the slot flux* is

$$= \frac{I_c W_t T_c R_s \pi}{10^8}\left(\frac{L}{s}\{1{\cdot}33d_s + 0{\cdot}52 + 2{\cdot}16s\sqrt{n}\}\right)C_3 \quad . \quad . \quad (2)$$

The slot voltage is thus directly affected by the value of the constant C_3, which is equal to:

$$\frac{C_s}{C_s + B_1 - k + C_h}.$$

Therefore, to increase the width of the brush, B_1, is to decrease the voltage generated in the short-circuited armature coils by the slot flux and to increase the width of the commutating zone. The part of the reactance voltage due to the slot flux is generally the largest.

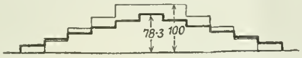

FIG. 1.—MAGNETOMOTIVE FORCE CURVE PRODUCED BY ARMATURE COILS UNDERGOING COMMUTATION.

Heavy line represents case where brush covers three commutator bars. Light line represents case where brush covers two commutator bars.

Assume, for instance, a four-pole motor the brushes of which cover three commutator bars. Suppose, also, there are three commutator bars per slot and the armature coils are chorded one-fourth of a slot, then the constant C_3 in formula (2) is

$$C_3 = \frac{C_s}{C_s + B_1 - k + C_h} = \frac{3}{3+3-0{\cdot}5+0{\cdot}75} = 0{\cdot}48.$$

Now suppose that the brush were changed and that the density were so low that a brush could be used which only covers two commutator bars. Then

$$C_3 = \frac{3}{3+2-0{\cdot}5+0{\cdot}75} = \frac{3}{5{\cdot}25} = 0{\cdot}571.$$

Or the value of the E.M.F. due to the slot flux will be 19 per cent. greater.

Assume now that the armature coils undergoing commutation have only the circulating currents in them caused by the short-circuit voltage generated in the coils as mentioned above. The magnetomotive force produced by these coils is represented by Fig. 1. The heavy line represents the first case and the light line the second. This also gives an indication of the short-circuit voltage generated in the coils, since it is this voltage which produces the local currents referred to. The heavy line represents a much better condition from the standpoint of good commutation, because the maximum value is lower and the maximum value is not as much greater than the average, as is the case with the curve given by the light line. It is, therefore, easier to make the face of the commutating pole the correct shape and the instantaneous variations will not be so large. In the case of the dark line the commutating pole will have to have a wider face. The maximum value increases about 21 per cent. when the brush width is decreased from the width of three bars to two bars.

In general, good commutation cannot be obtained if the voltage generated in the armature coils short-circuited by the brushes exceeds four to five volts per coil. If the brush width is increased, the value of the constant, C_3, is decreased and, therefore, the short-circuit voltage per coil is also made smaller. This may be just enough to bring the value of the short-circuit voltage per coil within safe working limits.

When a motor has a high short-circuit voltage, it is generally necessary to make some refinements in the details of design. The strength of the commutating pole may be made sufficient to generate a voltage equal and opposite to the average re-actance voltage per coil, but if, due to the high maximum voltage per coil, its strength is not sufficient to counteract the voltage in the middle of the commutating zone and is too strong for the voltage just at the edges of the zone, sparking will result.

When the brush width is increased the width of the commutating zone is also increased, and if this is carried too far the brush will short-circuit some of the armature coils when under an active field, due to the fringing of the main field flux. If this happens it is almost impossible to make the machine commutate properly, and the only thing to do is to make the brush narrower.

The commutating poles should cover approximately the width of the commutating zone, so the width of the brush cannot be increased beyond a certain limit on this account. When the commutating pole is not wide enough it does not sufficiently compensate for the short-circuit voltage generated in the armature coils on the outside edges of the commutating zone. Therefore there will be local currents which may cause sparking and heat the armature coils above normal.

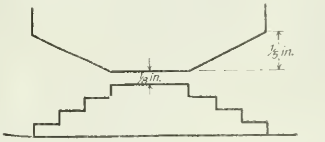

FIG. 2.—MAGNETOMOTIVE FORCE CURVE AND COMMUTATING-POLE FACE WHICH ARE NECESSARY FOR NEUTRALISATION.

The width of the commutating pole and zone can be determined from formula (1). The shape of the field which it has to neutralise is shown in Fig. 2. and therefore, the commutating-pole face should be the inverse of the curve shown. If, therefore, the air-gap in the middle of the pole is one-eighth inch, the air-gap on the edges of the pole should be approximately one-half inch, since the strength of the field to be neutralised is four times as great in the centre of the pole as on the edges.

It can also be seen from Fig. 2 that if the commutating pole is correct for the brush width that gives the magnetomotive force curve shown, it may not be correct for a narrower or wider brush, since the shape of the magnetomotive force curve is changed.

The brush would have to be wider the fewer bars there are on the commutator in order to cover the same number of bars. However, it is generally necessary to make the brush wider as the number of bars is increased, in order to keep the same width of commutating zone.

It should not be understood from the above, however, that the brush width could be increased indefinitely, and thereby commutating conditions made better, for the limit of the allowable total volts across the brush is reached. Approximately two volts across the brush uncompensated for is permissible with fairly good commutation. If without the commutating pole there is eight volts across the brush, the allowable departure from exact compensation is 25 per cent. If, however, there is 16 volts across the brush normally, the voltage will have to be compensated for within 12·5 per cent. Therefore it is necessary to be sure that the total volts across the brush does not rise to too high a value.

When the brush width is changed the brush position, or neutral, is also changed. The amount that the brushes will have to be shifted is equal to half the change in the brush width.

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* From a paper on "A Theory of Commutation and its Application to Interpole Machines," in the "Transactions A.I.E.E.," 1911, Vol. XXX, p. 2,386, in which

I_c current for conductor.
W_t total number of wires on the armature.
T_c turns per individual armature coil.
R_s revolutions per second.
S width of slot, assuming parallel sides.
n ratio of width of armature tooth to the width of armature slot, at the surface of the core.
L width of armature core, including ventilating spaces.
d_s total depth of slot.
C_3 correction factor for the brush width, chord winding, &c.

THE ELECTRICIAN:

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SAFETY RULES IN THE U.S.A.

To receive a volume of Safety Rules on Electrical Work running to 323 pages is an unusual experience and causes the recipient to have some misgivings if such a bulky volume is really essential to the safety of those working with electrical plant and of the public generally. Yet this is the size of the National Electrical Safety Code issued by the Bureau of Standards. Although we had already seen parts of this volume, we had not received the complete Code as now published, and were, therefore, unaware of the magnitude of the work.

At first sight we are tempted to ask if such voluminous regulations will secure the end for which they are issued, and whether those who are anxious to stimulate the "Safety First" movement, which has become so prominent of late, will not lose some of their force in seeking to cover so much ground. It would be unfortunate if these rules were to suffer the fate of the proverbial business system which was so perfect, but which required so much attention, that no time was left for the business to which it was applied.

On the other hand, it should be observed that this Code is the outcome of a great deal of work. About 30 public conferences on the Code were held in various parts of the United States during a year and a half, and in the conference held in New York in the autumn of 1915 more than 100 persons participated. Although certain criticisms have been made it must be acknowledged that the Code is the considered opinion of a large number of experienced engineers in the United States. The view is urged that the Code must be detailed so as to cover every case that may arise as far as possible, and so relieve inspectors of any great responsibility. So far the Code has been adopted in Pennsylvania, and will shortly be adopted by the Public Service Commission having jurisdiction over Greater New York and probably by a number of other States.

It is a little difficult to draw a clear distinction between Safety Rules and Wiring Rules. To some extent the Code consists of Wiring Rules, but in a general way it is supplementary to the National Electrical Safety Code. It is of the same nature as our Home Office Rules. In comparing it with similar publications in this country one is struck by the much greater detail, and also by the fact that each section is followed by a lengthy discussion setting forth the grounds on which each particular rule has been based or giving explanations. This in itself naturally adds very much to the bulk, and, in fact, accounts for about 100 pages. Such discussions serve a very useful purpose, but it is just a question how far it is desirable to go. In some respects we feel that the rules have gone rather too far in detail. For example, in the rule dealing with floors we notice the following:—

> Floors shall have even surfaces and afford secure footing. Projecting nails, loose boards, uneven or greasy wood floors and smooth iron floors should be avoided.

And in the discussion on this part of the Code we find the following:—

> Falls, hidden obstructions, and similar mechanical accidents are responsible for the greater proportion of all personal injuries in stations.

In another rule we read that—

> Defective equipment shall be put in good order or permanently disconnected. Defective wiring, when hazardous, should be repaired or removed.

Further we read—

> Infrequently used equipment or wiring maintained for future service should be periodically inspected to determine its fitness for service.

And in the discussion on this last rule we read—

> Equipment seldom used is frequently neglected and so may be dangerous wherever placed in service. This can be avoided by systematic inspection.

Although we fully agree with the sentiments here expressed, it seems to us that these points are rather matters of common sense and that the rules may lose force by being encumbered with so much detail. This depends, of course, on the class of reader that is in view. If, for example, the reader is the mechanic or the wireman, considerable detail may be desirable. We doubt, however, if this is the case; we imagine, rather, that the Code is addressed to those in authority. In that event we feel that the rules would gain by abbreviation so that there is not too much to observe. It is usually well to rely for details on good standard practice and to allow such practice to develop spontaneously as far as possible, being supplemented by rules of a general character.

We may mention that the Code consists mainly of four parts, namely (1) rules relating to electricity supply stations, (2) rules referring chiefly to overhead lines, (3) rules for the installation and maintenance of electrical utilisation equipment, and (4) rules to be observed in the operation of electrical equipment and lines. By far the largest section is that dealing with overhead lines, and here much useful information is to be found. One appendix gives a number of tables of loading data, normal sags, tensions, and resultant loadings; whilst another appendix deals with wind pressure, numbers of wires per pole, and gives formulæ for calculation of moments of resistance of poles and determination of size of pole. In the discussion of this part of the subject there is given a number of construction diagrams of pole work and graphical data of sags commonly adopted.

In conclusion, we may say that the Code is published by the Bureau of Standards at Washington at the extremely low price of 10d. in paper, or 1s. 3d. in flexible cloth, and whatever views may be held as to excess of detail we are sure our engineers, more particularly those engaged in overhead line work, would do well to spend this modest sum and to have a copy by them.

REVIEWS.

Copies of the undermentioned works can be had from The Electrician Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Telegraphy: A Detailed Exposition of the Telegraph System of the British Post Office.

By T. E. Herbert. 3rd edition. (London: Whittaker & Co.) Pp. xx. + 985. 9s. net.

The first edition of this book appeared in 1906, the second in 1907, while no less than four reprints have been issued before the publication of the edition now under consideration. These facts in themselves are sufficient evidence as to "Herbert" being valuable to a large body of students. The present edition consists of an introduction, 23 chapters and 10 appendices, running into nearly 1,000 pages, while there are over 600 illustrations and a very complete and well-compiled index.

In the preface to the first edition the author states that the object of the book is to supply the need for an up-to-date and detailed exposition of the telegraph practice of the British Post Office, and also to provide for the requirements of the Post Office Department and the City and Guilds' examinations on the subject. Both of these aims are very completely met by the author's effort, but in doing so the book, of necessity, becomes elementary in its treatment of the engineering side of telegraphy. This may be gathered by the fact that the earlier chapters deal with such subjects as elementary magnetism and electricity and simple calculations relating to circuits and conductors. The author is not to blame for this, having regard to the objects set out in his preface, but the advanced student, while he will find the book useful as a work of reference, will be disappointed with the all too elementary style of treatment which has had to be adopted. The author states that "After anxious and careful consideration in the light of an extensive teaching experience, I have deemed it best to avoid the use of mathematics." The explanation of a theoretical point is, therefore, limited in its depth, although the author is curiously inconsistent here, for on p. 630 he deals with the arrival curve on a long submarine cable, and gives the series from which the curve is plotted—for a cable without apparatus—and the usual first approximation for small values of t.

When we turn to the chapter on apparatus, duplex and quadruplex systems, repeater working, central battery methods and battery arrangements, the treatment is found to be excellent. The sections on aerial and underground lines are also exceedingly good, and the question of power circuit interference with telegraph circuits now finds a place.

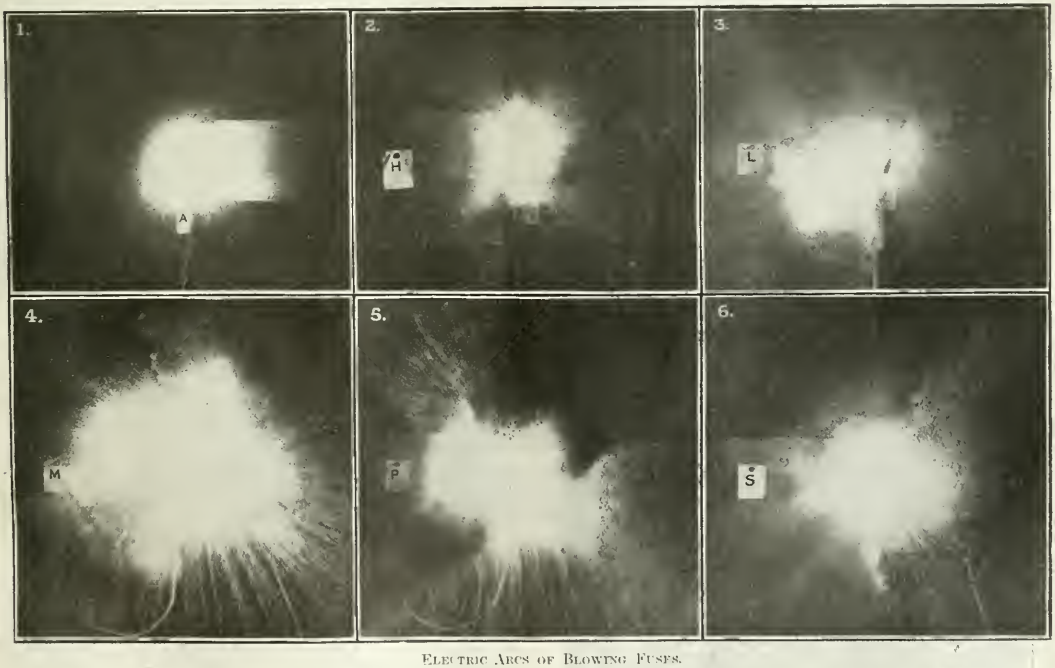
A considerable section of the book is taken up with descriptions of the Baudot, Murray, Western Electric and other type printing telegraph systems. The Hughes printer is explained by means of a series of excellent diagrams, as is also the Baudot. Other systems are illustrated by a series of half-tone illustrations, which are not very clear.

To the aspiring telegraphist and the younger student the book leaves nothing to be desired. The text is clearly written, the diagrams are well drawn and lavishly supplied, and the general get up of the book is creditable to author and publisher alike. It is a monument to the author's industry.

The mature student of telegraph engineering will find the book valuable as a reference or record. He will not turn to it as a guide to the higher branches of the art. Later, let us hope, Mr. Herbert will either shed a few chapters to make room for a different style of treatment or write an entirely different companion work. It is lamentable to record that while the British Postal Telegraph system has led the world, we have, as yet, no British text book on telegraph engineering. Germany has its "Theoretische Telegraphie," and America has recently given the world a book with the definite title "Telegraph Engineering," but the British equivalent has yet to appear.

FUSES ON SHORT CIRCUIT.

is well recognised that in the testing of fuses as ultimate safeguards it is desirable to test them on a dead short circuit, as this is the condition which they may be required to meet at any time. Generally speaking the conditions in service are not nearly so severe, but this fact does not relieve the engineer from the responsibility of providing fuses which shall serve as a protection against short circuits. What has not been fully recognised is the fact that the change of generating plant from reciprocating engines to steam turbines has increased very materially the current which fuses may be called upon to carry before they blow, and that consequently the rate at which energy is dissipated at the moment of rupture may be much higher than was usual some years ago. This change of conditions has been brought prominently to the notice of Mr. Sydney W. Baynes, Chief Electrical Engineer of the St. Pancras Borough Council. With the old reciprocating generating sets at St. Pancras severe failures were seldom found in fuses for house services, but since the introduction of large turbo-generators so many failures have come under his notice that Mr. Baynes has conducted experiments to determine how far reliance may be placed on the ordinary fuse. A number of photographs were taken of fuses on short circuit and some of those we now have pleasure in reproducing.



Electric Arcs of Blowing Fuses.

Fig. 1.—220-volt Short Circuit on 3-in. Break. 10-ampere fuse. Two strands of 5-ampere lead.
Fig. 2.—220-volt Short Circuit on 4 in. Break. 10-ampere fuse. Two strands of 5-ampere lead.
Fig. 3.—440-volt Short Circuit on 4 in. Break. 10-ampere fuse. Two strands of 5-ampere lead.
Fig. 4.—440-volt Short Circuit on 4 in. Break. 40-ampere fuse. Eight strands of 5-ampere lead. (The arcing continued until the automatic cut-out was tripped at approximately 900 amperes.)
Fig. 5.—440-volt Short Circuit on 4 in. Break. 50-ampere fuse. Ten strands of 5-ampere lead. (Automatic switch tripped at 1,000 amperes.)
Fig. 6.—440-volt Short Circuit on 3 in. Break. 10-ampere fuse. Two strands of 5-ampere lead. (Automatic switch tripped at 1,200 amperes.)

It should be noted that tests were made under working conditions, the current being drawn from the distributing system, being carried first by a long feeding main and back to the power station along the distributing mains.

Particulars of the mains used are as follows:—

For tests carried out at 440 volts—

3,460 yards, consisting of 1,730 of 1 sq. in. feeder, 350 of 0·2 sq. in., 1,000 of 0·25 sq. in., 400 of 0·5 sq. in. distributors, excluding length of connecting cable.

For tests carried out at 220 volts—

1,730 yards, consisting of 865 of 1 sq. in., 165 of 0·2 sq. in., 500 of 0·25 sq. in., 200 of 0·5 sq. in. distributors, excluding length of connecting cable.

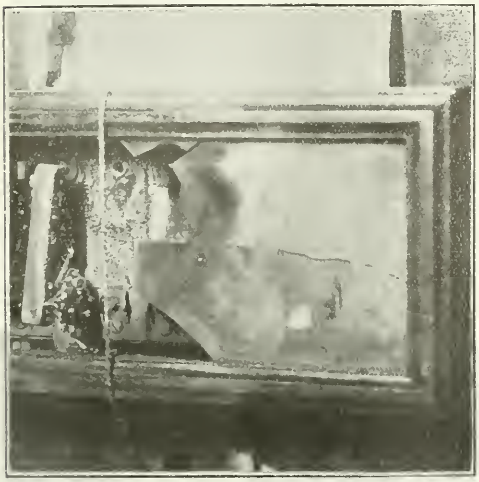


Fig. 7. Effect of Short Circuit on Common Type of Fuse Board.

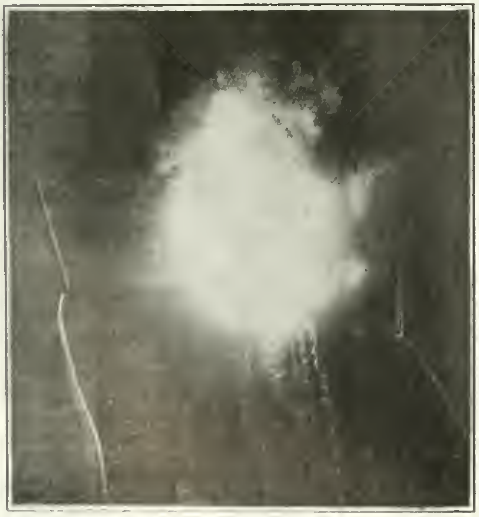


Fig. 8.—Showing Fuse Blowing on the Fuse Board shown in Fig. 7.

The effects obtained are shown by the accompanying illustrations, Figs. 1 to 6, in which the fuses are supported on a board 9 ins. wide. This width gives an idea of the size of the arc. The streamers are due to molten metal. From the particulars given under these figures it will be seen that in most cases the fuse was intended to blow at 10 amperes. In two cases the current was observed on an ammeter and was seen to reach a high figure, namely, 1,000 amperes in one case and 1,200 in another, when the automatic switch tripped. Power was given by a continuous current turbo-generator of 1,000 kw. and two 1,000 kw. motor converters supplied by a 2,500 kw. turbo-alternator. These generators were also supplying the distributing network. There was, therefore, ample power to maintain the voltage. In several cases it was found that the arcing continued until either the fuse terminals were demolished or the automatic safety trip gear was released.

Fig. 7 shows the effect on a common type of fuse distribution board, whilst Fig. 8 shows the photograph of the arc in this case. It will be noticed that the terminals have been demolished and that the 7/16 cable leading in the current at the top has been fused. In Fig. 8 attention may be drawn to the fact that the cable on the left-hand side has shifted, owing to the large electromagnetic forces brought into play. The fuse box is completely hidden by the flash.

Owing to the experiments here described the conclusion has been reached by Mr. Baynes that fuses of the cartridge type should be used, and that they should be so made that they cannot be easily bridged by ordinary fuse wire instead of being properly replaced when blown.

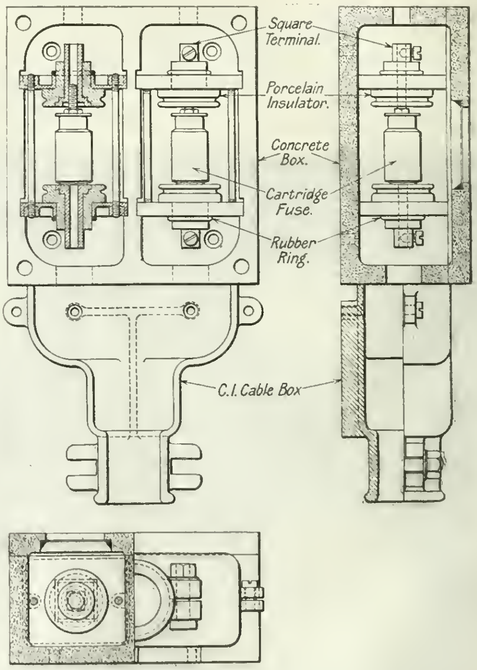


Fig. 9.—Details of Concrete Fuse Box and Fittings.

Owing to the destructive effect which takes place if an arc strikes earthed metal, Mr. Baynes has designed fuse boxes made entirely of special concrete, as described in The Electrician, Vol. LXXI., page 401. They are manufactured by Messrs. Telling, of Bermondsey, to the specification of the St. Pancras Electricity Department. We are now able to give details of the latest type of box, as shown in Fig. 9. The boxes themselves are very cheap, have a good finish and appear to make a thoroughly satisfactory job. They are fitted with brass screw sockets so that the lids can be easily fastened on, and they are used in conjunction with cast-iron cable sealing boxes, both the cast-iron box and the concrete box being fixed to the wall as indicated. The internal fittings are of simple design for carrying Zed fuse cartridges; these are fixed very easily by means of the screw shown. There is, of course, no possibility of damage by an arc striking earthed metal. The boxes are so made that they can be fixed side by side and coupled together so as to be adaptable to the circuits to be supplied.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(*Continued from page 555.*)

XVII. GENERAL PERFORMANCE CURVES OF ROTARY BALANCERS.

Figs. 15 and 16 show portions of the complete curves for $B=+1/10$ and $B=-1/10$ respectively, only those parts being given which start on the practically useful sections and continue out to the point of reversal. The same general shapes hold good as in Fig. 14, but owing to B having a value other than zero, A becomes zero at some point other than the turning point, so that e_4 passes through zero before the limit is reached, and the change over from motoring to generating comes at a relatively different point. The fully detailed description of Fig. 14 already given will enable these curves to be understood without further comment.

Fig. 17 shows the case of $B=-1/5$. For this condition e_3-e_4, which is always equal to $C_3(R+2BV/100)$, is $C_3(1-2\times 1/5\times 250/100)=0$, so that e_3 is always equal to e_4. In the general case, $e_3=e_4$ when $R+2BV/100=0$ or $B=-100R/2V$. At that point $A=\{(100R/2V)C_3\pm 100e_0/V\}/\{(100R/2V)C_3+100e_0/V\}$, as the other terms under the root cancel out.

Therefore, $A=1{\cdot}0$ or $(C_3R-2e_0)/(C_3R+2e_0)$, which is $(C_3-490)/(C_3+490)$ in this case. The turning points are at ±∞.

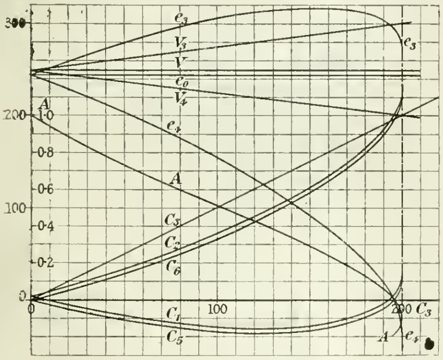


FIG. 15.—REPRESENTATIVE CURVES FOR ROTARY BALANCER WITH $B=+0{\cdot}10$.

$e_3=C_3(R+2BV/100)/(1-A)$ always; and in this case A is either 1·0 or something other than 1·0. The numerator is always zero. Hence e_3 is zero when A is not unity, and e_3 is $\frac{0}{0}$ when A is unity. The indeterminate form can be resolved, for $e_3-e_3A=C_3(R+2BV/100)$, A being unity. But $e_3=V_3-CR-C_5R=V-CR+(q/100)V+C_3R/2$, since $-C_5=C_3/2$, A being unity.

Hence

$$e_3=e_0+C_3R/2+(BC_3/100)V, \text{ or } e_3-e_0=C_3(R/2+BV/100).$$

Hence $e_3-e_3A=2e_3-2e_0$, or $e_3(1+A)=2e_0$, or $e_3=2e_0/(1+A)=e_0$, since A is unity.

Thus e_3 and e_4 lie on the line e_0 and on the zero line, and the closed curves of the previous diagrams now become two parallel lines. When $e_3=e_4=0$, the case is that of pure resistances with no E.M.F. in the circuit. For this part of the diagram, A has the value shown in the curves which go to infinity at $C_3=-490$ and become unity when $C_3=\pm\infty$. This means that although e_3 and e_4 are both zero, they are such that the ratio of the two zeros is not unity, and hence, in this mathematical sense, e_3 is not equal to e_4 for this part of the diagram. Using the idea of torques in this limiting case, C_5 and C_6 will be such that their ratio is also A; that is, although e_3 and e_4 are each zero, C_5 and C_6 are not equal to each other, but must have a varying ratio, A, in order to give a true zero of torque always. This may appear to be fantastic, but it is an interesting case of limits, and is, mathematically, quite in order. For $A=1$, $-C_5=-C_6=C_3/2$, and, under the same circumstances, $e_3=e_4=e_0$. These, along with V, V_3 and V_4, are plotted in Fig. 17, and C_1 and C_2 are shown as 5 amperes greater than C_5 and C_6 respectively. C_3, C_5 and C_6 all pass through zero in this group of values. As $B=-1/5$, V_3 becomes zero when $C_3=500$, which represents a dead short circuit on the loaded side, through which $C_1=245$ amperes flows, C_5 being 250 amperes, while C_2 is 255, and C_6 is 250 like C_5. Any further increase of C_3 necessitates the introduction into the system of an E.M.F. in series with $2V$ in order to give the rest of the diagram a physical meaning, and so it passes beyond the scope of the present consideration. But the case is important within its proper limits, as it represents the condition, already referred to, where the shunt windings of the two sides are in series across $2V$, and are not connected to the middle wire; this is an arrangement sometimes used in emergency, in cases of heavy overload. Since $e_3=e_4=e_0$, there is no change in speed so long as the fluxes do not change. There would actually be some slight change due to the influence of armature reaction in reducing the flux, but apart from this there is no reason for the speed to change. This is also clear because $-C_5=C_6$, and hence the superposed torques are balanced from the very start of their existence and there is actually no nett accelerating or retarding torque available to change the speed.

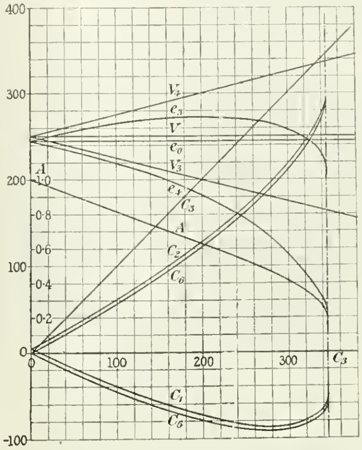


FIG. 16.—REPRESENTATIVE CURVES FOR ROTARY BALANCER WITH $B=-0{\cdot}10$.

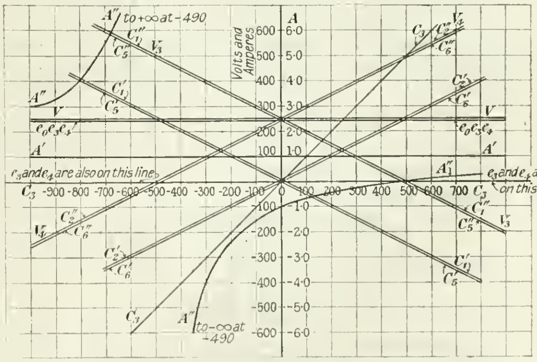


FIG. 17.—REPRESENTATIVE CURVES FOR ROTARY BALANCER WITH $B=-0{\cdot}20$.

As V_3 becomes negative while C_3 is still positive, R_3 may be considered to have become negative, this having the same effect, could it occur, as an E.M.F. in series with $2V$. The introduction of negative values of R_3, though physically inconceivable, allows the treatment of the case to be mathematically continuous.

The part of Fig. 17 with $e_3=e_4=0$, having $A=\frac{C_3R-2e_0}{C_3R+2e_0}$, gives $-C_5=(C_3R-2e_0)/2R$ and $C_6=(C_3R+2e_0)/2R$: these are $(C_3-490)/2$ and $(C_3+490)/2$ respectively, and are straight lines 245 amperes above C_5 and C_6 for $A=1$ respectively; C_1 and C_2 for this case are again 5 amperes higher still. The closed curves for currents in the previous figures have thus become pairs of parallel straight lines which meet at infinity, at which point C_3 also turns back. The speed for this part of the arrangement is zero, because the ratio of the unbalanced to the balanced speed has its numerator zero, and its denominator not zero, A being anything but unity. Here again V_3 becomes negative after $C_3=500$, the short circuit in this case meaning that C_6 is 495 amperes and C_5 is 5 amperes, C_2 being 500 and C_1 zero. The hypothetical, and now absolutely fictitious, 5 amperes are still supposed to exist separately, but $C_2=500$ is a strictly true result. Negative values of V_3 again indicate that some additional external E.M.F. has been introduced into the system, and the balancing of the set must, therefore, be considered as confined between the limits denoted by $C_3=\pm500$. It is extremely interesting to note that the case of resistances used as a balancer can be treated as a limit of the general case, with the E.M.F.s each zero, yet mathematically unequal, but with the zero torques absolutely equal in magnitude as always.

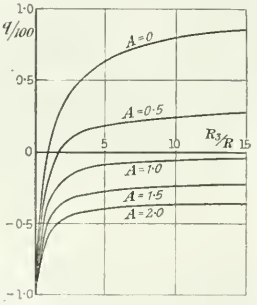


FIG. 18.—CURVES OF $q/100$ DEPENDENT ON R_3/R AND A.

XVIII. ROTARY BALANCERS ON SHORT CIRCUIT.

In this section some general curves are considered, with special reference to what happens when a short circuit occurs on one side of the system.

$$q=\frac{100}{V}\left\{\frac{(e_3^2-e_4^2)e_0R_3-(e_3^2+e_4^2)VR}{(e_3+e_4)^2R_3+(e_3^2+e_4^2)R}\right\},$$

and this may be written, since $e_4/e_3=A$,

$$\frac{q}{100}=\frac{(1-A^2)(e_0/V)(R_3/R)-(1+A^2)}{(1+A)^2(R_3/R)+(1+A^2)},$$

which gives a means of relating $q/100$, A, and R_3/R. Fig. 18 shows curves of $q/100$, dependent on R_3/R, plotted for various values of A again using the numerical values given in Fig. 13. This shows how the compounding changes for a given value of R_3/R, altering from undercompounding, with $q/100$ negative, to level compounding with $q/100=0$, while A has some value always less than unity, and passing to overcompounding, with $q/100$ positive, for still smaller values of A. These curves contain points corresponding to the curves in Figs. 14, 15, 16 and 17. For example, when $q/100=0$ and $A=0$, $R_3/R=1{\cdot}02$. Now $q/100=0$ in the case of Fig. 14, and $R_3/R=1{\cdot}02$ for $q=0$ gives $C_3=250/1{\cdot}02=245$ amperes, which is the limiting value of C_3 for that case. For $A=0{\cdot}5$, and $q/100=0$ again, $R_3/R=1{\cdot}70$ and this gives $C_3=250/1{\cdot}70=147$ amperes, which is again a point on Fig. 14.

The expression for $q/100$ given above may be written

$$\frac{R_3}{R}=\frac{(1+A^2)(q/100+1)}{(1-A^2)(e_0/V)-(1+A)^2q/100}.$$

R_3/R has a turning value when the differential of the right hand side, with respect to A, is equal to zero. This condition resolves itself into $A^2-2\{(e_0/V)/(q/100)\}A-1=0$,

or,
$$A=\frac{1}{q/100}\left\{(e_0/V)\pm\sqrt{\{(e_0/V)^2+(q/100)^2\}}\right\}.$$

Taking a case where $q/100=0{\cdot}2$, A becomes $-0{\cdot}10$ for the turning value of R_3/R, and R_3/R has then the value 1·5. If $q/100=0{\cdot}2$, V_3 must be 300, and C_3 must, therefore, be 200. This is the case where $B=+0{\cdot}10$, since $B=q/C_3=20/200=0{\cdot}10$, and this corresponds to the turning value of Fig. 15, where A actually has the value $-0{\cdot}10$. If R_3 be reduced below the limit for any given value of $q/100$, this value of $q/100$ can no longer be got with any value of A except an imaginary one, and actually $q/100$ changes to some new value, less than before.

The most interesting case arising out of Fig. 18 is that of a short circuit, when $R_3=0$, and hence $R_3/R=0$ also. The value of $q/100$ is then $-1{\cdot}0$ always, no matter what ratio the fluxes have to each other. That is, V_3 simply becomes zero, and V_4 rises to 500. As it is impossible ever to have an absolute short circuit, R_3/R is never actually zero, but a consideration of what would happen if it were zero shows the limits which are being approached as the short circuit becomes more nearly complete.

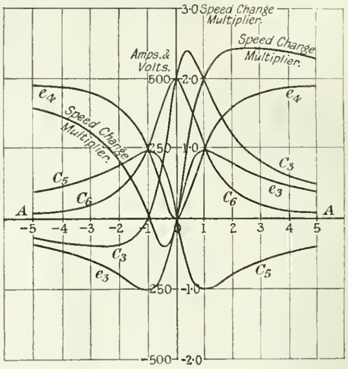


FIG. 19.—CURVES OF ROTARY BALANCER ON SHORT CIRCUIT PLOTTED AGAINST A.

$C_3=V_3/R_3=V(1+q/100)/R_3$; $R_3=(V/C_3)(1+q/100)$
$=V/C_3+BV/100$; $C_3=V/(R_3-BV/100)$

are relations which are always true, even in limiting cases.

Since $R_3=(V/C_3)(1+q/100)$, and $R_3/R=\frac{(1+A^2)(q/100+1)}{(1-A^2)(e_0/V)-(1+A)^2(q/100)}$,

$(V/C_3)(1+q/100)=\{(1+A^2)R(q/100+1)\}/\{(1-A^2)(e_0/V)-(1+A)^2(q/100)\}$,

which gives $C_3=(V/R)\{(1-A^2)(e_0/V)-(1+A)^2(q/100)\}/(1+A^2)$,

or
$$C_3=\frac{1-A^2}{1+A^2}\cdot\frac{e_0}{R}-\frac{(1+A)^2}{1+A^2}\cdot\frac{q}{100}\cdot\frac{V}{R}.$$

In the present case $q/100=-1{\cdot}0$ for $R_3=0$, hence the value of C_3 on short circuit is

$$C_3=\{(1-A^2)/(1+A^2)\}(e_0/R)+\{(1+A)^2/(1+A^2)\}(V/R)$$

Differentiating this with respect to A shows that the curve of C_3, dependent on A, has turning points at $A=-0{\cdot}12$ and $A=-2{\cdot}38$, the values of C_3 then being 600 and -100 respectively. The complete curve of values of C_3, for values of A from -5 to $+5$, is shown in Fig. 19, and it is interesting to note that every value on the curve, if expressed merely as V_3/R_3, is of the form 0/0. C_5 and C_6 are also plotted, being derived from the expressions

$$C_5 = -C_3A/(1+A), \text{ and } C_6 = +C_3/(1+A).$$

e_3 and e_4, also shown in the figure, are derived from

$$e_3 = V_3 - CR - C_5R,$$

and
$$e_4 = V_4 - CR - C_6R,$$

which, since $V_3 = 0$, $V_4 = 500$, $C = 5$, and $R = 1$, become $e_3 = -5 - C_5$ and $e_4 = 495 - C_6$. In this case e_3 has nothing to do but send $C_1 = C + C_5$ through 1 ohm in the generating direction, while the difference between 500 and e_4 has to send $C_2 = C + C_6$ through 1 ohm in the motoring direction. The distribution of current is shown for $A = 0{\cdot}5$ in Fig. 20; because of the E.M.F.s in the circuit besides 2V, the current through the short circuit is actually greater than 500 volts would give alone, acting across the part of the balancer not short circuited, which has a resistance of 1 ohm. C_5 and C_6 are in the correct ratio of $-0{\cdot}5$, and the system is stable with $q/100 = -1{\cdot}0$.

In regard to the speed of the balancer on short circuit, the ratio of this speed to the balanced speed is, as always, given by

$$\frac{1+A}{1-A} \cdot \frac{C_3R + 2qV/100}{e_0} \cdot \frac{\varphi_0}{\varphi_3+\varphi_4}.$$

For short circuit in this case, therefore, the ratio of speeds is

$$\{(C_3-500)/245\}\,\{(1+A)/(1-A)\}\,\{\varphi_0/(\varphi_3+\varphi_4)\}.$$

The part $\varphi_0/(\varphi_3+\varphi_4)$ is not certainly known, and, therefore the rest of the expression only, $\{(C_3-500)/245\}\,\{(1+A)/(1-A)\}$, is shown in the diagram, and is the amount by which $\varphi_0/(\varphi_3+\varphi_4)$ must be multiplied in order to give the actual ratio of the two speeds.

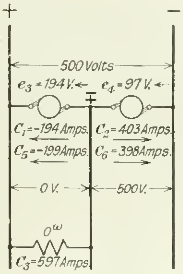


Fig. 20.—Distribution of Current in Rotary Balancer on Short Circuit with $A = 0{\cdot}5$.

The diagram shows that e_3 and C_5, multiplied together, give the same product as e_4 and C_6. It also shows that for $A = 1{\cdot}0$, C_5 and C_6 are each exactly half of C_3 as usual, while e_3 and e_4 are each equal to e_0. Thus all the relations already investigated hold good at short circuit also.

Fig. 21 is the same as Fig. 19, but has everything plotted against C_3 instead of against A. The general form is similar to that of Figs. 14, 15, 16, and 17, but in this case, instead of B being constant, q is constant and equal to -100, while B has a different value for each value of C_3, as it is always equal to q/C_3. Fig. 21 shows complete curves for everything except A, which goes to infinity at $C_3 = 5$, since

$$C_3 = \{(1-A^2)/(1+A^2)\}(e_0/R) + \{(1+A)^2/(1+A^2)\}(V/R).$$
$$= \{(1/A^2-1)/(1/A^2+1)\}(e_0/R) + \{(1/A^2 + 2/A + 1)/(1/A^2+1)\}(V/R),$$

which, when $A = \infty$, becomes $C_3 = (-e_0+V)/R = 5$. Arrows are shown at corresponding starting points on the various curves indicating, by their direction, those parts of the curves which also correspond to each other; these are also distinguished by letters with single and double dashes. Curves for C_1 and C_2 are drawn in Fig. 21; they were not shown in Fig. 19.

The speed change curve again gives the factor by which $\varphi_0/(\varphi_3+\varphi_4)$ must be multiplied in order to give the actual ratio of change, and is again plotted from $\{(C_3R-2V)/e_0\}\{(1+A)/(1-A)\}$.

The exact values of the turning points of C_3, already given as 600 and −100, are found as follows:

C_3 turns when A turns, and A turns when the part of its value which is under the square root is zero, that is, when

$$(100e_0/V)^2 - 2q(100C_3R)/V - (100C_3R/V)^2 = 0.$$

As in this case $q = -100$, this is the same as

$$-(e_0/V)^2 - 2C_3R/V - (C_3R/V)^2 = 0, \text{ or } C_3^2 - 2\frac{V}{R}C_3 - \frac{e_0^2}{R^2} = 0,$$

or
$$C_3 = \frac{2V/R \pm \sqrt{(4V^2/R^2 + 4e_0^2/R^2)}}{2}$$
$$= \frac{1}{R}\{V \pm \sqrt{(e_0^2+V^2)}\}.$$

Hence the turning values are $250 \pm \sqrt{122{,}525}$
$= 250 \pm 350{\cdot}035,$
$= -100{\cdot}035$ and $+600{\cdot}035.$

The middle point between these two extremes is at $C_3 = V/R = 250$, while the whole width of the diagram is $2\sqrt{(e_0^2+V^2)}/R = 700{\cdot}070$ amperes.

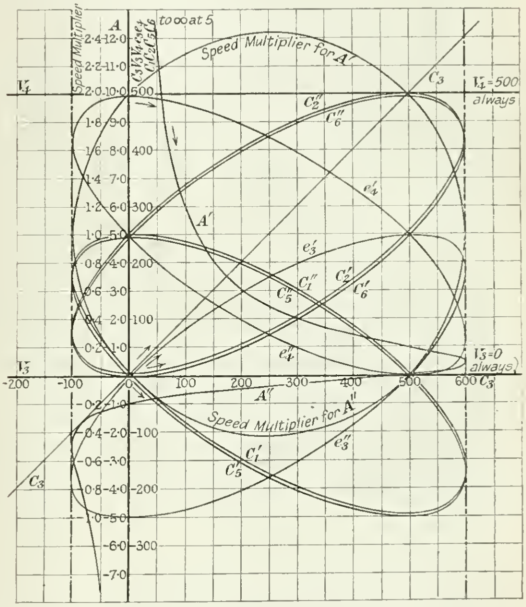


Fig. 21.—Curves of Rotary Balancer on Short Circuit plotted against C_3.

In regard to the shape of the curve for the speed ratio multiplier, it is possible to show that

$$\{e_0\,(\text{multiplier} - 1)\}^2 + \left(C_3 - \frac{V}{R}\right)^2 = e_0^2 + V^2 \text{ in this case.}$$

For the first term is $\left\{e_0\left(\frac{C_3R - 2V}{e_0} \cdot \frac{1+A}{1-A} - 1\right)\right\}^2$, and this, by inserting the value of A in terms of the other quantities, reduces to $e_0^2 + 2C_3RV - (C_3R)^2$. The second term, $\left(C_3 - \frac{V}{R}\right)^2$, is $\{(C_3R)^2 - 2C_3RV + V^2\}/R^2$, so that the sum is $\{(C_3R)^2 - 2C_3RV\}(1/R^2 - 1) + e_0^2 + V^2/R^2$, which in this case, with $R = 1$, reduces to $e_0^2 + V^2$. The meaning of this is that if the scale used for the multiplier on the diagram be e_0, or 245, times the scale used for current and volts, the curve for the multiplier will be a circle of radius $\sqrt{(e_0^2+V^2)} = 350{\cdot}035$, measured on the scale for C_3, with its centre at the point given by $C_3 = V/R = 250$ and multiplier $= 1{\cdot}0$. In Fig. 21, the multiplier is plotted to a scale actually $V = 250$ times that used for the other quantities, so that the form is actually an ellipse with its major axis 250/245 times its minor axis. The maximum and minimum values of the multiplier occur when $C_3=250$; and, from what has just been stated, they must be respectively $1-\sqrt{(e_0^2+V^2)}/e_0$ and $1-\sqrt{(e_0^2+V^2)}/e_0$, or $1+350{\cdot}035/245$ and $1-350{\cdot}035/245$, or 2·429 and −0·429.

(*To be continued.*)

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

Permit me to say in reply to inquiries that my contributions on the above subject were made to THE ELECTRICIAN because this is the age of electricity. Homilies on the subject in regard to the difficulties overcome by other nations in other ages are merely annoying. We have penny-in-the-slot telephone boxes and other luxuries of a similar nature to grapple with. Other questions are dealt with in my contributions.

While I appreciate the courteous tone of Mr. Allcock's letters, I would remind him that the reform which we both desire can only be secured on a definite plan for reconstruction. That surely must be perfectly clear. If every proposal for the destruction of an existing condition were given consideration, sustained Government would be impossible. It is up to the would-be reformer to make good his case. He must, therefore, assume the offensive; but attack is hopeless without an objective and enthusiasm. Who could "enthuse" on a two-shilling piece?

Expletive negatives, such as "take it for granted that you must not touch the pound," are the tried weapons of unreasoned opposition. They succeed because the majority of people are indifferent to their immediate surroundings, and are accordingly unobservant, and lack ideas and ideals. To attempt to placate irrational opposition is a great mistake. To enter into intelligent argument against a manifestly impracticable proposal is equally dangerous. Both elements are harmless if treated with indifference, but regarded seriously they assume an importance they would not otherwise obtain.

The time may shortly come when it will be necessary to form an independent organisation for urging the decimalisation of our monetary system. There are many who object to this question being made a mere stepping stone for introducing the metric system.

London, Feb. 5. G. O. PARSONS.

TO THE EDITORS OF THE ELECTRICIAN.

Mr. Allcock, in his letter in your last issue, says that he would prefer that those of us who have written on this subject in your columns should avoid thinking of the details incidental to a change of system, and should join in urging the Government to adopt a decimal system. But many of the matters I dealt with in my article (in your issue of January 26th) are not details. I pointed out that gold must be the basis of international exchange, and that any token coin such as the shilling or the florin would not do. Mr. Parsons intends the shilling to be not only the unit of calculation in this country, but the basis of international exchange, and he says that, if this is so, the sovereign as a measure of value would be "dead." This is surely not a detail. And I pointed out that it would cause much difficulty and inconvenience if the unit of calculation in this country was different from the basis of international exchange, and that consequently the florin system would not be suitable, though in this system the sovereign could remain the basis of international exchange. This is not a detail either. And it is not exactly a detail that the people of the British Islands, who have been accustomed to talk of, and think of, and calculate in pounds, should have to talk of, think of and calculate in florins. Almost every person in this country makes the pound his unit, and this is so even in the case of people who may never have as much money as a pound.

One of Mr. Allcock's objections to my system is that it might in some cases result in the use of four money columns. I said that people could, if they liked, use four columns, or any suitable marks, to divide the various denominations, but that the vast majority of people would do without anything of this kind, and would use merely the sign of pounds and the decimal point. However, the people who would use four columns in my system would use three in Mr. Allcock's if they kept only one figure in each column, except that for the highest denomination, and it would be quite as easy to use four columns as three. If they kept two figures in the right-hand column they might as well keep three. In all these cases it would be much easier to divide or to multiply always by 2 than by 4 and by 12 and by 20, as must be done at present.

Mr. Allcock's other objection is that people would find it difficult to express a farthing by £0·001, while he thinks they could express it easily by 0·01. I believe that those who would find difficulty with £0·001 would find equal difficulty with 0·01. A good many people are not accustomed to decimals of any kind and do not take to them. It is said that when Lord Randolph Churchill was Chancellor of the Exchequer, and when percentages—in decimals—of something were shown to him, he said that he "never could understand what these d——d dots meant." The people who would find a difficulty in expressing a farthing as a decimal part of a pound would do better to write it down as a farthing and use columns or division marks, and not incur any needless risks with the decimal point.

Feb. 5. JOHN JOHNSTON.

TO THE EDITORS OF THE ELECTRICIAN.

I have read with much interest the correspondence in THE ELECTRICIAN on this subject, since some months ago I submitted to a public body, from whom we shall probably soon hear on the matter, a scheme of decimalisation embodying the same system of coinage as proposed by the Manchester and District Metric Association, but with the addition of a 3c. piece, which, I believe, would be found a most useful coin, especially by newspaper proprietors, who would like to increase their prices by 50 per cent., but cannot cheek charging ¾d. a copy—two coins at present.

In the system I proposed, however, it was suggested that we should have still the £, with florins and cents, £. f. c., in fact, instead of £. s. d.

Foreign invoices might be rendered in f. and c. only, but the book entries could still be in three columns of figures, and such a sum as One hundred and nineteen pounds nineteen shillings and eleven pence three-farthings could be written, without causing any confusion, either as £119. 9f. 99c., or f.1,199. 99c., instead of £119. 19s. 11¾d. There is the further advantage that all cheques would be paid to the full amount of the invoice, instead of having the extra halfpenny, sometimes charged, struck off in the cheque.

COINAGE.

Gold ……	£ or sovereign	= 10 florins	= 250d.	= 1,000 cents.
	Half sovereign	= 5 ,,	= 125d.	= 500 ,,
Silver ……	Florin		= 25d.	= 100 ,,
	Half florin		= 12½d.	= 50 ,,
	Quarter and florin		= 6¼d.	= 25 ,,
Nickel ……	10 cent piece (or dime)		= 2½d.	= 10 ,,
	5 cent piece		= 1¼d.	= 5 ,,
Bronze……	4 cent piece		= 1d.	= 4 ,,
	3 ,,		= ¾d.	= 3 ,,
	2 ,,		= ½d.	= 2 ,,
	1 ,,		= ¼d.	= 1 cent.

MONEY TABLE.

100 cents (c) = 1 florin (f).
10 florins = 1 pound (£).

The present florins, shillings and sixpences could remain in circulation until gradually replaced by the new coins representing 100c., 50c. and 25c. The threepenny piece would disappear (it has a habit of doing so now without leave asked or given) except where hoarded for Church offertory purposes, and only those who proclaim their piety and generosity by stating that "they always put silver in the plate," would regret the loss of the little elusive piece. Tramcar and omnibus conductors would rejoice.

London, Feb. 2. A. J. LAWSON.

FIRST LONDON ENGINEER VOLUNTEERS.

We have received a copy of the Adjutant's Report on the first year's work of the First London Engineer Volunteers, in which it is pointed out that this year has been largely one of organisation and an anxious one for those in authority.

In January, 1916, there were two Corps occupying jointly the Headquarters in Eccleston-place—the Fourth Battalion, Central London Volunteer Regiment and the Engineering Institutions Volunteer Engineer Corps. They drilled and did much of their work together. The former body has only just been formed from the remnants of the Architects' and London County Council Corps, which formed two Companies. There were many difficulties in the way of good organisation, however, partly because there was in the air a prospect of amalgamation of the 4th C.L.R.V. with the Electrical Engineers and partly because, in this expectation, no responsible Commandant had yet been appointed. It is not surprising, therefore, that for the early part of the year a spirit of unrest was abroad. Although work was carried on, it was only because the officers were keen and zealous, that any real progress was made.

But in May the period of unrest came to an end. The old 4th C.L.R.V. and E.I.V.E.C. became incorporated as the First London Engineer Volunteers, and, for the last six months, its progress has been both real and apparent. Under the firm but kindly rule of Lieutenant-Colonel Clay, the work of re-organisation has been successfully accomplished and the Corps has received the approval of its inspecting officers. The County Commandant, Sir Desmond O'Callaghan, K.C.V.O., who has officially inspected the Corps, both on parade and at its work in Headquarters, has expressed hinself as "entirely satisfied with all he saw." Official recognition and Khaki is imminent.

The work that has been done during the past six months may be divided into drill and technical work. The former is good and has improved decidedly, during the past three months, an improvement which the institution of N.C.O.'s Classes must tend to increase. The technical work has been largely in the form of entrenching on Sundays, and such elementary instruction in bridging as can be given at Headquarters, together with theoretical instruction in the form of lectures. The entrenching work at Otford (in connection with which a very successful camp was held in August) has reached a high order of excellence, and has been warmly commended by the London Defence Authorities. Other technical instruction has not, perhaps, progressed so well, but this is a defect that will be remedied in the near future.

The work of the searchlight classes is of great value and is estimated as a valuable asset to the Corps. Originally the special department of No. 3 Company (the old E.I.V.E.C.), these classes have been thrown open now to the whole Corps and sappers wishing to join have only to apply to their Company Officers and to await vacancies, as the number that can be accommodated in each class is limited. Musketry has been well looked after by Mr. A. Gerard, the Instructor of Musketry, to whose zeal and efficiency the Corps is greatly indebted.

Other departments which have been formed recently are the band and the ambulance class. The former is but a nucleus of drums and bugles at present, but it is a healthy nucleus and has already made a difference to the marching of the Corps.

Those who are responsible for the programme for 1917 are making every effort to ensure a good, practical and progressive training, which shall make each man in the Corps a fair practical engineer soldier in as short a time as possible—provided he chooses to avail himself of his opportunities.

Theoretical instruction will be given at Headquarters, to be supplemented by practical instruction in camp. Drill will be well looked after, musketry will "carry on" and there will be an additional incentive to good work by reason of the struggle of the three Companies to hold the Commandant's Cup.

In conclusion it is pointed out that what is required for complete success is better attendance and particularly more recruits. We trust that all our readers who have time to spare for this class of work will not fail to join the First London Engineer Volunteers and thus feel that they are doing something to render themselves efficient for the time when they may be called upon to serve their country.

LEGAL INTELLIGENCE.

Electric Supply Corporation's Debentures.

Mr. Justice Eve has reserved judgment in an action against the Midland Electric Corporation for Power Distribution (Ltd.), by Mr. Geo. Wm. Fowler, executor of the late Miss Mary Jane Fowler. He claimed payment of £1,800, the value of 18 debentures of £100 each, a premium of £45, and interest at rate of 4½ per cent. from June 30, 1913, the date when the debentures matured.

The case for plaintiff was that after the death of his aunt the company sent her notices of the expiration of the series of debentures of which hers formed a part and of the issue of a new series. These, of course, she did not receive, and plaintiff claimed that interest on the debentures continued to run until they were paid off. The company first declined to pay any interest from June 30; but afterwards they said they were willing to pay the income on the money set aside for the payment of the debentures. He also contended that it was the duty of the company to find their creditor within the realm, the debentures not being payable at a particular place. There was an executor who could give a proper discharge for the money.

For the company it was argued that plaintiff had been in default in not doing certain things which would have put the company in possession of the knowledge they required, that he was responsible for what had happened, and that that was a good reason why no further interest should be paid. The debentures were in the common form in not having any place specified where payment should be made, and that it was no part of the company's duty to send people wandering through the land in order to make legal tender of money due to debenture holders who did not choose to apply for payment in the usual way. If plaintiff's contention was upheld it would mean that in the future debentures would have to be framed in a very different way.

Alien Enemy Patent.

Last week the Controller of Patents (Mr. Temple Franks, C.B.) heard the application of Benham & Son (Ltd.) for a licence to use patent No. 26,347 of 1912, owned by Martin Albrecht, of Frankfort-on-Main, relating to electric heating devices or bodies of the kind. It was stated that the method consisted of strongly pressing a thin metal casing around a resistance strip in such a way that the heat produced in the resistance strip by the electric current would be transmitted almost instantly to the wall of the casing.

Mr. BOUSFIELD (for Benham & Sons) said applicants had made a speciality of electric kitchen appliances, and also appliances for use in hospitals. One of these was an apparatus for heating water. The apparatus referred to in the letters patent, while it had its special features, was after a well-known type. There was an electric resistance wire enclosed in a casing, and, as the Court was doubtless aware, an electric current was passed through it, the resistance material was heated, and the heat was transferred to the water or other liquid in which the casing was immersed. The problem had been to transfer promptly the whole of the heat to the surrounding medium. A simple device of that kind had been contrived to place in shaving water. A man dropped a rod of metal, coupled up by wires to a heating installation, into his shaving jug, and it boiled the water at once. Messrs. Benham & Sons had applied for letters patent for that device, but they found in front of them the patent they now asked for. The main purpose of the apparatus was for heating water; it might be made in any size. The rod had inside it insulating mica, and on every side of the element were other strips, and the whole thing was put into a tube. By reason of its arrangement and compression the heat got away at once. The custom previously had been to mount the pieces loosely, with the result that a large part of the heat did not get to the outside at all. What Messrs. Benham & Sons desired to do was to compress the tube into its casing, so that there was actual contact between the outside layers of insulating material and the casing. This would give direct conduction of heat from the heated element to its casing. The efficiency was said to be 95 per cent.

Replying to the Controller, Mr. CHARLES R. ALLANSBY, applicants' assistant manager, stated that already they had made electrical heating appliances by attaching the heating element to the base of the vessel on the outside. Now they desired to immerse the element in the water. They might eventually make specially constructed kettles, with a grooved receptacle for the element, and then water could be boiled without an exterior fire or appliance. They wished to put the apparatus they now had in hand upon the market at once, and would be ready to pay a royalty of 5 per cent. to the end of the war. They anticipated a public demand, and they proposed to employ the method in apparatus they were making for their own use. The article would be made in various sizes, and for some purposes one might require half a dozen more according to the capacity of the vessel. It would be useful for the sterilising of vessels such as surgeons used for their implements when carrying out an operation. The element would be smaller in that case. Electricity in the kitchen was receiving considerable attention in these days when economy of foodstuffs was the first concern. Meats cooked by fire or gas shrank a sixth in bulk. With electricity this was saved. Wherever there was electric power for cooking this new device was sure to be welcomed, and people with electric kitchens could warm by electricity instead of by coal or gas.

The CONTROLLER said he saw no reason why this licence should not be granted. He would recommend a royalty of 5 per cent., to be paid to the Public Trustee, and the licence would issue at an early date.

Enemy-Controlled Company.

An application was recently made to Mr. Justice Astbury to stay proceedings in the winding up of Cedes Electric Traction (Ltd.), in order that the Board of Trade should have an opportunity to decide whether they desired to exercise their rights and duties under the Trading with the Enemy Act, the allegation being that this was a company under the control of alien enemies with debts owing to English creditors.

In giving judgment, his LORDSHIP said that the company was registered in 1910 and was said to be under the control of enemy subjects, and it was alleged that its shares and debenture holders were alien enemies. The summons to stay proceedings was by an English creditor who obtained judgment against the company in 1915 for £1,500. Subsequently in the same year the company issued £3,000 worth of debentures, and in December, 1915, a winding-up petition was brought by another English creditor. In January last year the Trading with the Enemy Act was passed, and in April of 1916, the petition came on for hearing and the usual winding-up order was made without any of the facts that he had stated being brought to the attention of the Court. It appeared that there were a number of unsecured English trade creditors of the company. A foreign enemy now claimed to be a creditor for a very large sum, which, if the debt existed, would absolutely swamp the assets so far as the English creditors were concerned. The business was now being carried on by a receiver for the debenture holders, who were said to be alien enemies. The application to stay the winding-up temporarily was to give the Board of Trade an opportunity of considering whether they wished to act under the legislation he had referred to. Subject to proper undertakings being given by the applicant, he thought the application ought to succeed, and upon proper undertakings being given he proposed to stay the winding up for six months to give the Board of Trade the opportunity already mentioned.

It was stated that the undertakings would be given.

Battersea Borough Council v. Geo. Juchau.

At Wandsworth County Court last week plaintiffs sought to recover £14. 1s. 4d. for the installation and hire of three electric lanterns.

Mr. E. T. Dale (for plaintiffs) said the lanterns were supplied and erected under an agreement for their use for three years, but owing to the police regulations the lights were in use only a few months. Though under the agreement the Council had the right to charge the full amount they offered a reduction of 75 per cent. to all customers. Defendant did not avail himself of the offer. He was charged rent till September, 1915, and in addition the actual cost of installation. Apart from a small meter rent the hire agreement was 13s. 9d per quarter, or £2. 15s. a year for each lamp. The full amount would have been £24. 18s. 8d., but defendant was only charged with the cost of the installation. Defendant said he had only been able to use the lights three of four days when war broke out. He agreed that he had entered into the contract, and had paid £2. 3s. 3d. under it. The three lamps were outside the shop, but he had not had the light, and he was not going to pay.

Judge Harrington said it was quite clear from the decision in the Leiston case, which was upheld on appeal, that he would have to decide against defendant, though it might seem a hard case. He gave judgment for the amount claimed with costs.

De'Ath v. London Electric Railways.

Mr. S. Walker recently sat at the Surveyors' Institution, Westminster, as arbitrator in the claim for compensation by Mrs. P. De'Ath against the London Electric Railways Co. for damages alleged to have been caused to her property in Kilburn by noise and vibration from the Bakerloo Extension Tube Railway.

For the applicant it was stated that she complained of noise and vibration immediately after the railway was opened in January, 1915. A few months later her solicitor made a claim, but at the request of the Company the matter stood over until January, 1916, when liability was disputed. It was admitted that the tenants who occupied the premises at the beginning of the war had remained in occupation. A surveyor who gave evidence estimated the depreciation at £300.

On behalf of the Company, Mr. E. Hills argued that the noise was negligible, and that as no damage had occurred for two years claimant was not entitled to compensation.

Surveyors gave evidence that the noise was negligible and that there was nothing which depreciated the value of the property.

The Arbitrator reserved his decision, but ultimately decided that no damage had been caused.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title

1915 Specifications.

13,7[illegible] [illegible] Apparatus for augmenting the [illegible] current [illegible]

1916 Specifications.

[illegible] Fuse for protecting electric circuits. (6/1/16.) 102,824.

[illegible] alt-silver alloy. (7/1/16.) 102,828.

[illegible] balancer. (13/1/16.) 102,836.

[illegible] outfit. (14/1/16.) 102,719.

[illegible] C. C. Means of equalising or balancing electric [illegible] (3/2/16. addition to 11,905/13 [illegible]

[illegible] (1[illegible]/16.) 102,76[illegible]

[illegible] (21/2/16.) 102,768. [illegible] flux [illegible]

4,[illegible] [illegible] (7/3/16.) 102,772.

[illegible]

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 18, 1916.

18,113 Schuster. Galvanic cells.
18,144 Marks. (Soc. anon des Etab. L. Bleriot.) Magnetos with fixed armatures.
18,145 Burney & Blackburne & Cobb. Terminals for elec. wires.
18,158 Garde. Electric lampholders.
18,160 Soc. anon pour l'Eclairage Elec. des Vehicules. Advancing ignition in explosion engines. (29/12/15, France.)

December 19, 1916.

18,173 Sayers. Electric telegraphs.
18,193 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits.
18,194 Abbingdon-Ecco (Ltd.) & Bianco. Ignition magnetos.
18,208 Neuland. Dynamo electric machinery.

December 20, 1916.

18,255 Eastern Telegraph Co. & Davies. Electric voltage regulation.
18,257 Midgley & Vandervell & Co. Electric switches for switchboards, &c.
18,328 Newberry. Carton and shade for electric lamps.

December 21, 1916.

18,285 Davies. Electric generator, motor or motor transformer.
18,287 Tubbs. Electro-deposition of metals.
18,300 Automatic Telephone Mfg. Co. Automatic telephone systems. (31/12/15, U.S.)
18,301 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits.
18,307 Franks & Telephos, &c., Ltd. Co. Operating electric switches from a distance.
18,323 Westinghouse Metal Filament Lamp Co. (Westinghouse Lamp Co.) Manufacture of filaments for incandescent lamps.
18,324 Soc. anon pour l'Eclairage Elec. des Vehicules. Distribution boards. (21/1/16, France.)
18,326 Elektrizitatswerk Lonza. Manufacture of crude calcium cyanamide. (6/7/16 Switzerland.)
18,341 Jones. Elec. motor mechanism.

December 22, 1916.

18,366 & 18,367 Angold & Railing. Hand-driven portable dynamo-electric machines.
18,374 Dowson. Electro-pneumatic brakes. (1/6/16, U.S.)
18,381 Fiat-san Giorgio Soc. anon. Electrically controlling helms of ships. (22/12/15, Italy.)
18,386 Plaisant. Aerial conductors.
18,387 Plaisant. Dynamo-electric machines.
18,389 Marks. (Uytborck.) Prevention of increase of potential in electric installations.
18,398 Hogan & MacLagan. System of X-ray tube operation.
18,402 Rodriguez. Transmission of currents of varying potential.
18,408 Gooding & Randall. Wire covering machines.
18,411 Sperry. Operating electrodes for searchlights. (22/12/15, U.S.)
18,423 Roulland. Current-saving devices for electric welding.
18,425 Bibby. Electric transformers for furnaces.

December 27, 1916.

18,462 & 18,463 King. Sparking plugs.
18,464 King. Electrodes of sparking plugs.
18,466 King. Electric starters for internal combustion engines.
18,503 Breeder & Lucas. Electric signalling lamps.
18,504 Vandervell & Co. & Midgley. Electric starters for internal combusuion engines
18,506 & 18,507 B.T.-H. Co. (G.E. Co.) Incandescent arc devices.
18,509 Ellis & Thompson. Electric transformers.
18,510 Van Duyl. Insulators for leading in electric conductors.
18,511 Dorey. Dynamo-electric machines.

December 28, 1916.

18,541 Suten. Electric apparatus for waving hair.
18,552 Soc. anon pour l'Eclairage Elec. des Vehicules. Advancing the spark in internal combustion engines. (9/9/16, France.)
18,553 Jaubert. Electrolytic production of non-metallic substances. (29/12/15, France.)
18,562 Johansson. Automatic cutouts.

December 29, 1916.

18,584 Buckingham. Electric hand lamps, &c.
18,591 Somerfield. Adjustment for X-ray machine to absorb nitrous and nitric compounds generated from the air by electric discharge.
18,609 Pinnock. Electric warming apparatus.
18,611 Chkliar. Accumulators, particularly electrodes or plates for same.
18,624 Waite. Trolley heads.

December 30, 1916.

18,649 Cannart d'Hamale. Electro-mechanical make and break movement.
18,661 Gotterson & Steven. Gear for controlling alternating-current motors.
18,672 Hartmann. Transforming and rectifying alternating or polyphase current (30/12/15, U.S.)

January 2, 1917.

10 Ashton. Adjustable electric light and gas shades.
16 Sandeman. Electric starters for engines.
18 British Insulated & Helsby Cables & Brotherton. Electric cables.
34 B.T.-H. Co. (G.E. Co.) Fluid flow meters.
38 Robinson & Smith. Automatic control of petrol-electric vehicles, &c.
41 Lang. Electric ignition for engines.
80 B.T.-H. Co. (G.E. Co.) Systems of ship propulsion.
84 Slater. Control of electric motors.
90 Ohtani, Yago & Yanai. Electric lamp or other vacuum tube with copper leading-wire. (26/1/16 Japan.)
97 Wiegolaski. Electric treatment of reaction substances.

January 3, 1917

110 Holloway. Brake mechanism for railway and tramway rolling stock.
117 Levin. Electrolytic apparatus.
131 B.T.-H. Co (G.E. Co.) Incandescent arc lamps.
139 Marks. (S. A. des Etab. L. Bleriot.) Starting and lighting dynamos for cars.
145 Sandberg. Heat treatment of railway and tramway rails.
153 Electric & Ordnance Accessories Co. & Etchells. Electromagnetic switches.
155 Electric & Ordnance Accessories Co. & Etchells. Electromagnetic regulating and switching devices.

January 4, 1917.

180 M. L. Magnet Synd., Lister & Watson. Magneto-electric machines.
196 Vulkan Maschinenfabriks-A.G. Shock-resisting winding for rotating magnet coils. (24/5/16, Austria.)
216 Ellis. (Ambrose & Ellis.) Locking device for electric lamp globes.
220 Murray & W[illegible]. Electric welding apparatus. (12/1/16, U.S.)

January 5, 1917.

[illegible]49 Eastern Telegraph Co. & A[illegible]ton. Automatically re-transmitting tele[illegible] messages.
[illegible]53, 254 & 255 Murray. Electric welding.
264 Fr[illegible]. Electric ignition for en[illegible]
[illegible]75 Svenska Turbinfabriks A. B. Ljungström. Radial flow turbines. (10/1/16, Sweden.)
[illegible]76 Svenska Turbinfabriks A. B. Ljungström. Double turbines. (10/1/16, Sweden.)

January 6, 1917.

[illegible]82 Lancashire Dynamo & Motor Co. & Stansfield. A.C. dynamos.
[illegible]06 Sterling Telephone & Electric Co., Bell & Davey. Electric signalling.
313 Aktie[illegible] Elek[illegible] Telephone System. (15/1/16, Norway.)
314 & 315 Mason [illegible] (5/3/15, U.S.)

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The New War Loan.

During the week there was a further large addition to the number of subscribers to the War Loan and we give below a few of the principal electrical and general engineering firms who have participated in the issue. It is the bounden duty of everyone to lend whatever he can afford, and it is to be hoped that between now and the 16th inst. those who have not already subscribed will do so.

Bolckow, Vaughan & Co. (£500.000), Stewarts & Lloyds (£300.000), Ebbw Vale Steel, Iron & Coal Co. (£250,000), T. W. Ward, Ltd. (£100.000), Hans Renold (£75.000), Bluemel Bros. (£40,000), Braithwaite & Kirk (£40.000), Greenock & Port Glasgow Tramways Co. (£20,000), Airdrie & Coatbridge Tramways Co. (£7,000), Waygood & Otis, Ltd. (£10.000), Edward Le Bas & Co. (£25,000), Lodge Sparking Plug Co. (£25,000).

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Electricity Supply in New Zealand.

From the particulars given in another column it will be seen that the supply of electricity in New Zealand is developing at a rapid rate.

During the past year 27 licences were granted for the supply of electrical energy, compared with 25 in 1915, 17 in 1914, and 13 in 1913. Up to the end of December last 111 electricity supply licences had been issued and 10 tramway undertakings were working under statutory authority. It will be seen, therefore, that the New Zealand electrical field is making good progress, and it should be cultivated by electrical manufacturers. Although there is a pronounced feeling in favour of British goods, reports are to the effect that these cannot be got and that local dealers are falling back on American and Japanese goods. Even if unable to supply at once, British firms should explain the circumstances and keep dealers supplied with their catalogues and trade literature.

* * * *

Exportation of Parcels, &c.

His Majesty in Council on Feb. 6 ordered the following addition to be made to the Defence of the Realm Regulations :—

24c. The Admiralty or Army Council may, generally or in the case of particular persons, prohibit the despatch of parcels or samples to any neutral country or countries in Europe except with permission. The expression "parcels" includes parcels sent by parcels post or shipped on parcels receipt, and the expression "samples" includes samples sent by parcels post or samples post.

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Electricity Supply Companies in 1916.

During the week two London electric supply companies have announced their dividends for 1916, and these are at the same rate as in 1915. The Westminster Electric Supply Corpn. is paying 7 per cent., and the St. James' & Pall Mall Electric Light Co. 8 per cent. for the year. Under the conditions prevailing, the high price of coal and materials and the shortage of labour, these results are highly creditable. On the other hand, the National Electric Supply Co. (of Preston) has reduced its dividend from 7s. to 6s. per share.

* * * *

Inventions by Employees.

Disputes frequently arise as to inventions made by employees in the course of their employment and recently an interesting case of this character came before the High Court.

It appeared that in May, 1912, one Herman P. T. Lind entered the service of the British Reinforced Concrete Engineering Co. He was engaged in the drawing office for a month on trial at 30s. a week. Subsequently he was appointed assistant engineer at £3 a week, which was raised to £4 5s. a week. His duty was to investigate inquiries addressed to plaintiffs with reference to reinforced concrete constructional work, to prepare plans and to design the best method of carrying out such work. In October, 1914, the Powell Duffryn Steam Coal Co. inquired as to the best method of lining the headings of their coal-mine. Defendant was directed by plaintiffs to report on the matter and to design an appropriate lining. In the course of this employment Lind designed a form of reinforced concrete block for lining the headings of mines. He obtained letters patent (No. 22,663 of 1914) in respect of the lining, and plaintiffs claimed a declaration that the invention was their sole property, and that defendant held it as trustee from them.

The defendant pleaded that he was engaged by plaintiffs as draughtsman and not as an assistant engineer. During the whole of his employment he carried out ordinary draughtsman's work under the control of the Company's chief engineer. He made various schemes or designs for carrying out the work at the Powell Duffryn Colliery. While so engaged it occurred to him that the problem of supporting the roofs and walls of structures subject to large forces of compression could be dealt with on quite new lines, and he duly obtained letters patent for his invention. The invention was made without the knowledge or assistance of plaintiffs' chief engineer or of any other person.

In giving judgment, Mr. Justice Eve said that defendant discovered a method which would obviate concreting within the mine and would also comply with the four essentials of the original scheme. He disclosed this method to plaintiffs' chief engineer, who said that it was a good idea. A day or two afterwards Lind applied for letters patent for the invention, and they were duly granted to him. He had made no secret of what he had done ; he had consistently asserted his right to the invention and he had given his evidence with lucidity and candour. The question he had to decide was this : Was it inconsistent with the good faith which ought properly to be inferred or implied as an obligation arising from the contract of service that the servant should hold the patent otherwise than as a trustee for his employer ? Defendant said that it depended upon the terms of the contract of service. In a sense that was true ; but it was not wholly true. The terms of his employment obliged him to place the best design he could at the disposal of the company, and in his opinion, it was inconsistent with that obligation that he should be allowed to retain the patent for his own benefit. Therefore, he entered judgment for plaintiffs, with costs.

* * * *

Export of Samples of Prohibited Goods.

The Directors of the War Trade Department announces arrangements to facilitate the export without Privy Council licence of samples of prohibited goods.

A declaration must be made on Post Office Form P.P. 21 that the samples are of no commercial value, and giving the ultimate destination, or, in the case of samples having a commercial value, a declaration must be made on Form P.P. 21 and a certificate from a British Chamber of Commerce (giving an undertaking that the goods shall not be sold without the consent of the War Trade Department) must be sent to the Customs and Excise Surveyor, Renshaw-street, Liverpool, in the case of mails for America and West Coast of Africa, or to the Customs and Excise Surveyor, Mount Pleasant, London, E.C., in the case of other foreign and colonial mails. A schedule is also published of goods which are excluded from this permission.

The destinations to which these goods are prohibited are indicated by the letters (A), (B) and (C), and are as follows : (A) to all destinations, (B) to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates, (C) to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports. The following are included in the schedule :

(A) Magnetos, air craft (component parts of all kinds of), together with accessories, &c., aluminium, alloys of aluminium and manufactures of aluminium, cerium and its alloys, ferro-molybdenum and ferro-tungsten, field glasses, &c., platinum, alloys of platinum and manufactures of platinum, radium compounds, tungsten, steel containing tungsten molybdenum, vanadium or cobalt.

(B) Emery, corundum (natural or artificial), ferro-cerium, ferro-chrome, ferro-manganese, ferro-nickel, ferro-titanium and ferro-vanadium, iridium points, jewel points and caps for ships' compasses, mica, molybdenum, nickel, selenium, tin, raw rubber, vanadium, tungsten filaments, for electric lamps, &c.

* * * *

Electricity in the United States Mines.

Electricity is used very widely in the mines of United States for lighting and power purposes. At present time most of the installations, especially the older ones, operate with direct current. Some mines use alternating current for operating the fan and large pumps, transforming to direct current for hauling and miscellaneous power purposes only. The practice of centralising mine power plants has met with considerable favour, and some of these plants are very large and as up to date in equipment as any central generating station in the country. The practice of buying power from public service corporations is growing in favour and promises to become widespread. Mines that purchase power often operate the ventilating fan, hoists and all machinery on the surface by electric motors (usually a.-c. motors), and use no steam except for heating purposes.

At the present time there is a tendency towards the development of storage-battery locomotives for gathering, and in a few years splendid models of locomotives of this type will undoubtedly be on the market. Already many gathering locomotives of this sort are in successful use. The United States Bureau of Mines, in co-operation with the manufacturers of storage-battery locomotives, is engaged in the preparation of specifications for explosion-proof types of these machines. The coal mines of the United States are beginning to adopt individual miners' lamps, cap type, operated by storage-batteries. These lamps are meeting favourable consideration from operators, who have already installed about 90,000 of these lamps and are continuing the adoption of them at the rate of about 2,000 lamps per week.

The mine operators of the United States are devoting a great deal of attention to safety in mines, and several States have now adopted rules bearing directly on the safety of electrical equipment in mines. The States of Pennsylvania and California have however, the most comprehensive codes of rules of this character. The adoption of a woman's compensation law, which also requires that the mine operators shall insure themselves against accidents to their workmen, has largely increased the interest of mine operators in safety anf the use of safeguards. There has been formed in the United States by various insurance companies an organisation known as the Associated Companies, which insures mines against loss arising from accidents to the workmen. This company has published a list of standards similar to the code of the National Board of Fire Underwriters. These standards describe what the underwriters consider the maximum degree of safety, and are used as a basis for establishing insurance rates. In the United States the control of mines comes under the jurisdiction of the various State Governments, but in 1909 a Bureau of Mines in the Department of the Interior was organised by the Federal Government to investigate mining conditions all over the country. As a part of these investigations there was organised an electrical section of the Bureau which has devoted its attention to the safety of electrical equipment in mines. This section has made extensive investigations of explosion-proof motors, electric fuses, electric lamp bulbs, explosion-proof switches, portable electric (battery) mine lamps insulation of electric conductors methods of electric shot-firing, and rules for the installation of electrical equipment in bituminuos coal mines. Reports on practically all of these investigations have been issued. The most recent publication of the electrical section of the Bureau is Technical Paper 138, entitled, "Suggested Safety Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines," by H. H. Clark and C. M. Means. These rules, which were prepared with the co-operation of the electrical engineers of several large coal companies, are unusually complete.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 27, 1917, *to* Feb. 2, 1917

IMPORTS.

LONDON.—*U.S.A.:* Telephone material, £241; elec. machinery, £3,672; wire and cable, £177; unenumerated, £5,354. *Japan:* Unenumerated, £4,599. *France:* Glow lamps, £11; elec. machinery, £516; unenumerated, £208. *Switzerland:* Unenumerated, £469. *Canada:* Unenumerated, £54. *Holland:* Glow lamps, £810; unenumerated, £2,028. *Sweden:* Unenumerated, £491. *Denmark:* Elec. machinery, £380.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £41. *Melbourne:* Wire and cable, £17; elec. machinery, £258; telegraph material, £34; unenumerated, £1,830. *Sydney:* Elec. machinery, £1,114; unenumerated, £383. *Wellington:* Elec. machinery, £292 unenumerated, £297. *Adelaide:* Elec. lamps, 1,500 n.o.; unenumerated, £262.

AFRICA.—*Cape Town:* Elec. machinery, £30; wire and cable, £183; unenumerated, £312. *Port Elizabeth:* Elec. machinery, £10; unenumerated, £37. *East London:* Wire and cable, £1,878. *Durban:* Elec. machinery, £364; wire and cable, £315; unenumerated, £97.

EGYPT.—*Alexandria:* Elec. lamps, 100 n.o. *Port Said:* Telegraph material, £198. *Port Sudan:* Unenumerated, £14.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £438; elec. lamps, 1,170 n.o.; glow lamps, 2,400 n.o.; unenumerated, £499. *Calcutta:* Unenumerated, £278. *Madras:* Unenumerated, £118. *Ceylon:* Unenumerated, £70. *Singapore:* Wire and cable, £324; unenumerated, £157. *Bangkok:* Elec. lamps, 600 n.o. *Kilindini:* Unenumerated, £45. *Karachi:* Unenumerated, £26. *Sourobaya:* Unenumerated, £145. *Samarang:* Unenumerated, £30. *Rangoon:* Unenumerated, £44. *Penang:* Elec. machinery, £43; unenumerated, £24.

JAPAN.—*Kobe:* Unenumerated, £271.

CHINA.—*Hongkong:* Elec. machinery, £175. *Shanghai:* Unenumerated, £246.

U.S.A.—*New York:* Unenumerated, £410.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Unenumerated, £510. *Valparaiso:* Telegraph material, £23; unenumerated, £6. *Secondi:* Unenumerated, £21.

HOLLAND.—*Amsterdam:* Wire and cable, £86; unenumerated, £29.

FRANCE.—*Paris:* Elec. machinery, £41; wire and cable, £2,430; unenumerated, £132. *Calais:* Elec. machinery, £30. *Havre:* Elec. machinery, £26. *Rouen:* Unenumerated, £283.

SPAIN.—*Santanda:* Unenumerated, £80.

ITALY.—*Genoa:* Unenumerated, £2,084.

CANADA.—*Montreal:* Unenumerated, £25.

MALTA.—Wire and cable, £15; unenumerated, £237.

GIBRALTAR.—Submarine telegraph material, £8,000.

RUSSIA.—*Petrograd:* Unenumerated, £939. *Helsingfors:* Unenumerated, £24.

DENMARK.—*Copenhagen:* Unenumerated, £86.

FOREIGN GOODS (duty paid and free).

Amsterdam: Unenumerated, £61. *Melbourne:* Unenumerated, £534. *Bombay:* Elec. lamps, 20,500 n.o.; unenumerated, £16. *Calcutta:* Elec. lamps, 53,000 n.o. *New York:* Unenumerated, £575. *Port Elizabeth:* Unenumerated, £36. *Durban:* Unenumerated, £133. *Brisbane:* Glow lamps, 1,200 n.o. *Christiana:* Unenumerated £1,270. *Colombo:* Unenumerated, £11.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The address of Le Carbone (Ltd.) and of the London manager (Mr. J. O. Williamson) has been removed to Coventry House, South-place, E.C. Telegraphic address: "Lacombe Ave London."

Robert Fazackerley and John Edward Capper (trading as Fazackerley & Co.), electricians, &c., Market-street, Droylsden, Lancs, have dissolved partnership. Debts by Mr. Capper, who continues the business as Fazackerley & Co.

Hyman Marks and David Stevens (trading as the Stamford Engineering Co.), electrical and general engineers, 182, Stoke Newington road, London, N., have dissolved partnership. Debts by Mr. Stevens.

Plant for Sale.—The Madras Electric Supply Corporation (Ltd.) has for immediate disposal in Madras some second-hand plant, including three 500 kw. Davey Paxman-Crompton c.c. sets and two 500 kw. Davey Paxman-Crompton a.-c. sets, with one 250 kw. and one 125 kw. Crompton motor-generators, one 250 B.H.P. and two 110 B.H.P. three-phase motors. Offers to the Secretary, 1, Queen-Victoria-street, London, E.C. *See also an advertisement.*

Sale of Shares by Tender.—The Public Trustee invites tenders for the purchase of the whole or any part of 3,679 A shares of £10 each (fully paid) and 1,200 B shares of £10 each (fully paid) of the Tudor Accumulator Co. (Ltd.) which are vested in him as custodian by an order of the Board of Trade. Tenders must be delivered to the Public Trustee, Kingsway, London, W.C., on or before Monday, Feb. 26, and not Feb. 5, as previously advertised. *Further particulars are given in an advertisement.*

The Public Trustee announces that he will shortly offer for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Particulars and forms of tenders will be issued at an early date. Intending tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London W.C., in writing.

Names of Permanent Magnet Makers Wanted.—An advertiser requires the names of makers of permanent magnets for small moving coil recording instruments, or suppliers of steel suitable for same.

BANKRUPTCIES, LIQUIDATIONS, &c.

The R.E.T. Construction Co. (Ltd.) is being wound up voluntarily, and Mr. A. Page, 28, King-street, Cheapside, London, E.C., has been appointed liquidator. A meeting of creditors will be held on Feb. 12 at the Institute of Chartered Accountants, Moorgate-place, London, E.C.

A meeting to receive an account of the winding up of the Atlas Electrical Co. (Ltd.) will take place at Balfour House, 119, Finsbury-pavement, London, E.C., on March 5.

A meeting to receive an account of the winding up of the Volta Co. (Ltd.) will be held on March 7 at 3, Warwick-court, Gray's Inn, London, W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Leeds.—The Corporation is recommended to apply for sanction to a loan of £17,128 for two water-tube boilers with foundations, &c.

London County Council.—On Tuesday the Finance Committee reported on the application of the Woolwich Borough Council for sanction to borrow £23,152 for further extensions at the electricity supply station, the amount being made up as follows: turbo-alternator, £11,935; switchgear, £1,017, £12,952, and mains, &c., £10,200.

In May, 1915, the County Council dealt with the question of the outstanding period of loans granted for 42 years for plant and machinery rendered obsolete by extensions by requiring the Borough Council to agree to repay such loans within reduced periods equivalent in each case to half the period unexpired at April 1, 1920, the loans then affected amounting to £55,925. Moreover, it was provided that the loans for any obsolete plant and machinery should be repaid when such plant became obsolete in the opinion of the chief engineer of the Council, who was to be afforded facilities for inspecting the plant periodically. The Finance Committee now report that they are informed that a Peache-Allen set and a 100 kw. Parsons turbine will become obsolete upon the introduction of the machinery to be provided out of the proceeds of the present loan. The Borough Council is prepared to repay the outstanding debt, on this plant, within three months after the setting to work of the new plant, and this arrangement is said to be reasonable. The Borough Council states that the whole of the remaining plant must be retained against breakdown or overload of the converters. The Finance Committee are advised that the amount proposed to be paid for the new plant, &c., now required is reasonable, having regard to the present high prices prevailing, and that the usual periods of 25 years for mains (£10,200) and 15 years for plant (£12,952) may be allowed for repayment. The expenditure is for extensions which are necessitated by special circumstances, and as there is no objection to the sanction being given, they recommended accordingly, but that the order to borrow be not issued until the Borough Council had agreed to repay, within three months after the setting to work of the new plant, the outstanding balance of so much of the loan of £96,170, secured by deed dated Jan. 31, 1903, as was in respect of the plant (a Peache-Allen set and one 100 kw. Parsons turbine) which would become obsolete on the installation of the new plant.

Nuneaton.—Application has been made to the L.G. Board for sanction to a loan of £1,950 for a boiler and feed pump.

Todmorden.—The Council is recommended to purchase a 1,000 kw. turbo-generator, condensing plant, &c., at an estimated cost of £10,000.

GENERAL.

Marylebone (London).—The Guardians are endeavouring to secure the co-operation of the Borough Council in order that lads under their control should be apprenticed under the scheme of apprenticeship of the electricity department of the Council. The Electric Supply Committee is in favour of the suggestion.

Having regard to the necessity for all able-bodied men being required for the Army, the general manager (Mr. A. H. Sesabook) engaged a number of women to carry out the work required to be done at the generating station. It being impossible to find women already trained for such work, a request was made to those employees who had received temporary exemption to teach the women their duties. For some time considerable difficulty was experienced and some of the men either refused to carry out the instructions, or carried it out in such a way that little value could accrue therefrom. A workman who was the ringleader in the movement was dismissed and it is not anticipated that further trouble will be experienced. Complaint has been made by the men's Union with regard to the man's dismissal, and the Chairman of the Committee has interviewed the Secretary of the Union on the matter

Peterborough.—The salary of Mr. T. Rowland, who has hitherto been acting as borough electrical engineer, has been increased by £70 per annum, and his appointment has been made permanent.

Rochdale.—The engineer and manager of the Corporation electricity works (Mr. C. Clare Atchison) has tendered his resignation owing to ill-health. The resignation has been accepted by the Electricity Committee.

Salford.—An additional supply of energy is to be given to the works of Messrs. Edward Wood & Co. (Ltd.).

The existing agreement is to be extended for a further period of five years, but the minimum payment to be made by the company for electrical energy shall be £1,000 per annum. The company will provide the transformers and switchgear in connection with the additional supply.

An agreement has been sealed for the supply of energy to the premises of the Lancashire & Yorkshire Railway Co. in New Park-road.

St. Helens.—The Electricity Committee has made arrangements for the supply of electric current to proposed new electrolytic works.

Troon.—In regard to the proposal of Kilmarnock Corporation to erect an overhead transmission line to a new hosiery factory, the Troon Council have asked that the cable be laid underground.

TRACTION NOTES.

Bexley.—The Urban Council is negotiating with the L.C.C. with a view to the supply of some tramcars on the hire-purchase system.

Birmingham.—The Tramways Committee has decided not to make any contribution to the rates out of the profits.

This decision has been come to owing to the loss of £50,000 sustained through the Electric Supply Department failing to give a sufficient supply of current for continuous running.

Blackburn.—It has been decided to increase the tramway fares and shorten the penny stages.

The Accrington tramcars commenced running through to Blackburn on Feb. 1.

The Corporation have adopted the award of higher wages for tramway workers made by the Board of Trade Arbitrator.

Darwen.—The Tramways Committee has decided to raise the tramway fares.

Dundee.—In its annual report the local Society for the Prevention of Cruelty to Animals advocates the haulage of jute from the Harbour to the works and warehouses by tramcar.

The report states that the adoption of a system of tramway haulage for jute has been advocated for years past. There are always, even in peace times, complaints about congestion at the harbour during the jute import season, but the question has never been seriously considered either by the Harbour Trust, the Council, or the jute importers. Every time there is a jute block there is much talk about the lack of lorries, but none about tramways, which would not only get the jute much more quickly transported, but would avoid heavy strain on horses. The tramway system could easily be extended to the harbour and also to the large works, many of which are near the main tramway routes.

The Harbour Board has just appointed a Committee to consider this question.

Glasgow.—It is announced that the municipal tramway system is now free from debt, the whole of the capital expenditure of £3,835,156 having been repaid. There is also about £120,000 available for renewals and depreciation.

L.C.C. Tramways.—On Tuesday the Highways Committee reported that a number of additional tramcars had been run on various routes to counterbalance the closing of stations and higher railway fares, but there was a difficulty experienced in maintaining services owing to the shortage of men, which even for the normal services now exceeds 350, with the result that the service on any particular route can be increased only by reducing the services on other routes.

The existing tramway services would provide sufficient accommodation for any additional passengers arising from the closing of railway stations. Several other railway stations along or near tramway routes are closed on Sundays, but it is not anticipated that there will be any difficulty in the persons who formerly used such stations on Sundays securing accommodation on the tramcars. If it is found necessary, however, early Sunday morning cars will be run for the conveyance of munition workers; in fact, arrangements have already been made on one route. So far as can be ascertained, the increased railway fares, except on the East London through-running routes, have not resulted in any appreciable increase in the number of tramway passengers during the busy periods of the day. On the through-running routes via Bow Bridge and via Barking-road Bridge, however, there is a marked increase in long-distance tramway passengers. This matter is being closely watched, with a view, if necessary, to providing local services in the London area to accommodate local passengers who may fail to find accommodation as the result of the influx of long-distance passengers.

In December, 1912, the Council approved the substitution of four turbo-generators for reciprocating engines at Greenwich generating station. The third turbo-generator should be ready for running in August, 1917, and the Committee are advised that it is important for the requisite additions to the condensing water system to be put in hand immediately so as to allow the third set to be run simultaneously with the first and second turbo-generators. The modifications should be on a scale sufficient to provide ample water to run all four sets simultaneously, and ensure a considerable increase in the general safety of the station by providing alternative suction in case one of the pipes becomes blocked. It is, therefore, proposed to construct a second pipe similar to the one already installed but without the central division. The cost is estimated at £20,000 for the pipe work, £3,000 for alterations to plant at the station, of which £1,300 will be a capital charge and the remainder a revenue charge, and £500 chargeable to revuene account for structural alterations at the station, a total of £23,500.

The report and recommendations of the Committee were adopted.

Sunday's snowfall seems to have dislocated the L.C.C. tramway system, and great delays have occurred on several routes. Mr. G. H. Hume (Chairman of the Highways Committee) explained that owing to the heavy fall of snow salt was used in the tramway thoroughfares and as the salt melted it had the effect of causing short circuits, blowing off the fuses and rendering whole sections dead. The cars struggled over the conduit systems by fits and starts until about five o'clock on Monday, when the whole of the L.C.C. cars in urban London were brought to a standstill. In areas where the overhead method of transmission was in use the cars were able to run. On Tuesday there was an improved service, though delays still occur on certain routes.

Tenders are to be invited from selected firms for the supply of tramway fittings, &c., for alternative periods of six and 12 months in 1917-18.

In consequence of frequent breakdowns, a Committee has been appointed to consider what alterations are necessary in connection with the system and also the question as to fares and methods of fare collection.

L.C.C. Tramway Employees' Wages.—In December last the Court of Arbitration appointed by the Board of Trade issued its award on the question of the wages of employees of the traffic section.

The Court awarded that "on and after the first full pay day following Nov. 6, 1916, the male employees concerned who at present are, and who during the continuance of this award may be, in the employment of the London County Council in their traffic section, receive a further war bonus of 3s. 6d. per week, or 7d. per day, and that the claim on behalf of the female employees concerned has not been established." The grades affected by the award are motormen, conductors, assistant regulators, pointsmen and signallers, plough shifters, trailer car assistants, recreation room stewards, stop sign washers, destination board turners, controller handle-men, brakemen, punch repairers, breakdown hands and assistant ticket van-men. The cost of giving effect to the award (including its application to men, with dependants, on war service) is estimated at £19,105 in respect of the remainder of the current financial year, and £46,325 in 1917-18.

The award of the Court on the applications of persons employed in the electrical section is as follows:—

Charge engineers at sub-station to receive a war bonus of 2s. 6d. a week. The wages of fitters, turners, fitters' labourers, blacksmiths, hammermen, machine drillers, crane drivers and a wireman's mate to be advanced 3s. a week. The wages of bricklayers' labourers to be advanced 1d. an hour, such advance to be regarded as war wages, and to continue during the period of the war and nine months after the declaration of peace. With regard to shift workers and certain other employees at Greenwich station, men earning under 43s. a week to receive a further war bonus of 3s. 6d. a week, those earning 43s. up to and including 50s. a week to receive a war bonus of 3s. a week, and those earning over 50s. a week to receive a war bonus of 2s. 6d. a week. The foregoing advances to take effect on and after the first pay day following Nov. 6, 1916.

The cost of giving effect to the award is £955 in respect of the remainder of the current year and £2,310 in 1917-18.

The wages of men employed in the permanent way section have been advanced from 3s. to 4s. a week, and the estimated cost involved by the award is £3,715 for the remainder of the year and £8,935 in 1917-18.

The Court has also issued its award on the applications of certain grades of employees in the rolling stock department as follows:—

The wages of engineering employees (excepting toolmakers employed on munition gauge work), millwrights, electricians, coach-body makers, wheelwrights and mechanical and electrical repair staff at car shed (excepting light and power attendants) to be advanced 3s. a week.

The wages of controller repairers, light and power attendants at car sheds, beltmen and oilers, armature winders, armature banders, magnet and coil winders, plough repairers, wiremen at central car repair depot, painters, &c., at Holloway and central car repair depots, crane drivers, steam lorry drivers, slingers, tyre setters, and labourers at central car repair depot to be advanced as follows: The wages of those receiving under 35s. a week to be advanced 4s. a week, and the wages of those receiving 35s. a week and over to be advanced 3s. a week.

The wages of storekeepers and warehousemen receiving under 43s. a week to be advanced 3s. 6d. a week, and the wages of those receiving 43s. a week and over to be advanced 3s. a week.

The wages of women at the central car repair depot to be advanced 2s. a week.

The foregoing advances to be payable as from and after the first pay day following Nov. 6, 1916, and to be regarded as war wages, and as due to and dependent upon the abnormal conditions now prevailing.

The Court commend to the favourable consideration of the Council the case of women under 21 year of age who are engaged at the repair depot and who are doing women's work. The claim of controller repairers that their designation should be altered to that of controller fitters was held not to have been made out.

As from the first day of the pay week following Jan. 28, 1917, the hours of the electrical and repair staff at car sheds (except light and power attendants) employed on night shifts to be reduced from 10 hours to nine hours, the men to be paid the same amount as if working 10 hours; if at the end of four calendar months the Council finds that the reduction of hours is not reasonably satisfactory, the Council may alter the number of hours from nine to 10, or to any other period of time between nine hours and 10 hours (the same amount of pay being continued).

The cost of giving effect to the awards is £5,[illegible]00 for the remainder of the current year and £12,400 for 1917-18.

The above awards do not apply to persons under 21 years of age.

Liverpool.—Out of a total revenue of nearly three quarters of a million last year, the Liverpool City Tramways department made a profit of £236,111, from which £125,000 is being applied in reduction of the general rates.

Rotherham.—The Council has authorised the purchase of 10 second hand tramcars, in order to relieve the present congestion on the system.

LIGHTING & POWER NOTES.

Dudley.—The Streets and Lighting Committee has approved of 26 additional electric street lamps being lighted in the borough.

Electric Coal Cutters in the Transvaal.—The report of the Transvaal & Delagoa Bay Investment Co. states that the collieries owned by the company produced 573,837 tons of coal. Great improvements had been made recently in the design of electric coal cutters, and a plant of the most modern type, suitable to the conditions of the colliery, would be installed. Such plant would require additional electrical power, and the sum of £10,000 had been set aside to defray the cost of the installation. It was anticipated that increased efficiency and lower working costs would result.

New Electric Iron-Smelting Process.—"Engineering" states that a new Swedish invention for electric extraction of iron, with coke as a reduction medium, is attracting much attention, although the experimental stage is not yet quite over. Important practical results are confidently reckoned upon, and the new process is expected to prove advantageous, especially for Norway, where it is being tried.

TELEGRAPH AND TELEPHONE NOTES.

International Telegraph Conventions.—During 1916 the number of members of the International Telegraph Union was increased by one by the adhesion to the Convention of St. Petersburg of the Colony of French Somali.

Peru and French Oceania have adhered to the Radio-Telegraphic Convention of London.

Italian Wireless Telegraph Regulations.—Recently a decree was issued which makes it compulsory for merchant vessels carrying 50 or more persons to be provided with radio telegraph installations.

Long Distance Telephone Communication.—In its review of progress during 1916, the "Journal Télégraphique" announces that during the year telephonic communication was opened between Berlin and Sofia and between Montreal and Vancouver. In the latter case communication is effected by the intermediary of some U.S.A. telephone lines, the distance between the two towns being over [illegible] miles.

Radio-Telegraphy in 1916.—In a review of the progress of telegraphy in 1916 the "Journal Télégraphique" gives a list of the more important radiotelegraph stations opened during the year. It is stated that communication has been commenced between the following places:—

Isle of Tahiti to Samoan Islands and from there to New Zealand; Atar and Chinquetti (Mauretania) to Port Etienne; Cape Juby to Isle of Teneriffe; the Continent of Australia and Tulagi and the Solomon Islands in the Gilbert Archipelago; Seattle (Washington) and Yokohama; Barcelona and Budapest.

The following Transatlantic stations are now in operation: Sayville (N.Y.) and Nauen (Prussia); Tuckerton (N.Y.) and Eilvese (Prussia); Chatham (Mass.) and Stavanger (Norway); Marion (Mass.) and Nairbo (Norway); Belmar (N.Y.) and Carnarvon (Wales); New Brunswick (N.Y.) and Towyn (Wales); Glace Bay (N.S.); and Letterfrack (Ireland); Louisburg (N.S.) and Clifden (Ireland).

High-power stations have been erected at Funabashi (Japan) and Honolulu, which put Japan and San Francisco into communication.

Telephone Deposits.—Private telephone subscribers, not on the unlimited system, have received a demand for larger deposits when they have exhausted their first payments.

It is stated that economies in bookkeeping are being made in the Controller's department and accounts are being sent out quarterly instead of monthly, subscribers being, therefore, asked for a sum likely to cover their extra calls for the ensuing quarter.

EMPIRE NOTES.

Australasia.—H.M. Trade Commissioner in Australia reports that the Commonwealth Parliament has sanctioned the expenditure of £171,000 for the extension of the Tasmanian Government's hydro-electric plant at Great Lake and elsewhere.

Perth (W. Australia) Council has allocated £20,000 for the purchase of gas and electrical plant, and H.M. Trade Commissioner suggests that British manufacturers interested in the requirements of the Council should instruct their agents to get into touch with the City Electrical Engineer.

At a recent meeting of the Mt. Lyell Mining & Railway Co. (Tasmania), the chairman, Mr. B. Kelly, said a permanently successful basis for the treatment of zinc ore had recently been found in the use of electrolysis, and it was confidently anticipated that the ores could be roasted direct, and the zinc contents leached out, while subsequent treatment of the solution by electrolysis would yield electrolytic zinc of the highest purity. The rich leady residues from the leaching would be suitable for treatment in lead smelters in the usual way. The zinc treatment works would be in the vicinity of Zeehan and negotiations were in progress with the Government for the acquisition of the Tasmanian Smelting Co.'s leases and plant. The Mt. Lyell Co. had secured the services of a specialist in the electrolytic treatment of complex zinc ores from the Anaconda Co.

The Minister of Defence has stated, in regard to the future supply of electric cables to the Postmaster-General's Department, that an undertaking had been given to Metal Manufacturers (Ltd.), Port Kembla (N.S.W.), that it should have the opportunity of supplying all the copper goods which the company intended manufacturing, and which would be required by the Postmaster-General's and other Government Departments for 10 years.

At a recent meeting of the North Illawarra (N.S.W.) Council, a definite proposal to accept the scheme of electric supply offered by the Bellambi Coal Co. (S. Bulli) was submitted. The scheme was to install and supply current on a time-payment system, with interest. The proposal was, however, rejected as it was not considered good enough.

Canada.—An action has been commenced in the Supreme Court of Ontario for an injunction to restrain the Hydro-Electric Commission and the Attorney-General of the province from proceeding with the Chippewa hydro-electric development, on the ground that in the franchises of the Canadian companies the Government of Ontario has expressly contracted never to take water from the Niagara or Welland (Chippewa) rivers for the generation of electrical power.

In June, 1916, a Canadian Order in Council authorised the establishment of an Honorary Advisory Council on Industrial and Scientific Research for the Dominion. On the recommendation of the Minister of Trade and Commerce, the following have been appointed members of the Council:—

A. Stanley Mackenzie, Ph.D., president of Dalhousie College and University; F. D. Adams, Ph.D., D.Sc., dean of the faculty of applied science, McGill University, Montreal; Prof. R. F. Ruttan, M.D.; Prof. J. C. McLennan, Ph.D., and A. B. Macallum, M.B., Ph.D., Sc.D., University of Toronto; Walter C. Murray, LL.D., president of Saskatchewan University; R. Hobson, Hamilton; R. A. Ross, consulting electrical engineer, Montreal; and Tancrede Bienvenu, Montreal.

New Zealand Electrical Progress.—During the year 1916 the Public Works Department of the New Zealand Government issued 27 licences authorising the supply of electrical energy, making a total of 111 licences granted since 1887. The following is a list of the grantees of licences in 1916, together with the places covered:—

Napier Borough Council (Napier), Henry Bodley (Te Pohue), Huntly Town Board (Huntly), Louisa Jones (Wairakau—Te Aroha), Oamaru

Borough Council (Oamaru), F. Redwood (Spring Creek), Thames Borough Council (Thames), J. Chambers (Makopeka, Havelock North), Reefton Electric Light & Power Co. (Reefton), Spreydon Borough Council (Spreydon), Sumner Borough Council (Sumner), Hastings Borough Council (Hastings), Woolston Borough Council (Woolston), James Thomason (Murchison), R. Ellis (Brightwater), Wairoa Borough Council (Wairoa), Pahiatua Borough Council (Pahiatua), Hampstead Town Board (Hampstead), Rising Sun Gold Mining Co. (Aroha & Ohinemuri Survey Districts), Nelson Bros., Ltd. (Heretaunga S. D.), Kaitangata Borough Council (Kaitangata), Martinborough Town Board (Featherston County), Waimairi County Council (Waimairi County), Hamilton Borough Council (Hamilton), Riccarton Borough Council (Riccarton), D. J. Barry, Ltd (Tokomaru Bay), Inglewood Borough Council (Inglewood).

It will be noticed that 17 of the licencees are local authorities, the remaining 10 being companies or private individuals, compared with six local authorities in 1915 and 19 companies or private individuals.

There are only 10 tramway undertakings in operation in New Zealand under statutory authority. These are, with one exception (the Auckland system, worked by the Auckland Electric Tramways Co.), owned by local authorities, viz., by Wellington and Dunden City Councils, Wanganui, Napier, Gisborne & New Plymouth Borough Councils, the Christchurch and Gonville & Castlecliff Tramway Boards, and the Invercargill Borough Council and adjoining local bodies.

MISCELLANEOUS NOTES.

Alien Enemy Firms.—A supplement to the "Board of Trade Journal" of Feb. 1 contains a complete list (to Jan. 25) of the names of firms which have been ordered by the Board of Trade to be wound up under the Trading with the Enemy Amendment Act, 1916.

British Industries Fair.—The contract for wiring at this Fair (from 2,000 to 3,000 lamps) has been secured by W. C. Tackley & Co.

Calendar, &c.—We have received from Messrs. Alfred Graham & Co., Crofton Park-road, London, S.E., a useful desk blotting pad and calendar.

Customs Duties.—According to recent decisions the import duty on electrically heated photograph mounting machines is 20 per cent. and on telephone twine for lacing up cables and rubber bands for deadening vibration of telephone transmitters 3 per cent. ad val. British goods are allowed a rebate of 3 per cent.

Engineers' Wages.—On Monday representatives of the men engaged in the engineering and allied trades, and delegates from the employers' federation, resumed their conference with Sir Geo. Askwith, when further consideration was given to the question of the method of procedure for dealing with wage applications.

The unions represented included the Amalgamated Society of Engineers, the Steam Engine Makers, Tool Makers, United Machine Workers, Electrical Trades' Union, Scientific Instrument Makers, Pattern Makers, Blast Workers and General Workers' Union. At the close Mr. Robert Young, secretary of the Amalgamated Society of Engineers, stated that as a result of the conference satisfactory conditions were agreed to for dealing with wages on a national basis.

Lyons Fair.—The Secretary of the British Chamber of Commerce for the French Riviera and Monaco states that over 2,000 applications for space at the Lyons Fair (to be held from March 1 to 15) have been received by the Lyons Fair Committee. Certain British firms who did not exhibit at last year's Fair will exhibit at this year's.

Machine Tool and Engineering Association (Ltd.)—The directors report for 1916 states that since the last report 24 firms have joined the Association while one has resigned, so that the membership is now 157. One application for membership was refused.

The arrangement made by the directors postponing the Exhibition which was to have been held in 1916, till the autumn of 1918, was duly confirmed at a meeting of those members who had taken space. No applications have been received during the past year in respect of other exhibitions. Several of the directors and members have given evidence before the Board of Trade Engineering Inquiry Committee. The directors furnished to the Committee a report on the machine tool trade and made certain suggestions as to the steps necessary on the part of the Government to assist in further developments of the trade. A variety of Associations have been formed for the development of British trade after the war, but up to the present the directors state that they have not seen their way to give support to any of these new organisations.

In view of the decision of the railway companies that no machine tools should be carried at the companies' risk, except when packed, after June 1, 1916, representations were made to the companies, and the regulation was modified so as to apply only to lathes. On Sept. 28 a deputation met representatives of the railway companies at the Clearing House to discuss the matter, but it is regretted that railway companies were not willing for lathes to be sent at company's risk, except when packed. The question of further action is now under consideration.

The Association has been in communication with the Association of Trade and Technical Journals, with a view to the adoption of some arrangement to prevent the advertising of German goods after the war in British trade and technical journals. The Association was represented at a conference on Dec. 8, convened by the Association of Trade and Technical Journals, and the directors hope to be able at an early date to make definite representations on the matter to the members.

Municipalities and Income Tax.—At the last meeting of Oldham Electricity Committee complaint was made of the heavy income tax demand on the department.

The chairman (Ald. HARDMAN) explained that municipal undertakings were not dealt with in the same way as commercial undertakings, which returned their gross income and their gross expenditure and were assessed on the net profit. Although the Electricity Committee had only a profit of £5,100 last year they had to pay income tax amounting to £4,500.

TENDERS INVITED.

Synchronous Condensers.

The TORONTO ELECTRIC COMMISSIONERS invite tenders for Synchronous Condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28. *See also an advertisement.*

Train Lighting Cells.

The SOUTH AFRICAN RAILWAYS ADMINISTRATION require tenders for the supply of 3,420 Train Lighting Cells, the approximate requirements for the year ending Feb. 28, 1918 (Tender No. 756). A revised drawing of the cells required may be inspected at the Railway Stores at Cape Town, Port Elizabeth, East London, and Durban and at the office of the Chief Railway Storekeeper, Park Station Chambers, Johannesburg.

Turbo-Alternator and Condensing Plant.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of MELBOURNE electricity works. Tender forms from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Agents for the City Council, Billiter-square-buildings, London, E.C.; tenders to Chairman, Electric Supply Committee, Town Hall, Melbourne, by noon March 5.

Telephone Materials, &c.

Tenders are invited up to March 28 for the supply and delivery to the Postmaster-General's Department, State of South Australia, of Telephones, Telephone Parts, Cords, Line Material, Creed Tape, &c. Specifications, tender forms, &c., can be obtained at the Commonwealth Offices, London. *See also an advertisement.*

Automatic Telephone Exchange.

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Specification and conditions of contract from the offices of the High Commissioner, 32, Victoria-street, London, S.W., where tenders must be lodged by noon March 8.

Boiler, Coal Bunker, Conveyor, &c.

The Electricity Committee of HARROGATE Corporation invite tenders for the supply and erection of a by-product Steam Boiler, Overhead Coal Bunker, Coal Conveyor and Structural Steel Work. Specifications from borough electrical engineer, Mr. Geo. Wilkinson, M.I.E.E., to whom tenders are to be sent by March 5.

Wiring, &c.

Tenders are wanted by Feb. 21 for Electricians' Work at the War Hospital and the Merton Banks Sanatorium, KEIGHLEY. Forms of tender from Mr. J. N. Clarkson, 40, North-street, Keighley.

Tenders will be received by Mr. G. Davies, Aelybryn, Clydach, until Feb. 10 for electrical installation at Calfaria Baptist Chapel, CLYDACH. Specifications can be seen at the Minister's residence.

Arc Lamp Carbons.

Tenders are invited for the supply of 699,000 Arc Lamp Carbons to the City of MELBOURNE. Tender forms from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Billiter-square Buildings, London, E.C., to whom tenders are to be delivered by noon Feb. 14.

Electrical and General Stores.

BERMONDSEY (London) Guardians require tenders by 6 p.m. Feb. 22 for 12 months' supply of Electric Lamps, Ironmongery, &c. Forms of tender from the Clerk, 283, Tooley-street, S.E.

CHELTENHAM Corporation want tenders by Feb. 14 for 12 months' supply of Electric Light Fittings, Castings, Ironmongery, &c. Forms of tender from the Borough Engineer.

Tramway Materials and Stores.

The Tramways Committee of MANCHESTER Corporation invite tenders for the supply of Materials and Stores, including Motor and Controller Parts, Resistances, Coils, Trolley Poles, &c., Lamps, Switches, Bells, Insulation Material, Carbons, Overhead Equipment, Cable Wire, Oils, Paints, Ironmongery, Bolts, Screws, Axles, Tyres Castings, &c. Schedules from the general manager, Mr. J. M. McElroy. Tenders to Chairman of Tramways Committee, 55, Piccadilly, Manchester, by Feb. 13.

HALIFAX tramways department require tenders by Feb. 12 for 12 months' supply of lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor-Bronze Wire, Brake Blocks, Trolley and Overhead Line Materials, Castings, Oils, &c.

SALFORD Corporation Tramways Department require tenders by Feb. 12 for 12 months' supply of miscellaneous Stores. Particulars from the Manager, 32, Blackfriars-street, Salford.

CROYDON Council require tenders by 10 a.m. Feb. 19 for the supply of General Stores to the Tramways Department for three, six and twelve months. Forms of tender, &c., from the Tramways Manager.

TENDERS RECEIVED AND ACCEPTED

LEEDS.—The Electricity Committee recommend the acceptan of the tender of Babcock & Wilcox for the supply of two water-tu boilers and accessory plant at £12,959, and that of Messrs. W Airey & Son for foundations, seatings and flues, at £2,600.

LONDON COUNTY COUNCIL.—The Highways Committee h accepted the following tenders:—

Frodingham Iron & Steel Co., 325 tons of rolled steel bar for magne brake shoes; London Electric Wire Co., & Smiths (£691), British In lated & Helsby Cables (£1,353), and Midland Electric Wire Co. (£38 or cotton-covered copper wire.

FULHAM (LONDON).—The Electricity Committee have accept the tenders of the Stirling Boiler Co., for two boilers with sup heaters, £5,890; and the Erith Engineering Co. for two underfe stokers, £1,689 12s. 0d.

SALFORD.—The Council has accepted the following tenders:—

British Westinghouse Co., equipping blank switch cubicle, £102, a supply and erection of switch cubicle, £153; Willans & Robins maintenance of 5,000 kw. Willans-Zoelly turbo-alternator unit.

MANCHESTER.—The Electricity Committee has accepted following tenders:—

Babcock & Wilcox, two water-tube boilers and stoker links; Natio Boiler & General Insurance Co., supervision of boilers during constr tion; Liverpool Electric Cable Co., Callender's Cable & Construction C, C. Macintosh & Co., Western Electric Co., Pirelli General Cable Wor British Insulated & Helsby Cables, W. T. Glover & Co., and W. Henley's Co., cables; British Westinghouse Co., steel air ducts.

NEWCASTLE WEST (IRELAND).—The Town Commissioners ha accepted the tender of the Newcastle West Electric Light Co. for str lighting.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

EAST LONDON RAILWAY.—At the recent meeting the chairman (Lord Claud Hamilton) said that the Government control of the railways had affected their company in a way that was never contemplated at the time the Government entered into their arrangements with the large railways. Their six lessee companies were under Government control, but neither the East London nor the Joint Committee were recognised as controlled railways, although physically, of course, their line was controlled. They were called upon to forgo their legitimate share in the increased gross receipts, which had been very considerable, and were consequent upon the electrification of the line, which came into operation during 1913. Having regard to the increased traffics for 1915 and 1916, the East London Railway would normally be entitled to about £74,000 in respect of those years, instead of merely receiving the minimum rental of £30,000 for each year. Thus, there was apparently due to the company £14,500, out of which the accrued contingent liability to Dec. 31, 1916, for interest on electrification capital expenditure could be met (£12,400), leaving a balance of £2,100. He had laid their case before the Board of Trade. All they asked was that the Government should give the company a rebate amounting to the sum they had had to pay for interest on the capital advanced for electrification.

LANARKSHIRE TRAMWAYS CO.—The revenue for the year ended Dec. 31 last was £126,629. 19s. 6d. and expenses were £78,762. 8s. 2d., leaving £47,867. 11s. 4d. After meeting contributions payable to local authorities (£2,865. 11s. 6d.), debenture interest (£1,642), interest accounts (£1,822. 18s. 10d.), transferring £11,000 to reserve for depreciation, £2,500 to maintenance reserve and writing £2,393. 1s. 6d. off investments, &c., and adding amount brought forward (£958. 4s. 8d.), the balance is £23,002. 1s. 2d. Of this amount £11,117. 10s. has been paid for the interim dividend at rate of 6½ per cent. per annum for the June half-year on the issued share capital, and the directors recommend payment of a dividend at the same rate (6½ per cent. per annum) for the half-year ended Dec. 31, 1916. After paying £519. 7s. 8d. to the directors (being 10 per cent. of net profits after payment of 5 per cent. dividend for the year), £757 13s 6d has been carried forward. The revenue shows an increase of £20,586 and the expenses an increase of £12,671, compared with the revenue and expenses for 1915. It has been impossible, owing to shortage of labour and difficulty in obtaining materials, to maintain the undertaking in the usual state of repair and £2,500 has been transferred to maintenance reserve account in order to make some provision for the repairs which will have to be undertaken when the war is over.

LLANDUDNO & COLWYN BAY ELECTRIC RAILWAY (LTD.)—The profit, for the year ended Nov. 30, 1916 (after providing for ordinary operation and administration expenses and interest), amounts to £5,316. 14s. 1d., compared with £5,443. 12s. 6d. in 1915. Exceptional maintenance charges not applicable solely to the year (£1,195. 16s. 1d.) have been debited to reserve account. The net results have been affected by difficulties of obtaining labour and the increased cost of materials. With amount brought forward (£431. 17s. 5d.) the total availabl £5,748. 11s. 6d., part of which has been applied in providing for sink fund instalment (£1,615), and the directors recommend payment o dividend at rate of per cent. per annum (less tax), leaving to be car forward £157. 11s. 6d.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—The report for 1916 sta that the gross profit was £12,180, which, with the balance from the p vious year, makes a total of £12,812. The directors recommend a f dividend of 3s. 6d. per ordinary share, making 6s. per share; £4,00 reserved for depreciation, and £2,038 interest on bonus.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS (LTD.).—The rep for the year ended Oct. 31 last stated that after charging expense operation and administration and providing for depreciation, &c., th remains £11,945, and £651 was brought forward, making £12,596. A deducting debenture interest, &c., there remains £2,983. The direc recommend payment of interest at rate of 3 per cent. per annum (less t on the first income bonds, which will absorb £2,102, leaving £881 to carried forward. Traffic receipts increased by £2,486, but work expenses were higher, the net result being an increase in profit of £1,6 At the meeting on Tuesday the report and accounts were adopted.

CITY NOTES.

MEMORANDA (Feb 7).—Bank rate 5½ per cent. (since Jan. 18, 19 Consols, 51¾. Consols Pay Day March 1. Stocks and Shares Tic Day, Feb. 22. Pay Days Feb. 9 and 23. Price of Silver, 37¼d.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)— directors recommend a balance dividend for the year 1916 of 1s. per share (making 5 per cent. per annum), less tax. A sum of £5,500 been transferred to general amortisation fund and £108 carried forw

KAMINISTIQUIA POWER CO.—Last year's net revenue was $289,4 (against $306,559). Fixed charges absorbed $96,125 and divid $112,740, while there was transferred to surplus account $50,557. dividend on the stock was increased during the year from 6 to 7 per c The surplus earnings now stand at $336,697.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The direc recommend a balance dividend on the 7 per cent. preference shares the half-year ending Dec. 31, 1916, of 3s. 6d. per share and 5s. 6d. share on the ordinary shares, making with the interim dividend thereon a total distribution of 8 per cent. for the year.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The di tors recommend a dividend at the rate of 9 per cent. per annum, less for the half-year ended Dec. 31 last, making 7 per cent. for the year

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NOTES.

The Glasgow Tramways.

We have become accustomed to look upon the tramway undertaking of Glasgow as the municipal ideal towards which other similar undertakings should strive as far as possible. This feeling of the ideal will be still more pronounced in future now that the Glasgow Corporation has succeeded in entirely freeing the undertaking from debt. The history of the Glasgow tramways is noteworthy. In 1894 the tramways, which were then run by private enterprise, were taken over by the Corporation, and in 1901 the system was converted from horse traction to electric traction on the overhead trolley. Since then there have been various extensions, and the capital expenditure has risen to a total of £3,[illegible]35,156. During these years not only has the usual Sinking Fund been accumulated but a large fund has also been set aside for depreciation and renewals. The latter has now reached such a figure that it was decided at the last meeting of the Corporation to transfer such a sum as would raise the Sinking Fund from £1,560,267. its then value, to the figure given above for the capital expenditure.

◆

Thus the whole capital debt, including that for all extensions, additions to and improvements of rolling stock, &c., has been wiped out in the remarkably short period of 16 years. It might be thought that this achievement had been obtained by a policy of cheese paring. This, however, is by no means the case. The whole undertaking is in excellent condition, and the tramway fares are stated to be the lowest in the world. In future there will be no capital charges, and this will result in an annual surplus of something like £200,000 to £300,000. This noteworthy result is partly due to the well known fund at Glasgow which is called the "Common Good." It seems to be a sort of savings bank of the Corporation, being the recipient of all sorts of profits and properties, and dates back to about the end of the 12th century. The result is that a fund of several millions has been accumulated, which is always available for undertakings which are unquestionably for the common good, such as city improvements, housing, widening of streets, &c., and it is by means of this fund that an investment of £1,000,000 in the present war Loan has been made possible. It would be an excellent thing if other cities would start a fund of this kind, instead of impoverishing their undertakings by aiding the rates.

◆

Publicity and British Engineering Interests.

Recent developments in the war have shown very clearly the value of trained journalistic services in making known to neutral countries the ideas by which this country is swayed and in removing the misconceptions which the wider publicity of our enemies tends to foster. It is possible that enemy countries have gone to the other extreme in their efforts to interest neutrals, though most of us feel that their failure is due rather to the inherent weakness of their cause than to the ingenious methods by which they have endeavoured to support it. But no case, however sound, can withstand completely a campaign of misrepresentation without counteraction, and we as a country have in the past been remiss in assuming that our good intentions are necessarily evident and that it is invariably "bad form" to make any reference to our achievements. In the scientific and engineering field, where we are dealing with matters outside the range of view of the general public, this is particularly true. Germany's scientific achievements have undoubtedly been great, and we should be foolish to minimise them or to abstain from taking measures to remove defects in our own scheme of education or commercial organisation by which we have been handicapped. But we have suffered also by our indifference to the opinions of neighbours by hiding our light under the bushel of reserve. A notable instance is afforded by the conditions in Sweden, which country, contiguous as it is to German territory, has been literally flooded with German ideas, with the result that the intellectual public tend to have a very poor opinion of the literary and scientific achievements from other sources.

◆

We are led to make these remarks by a recent circular issued by the Engineering Standards Committee appealing for private support in order to undertake the translation and cheaper production of British Standard Specifications. It is pointed out, and truly, that the wide dissemination of this information in foreign countries would be of the greatest value to our future trade, and that other and more enterprising countries are already taking steps to make their corresponding propaganda known. The work of the Engineering Standards Committee is such as we have a right to admire and of which we may feel justly proud. The work is essentially of national value, and it is humiliating to think that the State should be so indifferent to its importance as to grudge the relatively small amount required to make it widely known. We see, over and over again, the same attitude in regard to the reports of Committees. After long discussion and experiment, a Report is issued, but at this point official interest ceases. No adequate steps are taken to make its contents readily accessible and intelligible, and no proper machinery exists to force it before the attention of the public in this country—still less before people on the Continent. We can only hope that, as has so often happened, private enterprise will step in where the State apparently fears to tread, and that eventually the requisite Government Grant will be forthcoming.

A Platinum Substitute.—An alloy known as rhotanium, of metals of the platinum group, which is claimed to be an entirely satisfactory substitute for platinum, is said to have been produced. The price of the new alloy is the same as that of platinum, but its specific gravity is about half that of platinum.

Translation of Engineering Standards Committee's Specifications.—The Institution of Electrical Engineers has contributed £500 for the translation of the Engineering Standards Committee's Specifications into foreign languages and for the foreign committees which the committee propose to set up in connection with the Standardisation Rules.

Dock Extensions at Tilbury.—By the enlargement of the main dock at Tilbury berthage has been provided for three additional vessels each 700 ft. in length. For the discharge of cargo the new quayage is equipped with 10 electric cranes, each capable of lifting 10 tons, and two more are under construction. This is only part of a much larger extension which the Port Authority has in view after the war.

Magnetic Indicator for Critical Temperatures. The fact that steel loses its magnetic properties on attaining the critical temperature forms the basis on which has been designed an instrument which infallibly indicates the instant when a mass of steel has attained the decalescent or hardening point. The instrument, which is made by the Gibb Instrument Co., Pittsburg, consists of a contact box containing magnet and coils, mounted on one end of a rod provided with handles and heat shield. The other end of the rod carries a fluxmeter, the needle of which indicates the gradual approach of the steel to the non-magnetic or critical point.

Canadian Iron and Steel Production.—According to "Canadian Machinery," of the total production of 1,298,325 tons of steel ingots and castings in the Dominion in 1916 about 39,100 tons were made in electric furnaces. In 1915 only 55 tons out of a total of 910,000 tons were made in electric furnaces. During the year just closed the production was greater than that of any previous year, the second largest production of steel being 1,045,000 tons in 1913. Compared with 1915, the increase in production of pig iron in 1916 was about 28 per cent., and of steel ingots and castings a little more than 12 per cent.

Power Plants on Trial.—American electric supply undertakings are reported to be energetically pushing the practice of furnishing improved plant on trial. The chief difficulty is the drawing up of an agreement ensuring that the customer will not refuse an expensive plant after its utility has been clearly demonstrated. Here the judgment of the engineer plays an important part. Any plant offered in this way must, to his certain knowledge, be such as to bring about improved efficiency, and in these circumstances it has been found by some companies that the customer almost invariably accepts the plant after trial, and that, at least in the case of relatively inexpensive machinery, the stipulation as to acceptance can be waived.

Artificial Abrasives. Among the qualities of an abrasive which rank high for practical purposes are uniformity of structure and hardness. In this respect the best artificial abrasives are superior to natural materials, such as sandstone, emery or corundum. In the electrical furnace two distinct classes of abrasives are now manufactured, the aluminous group and the carbide of silicon group. Silicon carbide, while extremely hard, is not so tough as the aluminous abrasives. Accordingly, the latter class are best adapted for materials of high tensile strength, while the silicon carbide group answers best for materials of relatively low-tensile strength, such as brass, bronze, marble, leather or wood. Tests have also shown that less horse-power is required with an aluminous abrasive than with a silicon abrasive when grinding steel; while in the case of cast-iron the contrary holds good. During the last six years the consumption of artificial abrasives in the United States has steadily increased, being in 1915 nearly double what it was in 1909.

Electrically Illuminated Fireplace.—Efforts have often been made to simulate in the electrical grate the conditions present in a wood or coal fire, which by mental association is so closely identified with comfort. It seems hopeless to attempt to imitate dancing flames, but in the United States relatively successful attempts to imitate glowing logs seem to have been made. In the latest device the logs are made of a translucent material and asbestos, reinforced with metal, and made hollow for the insertion of electric lamps. The bark and cut ends are hand painted to give the natural appearance of partially burned logs. Coal fires are imitated by the use of electric bulbs concealed in a mixture of selected pieces of coal and transparent lumps of glass. A "chemical smoke" is also suggested. One factor which it seems impossible to produce is the progressive change in appearance of a wood or coal fire as the material is used up. It is to be feared that a fire in which the conditions in this respect are stationary would never deceive for any length of time, however cleverly contrived. On the whole, the best plan would seem to be to recognise frankly that an electrical heater is not a wood or coal fire, and should not be expected to resemble one.

The British Glass Industry.—The Advisory Council of the Department of Scientific and Industrial Research have added to the list of their technical committees a Standing Committee on Glass and Optical Instruments. The members of the Committee are:—

Prof. H. Jackson (chairman), Mr. Conrad Beck, Prof. C. V. Boys, F.R.S., Mr. F. J. Cheshire, Mr. A. E. Conrady, Mr. A. S. Esslemont, Mr J. W. French, Dr. R. T. Glazebrook, C.B., F.R.S., Sir Howard Grubb, F.R.S., F.R.A.S., Mr. E. B. Knebel, F.R.A.S., Dr. T. R. Merton, Prof. J. W. Nicholson, D.Sc., Capt. Creagh Osborne, R.N., Mr. H. J. Stobart, Mr. J. Stuart, Mr. M. P. Swift, Mr. Wm. Taylor, Mr. F. Twyman, Lieut.-Col. A. C. Williams and Mr. W. F. J. Wood.

The Committee has appointed a series of sub-committees to which various special problems were referred. Among these problems the more important are: (*a*) Raw material for glass and glass making; (*b*) optical properties of a large range of glasses; (*c*) general physical and chemical properties of glass and glassware for scientific and industrial purposes; (*d*) testing and standardising of glassware; (*e*) workshop technique; (*f*) X-ray glass apparatus; (*g*) optical calculations and lens designing; (*h*) optical instruments; (*j*) translation of foreign works on optics.

The Standing Committee does not propose to limit itself to the above subjects, but is prepared to consider and report upon the necessity for investigation in other directions, relevant to its terms of reference. Manufacturers who have experienced difficulties requiring investigation for their solution in connection with the subject of glass and optical instruments, or who desire to make suggestions for special researches on these subjects, are invited to communicate in the first instance with the Secretary of the Research Department, Great George-street, London, S.W.

OBITUARY.

C. V. Burton.—The death occurred on the 3rd inst. of Dr. Chas. V. Burton as the result of an accident at the Royal Aircraft factory, Farnborough. Dr. Burton, who was born in 1867, was for a time secretary of the Physical Society. He was working at Lord Berkeley's private laboratory at Foxcombe, Oxford, when the war broke out, but he resigned to undertake experimental work at the Royal Aircraft factory.

Killed in Action. The following are reported to have died in action or of wounds:—

Sec. Lieut. L. A. O'Meara (E. Lancashire Regt.), who was killed on Feb. 6, was the only surviving child of Major W. A. J. O'Meara, late engineer-in-chief of the Post Office. Before the war Mr. L. A. O'Meara was entered as an engineering student at Cambridge University, but he joined the Artist's Rifles in January, 1916, when 18½ years, and he received his commission in August, 1916.

Lieut. R. Cecil Hopkinson, R.E., son of the late Dr. John Hopkinson, died of wounds on Feb. 9. Mr. Hopkinson, who was 25 years of age at the time of his death, was an Exhibitioner of Trinity College, Cambridge, where he obtained a first class in the Mechanical Science Tripos in 1913. Until the war broke out he was engaged in C. A. Parsons & Co.'s works.

PERSONAL.

Honours for War Workers.—The Prime Minister's list of New Year's Honours has now been issued, and among those who have been honoured are the following :—

Knights.—H. E. Haward, Controller of the London County Council ; F. L. Raven, Chief Mechanical Engineer of North-Eastern Railway since 1910, and Superintendent of Royal Arsenal Factories, Woolwich, since 1915 ; W. Lorimer, chairman of the North British Locomotive Co. and the Steel Company of Scotland ; Ald. Geo. A. Touche, M.P., chairman of the Cordoba Light, Power & Traction Co. and the United Electric Tramways of Montevideo, and a director of the Anglo-Argentine Tramways Co.

K.C.B.s.—Sir Frederick Wm. Black, C.B., Director-General of Munitions Supply (Director of Contracts, Admiralty) ; Sir Herbert A. Walker, acting chairman of the Railway Executive Committee.

C.B.s.—Lieut.-Col. Alfred Ernest Le Rossignol, London Electrical Engineers ; Sir Henry Fountain, C.M.G., Assistant Secretary, Commercial Dept. of the Board of Trade ; Philip Hanson, Director of Contracts, Ministry of Munitions.

The President of the new Air Board is Lord Cowdray ; the Director General of Military Aeronautics is Lieut.-Gen. Sir David Henderson ; the Controller of Aeronautical Supplies, Mr. Wm. Weir ; the Controller of Petrol Engines, Mr. Percy Martin ; and the secretary is Sir Paul Harvey.

The Marquis of Crewe has been appointed a member of the Privy Council Committee for the organisation and development of scientific and industrial research.

The Council of the Liverpool University have conferred the title of "Associate Professor" on Mr. J. Wemyss Anderson, M.Eng., M.Inst.C.E., M.I.Mech.E., Lecturer in Engineering Design and Drawing and in Refrigeration, and Dean of the Faculty of Engineering.

APPOINTMENTS VACANT AND FILLED.

A charge engineer is wanted by Ilford Urban District Council for their electricity works. Salary £120, increasing by annual increments of £10 to £150 per annum. Applications to the engineer and manager, Mr. Arthur H. Shaw, by Feb. 19. *See an advertisement.*

An advertiser requires a first-class electrical engineer, with experience in laying out oil works and plant.

A capable draughtsman, accustomed to switchgear design, is required. *See an advertisement.*

A temporary engineer-electrician is required for the Devon County Asylum, Exminster. Applications to the Clerk at the Asylum.

Several station engineers are required for Northern Command power stations in Lincolnshire district. Wages £2. 10s. to £3 per week. Applications to the District Electrical Engineer, Southern District, Somerville House, West Forest-road, Nottingham.

Leeds Corporation are recommended to confirm the following appointments :—Mr. Ernest Porter to be superintendent of the new electricity generating station, at £280 per annum ; Mr. H. Topham, engineer-in-charge, salary £140 ; Mr. C. H. King, works foreman, salary £182.

INSTITUTIONS AND SOCIETIES.

Association of Mining Electrical Engineers (West of Scotland Branch).—At a meeting of the above association on Jan. 21, a demonstration with mining signals and bells to comply with the Home Office Regulations was opened by Mr. H. A. M'Gabbe, convener of the Bell Signalling Committee. Mr. J. B. Thomson, the branch president, was in the chair. Various systems of sparkless signalling for underground use were shown. In the course of the proceedings a short Paper was read by Mr. Alex. M'Phail on "Modern Switch and Fuse Gear."

Faraday Society.—A General Discussion on "The Training and Work of the Chemical Engineer" will be held by the Faraday Society on Tuesday, Macrh 6, 1917, at 8 p.m., in the rooms of the Chemical Society, Burlington House, W. Sir Robert Hadfield, F.R.S., President of the Society, will preside over the Discussion, which will be opened by Sir George Beilby, F.R.S. Papers will be read on "The Training of the Chemical Student for Work in the Factory" by Prof. F. G. Donnan, F.R.S. ; on "The Training of the Works Chemist in Physics" by Mr. Charles R. Darling ; and a Paper entitled "A Plea for the Forgotten Factor in Chemical Training" by Mr. W. R. Cooper, M.A., B.Sc.

The following have signified their intention of contributing to the Discussion :—Mr. G. S. Albright, Dr. E. F. Armstrong, Dr. Charles Carpenter, Dr. Dugald Clerk, F.R.S., Prof. E. G. Coker, F.R.S., Mr. S. Z. de Ferranti, Mr. A. P. M. Fleming, Mr. E. Hatschek, Prof. G. G. Henderson, Prof. A. K. Huntington, Mr. H. A. Kent, Mr. W. McNab, Dr. R. Messel, F.R.S., Sir Gerard Muntz, Bart., Dr. F. M. Perkin, Mr. K. B. Quinan, Mr. W. Gathorne Young, and others.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Feb. 16th (to-day).

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Annual General Meeting. Paper on "Alternating Stress Experiments," by Dr. W. Mason.

Scottish Local Section, Institution of Electrical Engineers.

7.30 p.m. At 207, Bath-street, Glasgow. Kelvin Lecture, "Some Aspects of Lord Kelvin's Life and Work," by Dr. A. Russell.

SATURDAY, Feb. 17th.

Association of Mining Electrical Engineers, Midland Branch.

3.30 p.m. At the Midland Hotel, Mansfield. Paper on "The Steam Turbine and Its Industrial Application," by Mr. P. J. Plevin.

Association of Mining Electrical Engineers.

4.30 p.m. At the Royal Technical College, Glasgow. Paper on "Electrical Converters," by Mr. C. S. Buyers

TUESDAY, Feb. 20th.

Illuminating Engineering Society.

5 p.m. At the Royal Society of Arts, John-street, Adelphi, W.C Paper on "The Effect on the Eye of Varying Degrees of Brightness and Contrast," by Dr. J. Kerr.

Engineers' Club.

7.30 p.m. At the Engineers' Club, Albert-square, Manchester. "The Engineers' Club, What it is and What it Might be," opened by Mr. Edmund L. Hill.

WEDNESDAY, Feb. 21st.

Birmingham Local Section, Institution of Electrical Engineers.

7 p.m. At the University, Edmund-street, Birmingham. Discussion on "Fuel Economy."

Yorkshire Local Section, Institution of Electrical Engineers.

7 p.m. At the Philosophical Hall, Leeds. Paper on "Some Points in Connection with Engineering Specifications," by Mr. J. Shepherd.

THURSDAY, Feb. 22nd.

Greenock Electrical Society.

7.45 p.m. At Masonic Rooms, 22, West Stewart-street, Greenock. Paper on "Electricity Supply Costs," by Mr. F. H. Whysall.

FRIDAY, Feb. 23rd.

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington, S.W. General Meeting.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At Bolbec Hall, Newcastle-on-Tyne. General Meeting.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding : Lieut.-Col. C. B. Clay, V.D.

Orders for the Week :—

Officer for the Week.—Platoon Commander J. O. Cheade.

Next for Duty.—Platoon Commander A. Gerard.

Appointment.—209 Sapper S. Foster to be sec. cdr., No. 1 company (dated Feb. 8, 1917).

Monday, Feb. 19th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class Recruits' Drill, 6.30 to 8.

Wednesday, Feb. 21st.—Instructional Class, 6.15. Platoon Drill. Platoon No. 1.

Thursday, Feb. 22nd.—Platoon Drill, Platoon No. 7. Ambulance Class by M.O., 6.30.

Friday, Feb. 23rd.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill. No. 9. Signalling Class. Recruits' Drill. 6.25 to 8.25.

Saturday, Feb. 24th.—N.C.O.'s Class, 2.30, under Company Commander Fleming.

Entrenching.—Suspended until further orders.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

FLYWHEEL LOAD EQUALISERS.

These machines are largely used for electric winders and rolling mills. They have also been used for coal hoists and for coal and ore-handling plants.

Definition.—A flywheel load equaliser may be defined as one or more electrical machines coupled to a flywheel, and arranged in such a way as to flatten out automatically the load curve of any number of motors connected, either directly or indirectly, to the mains, so as to ensure that these motors impose a practically constant, and regulable, demand on the power station which supplies them.

This definition has been framed to cover: (*a*) The systems in which the flywheel equalises only for the particular load supplied by its own generator, and not for loads on other parts of the network; and (*b*) the systems in which energy is drawn from, or returned to, the mains by the equaliser during times when the demand is respectively less or greater than the average demand.

The difference between these two methods of load equalisation is an important one. Although of the flywheel load-equalisers in existence probably 90 per cent. or more belong to group (*a*), the other group nevertheless covers a much wider field, and it is not due to any defect in the systems coming under this group that they have found but few applications in practice. For a certain class of lifting machinery, as yet untouched by the electric crane maker, the systems of load equalisation in group (*b*) will, in all likelihood, come into greater prominence.

Principle of the Flywheel Load Equaliser.—A typical load diagram is depicted in Fig. 1, and the area of the diagram represents horse-power-seconds. It is assumed that the cycle is of short duration, and that it is repeated indefinitely. Local conditions make it necessary that the demand on the generating station should be constant. In Fig. 1 the height OA is such that the area OABC is equal to the area of the load diagram; OA is thus the average power, and means have to be provided for limiting the demand to this average. Beginning at O, for t_1 seconds the demand is less than the average; from the time t_1 to the time t_2 the demand is greater than the average, and from t_2 to the end of the cycle the demand is again less than the average. From this it appears that somewhere between the load and the generating station must be interposed a machine which, during times when the demand is less than the average, automatically stores energy, and which, during times when the demand is greater than the average, automatically gives out energy. In the example shown in Fig. 1 the energy to be given out is represented by the shaded area, and the area of [illegible] represents the energy stored. Assuming for the moment that means are available for automatically altering the speed of a flywheel as the demand varies, and that arrangements are at hand for the proper adjustment of the energy, it will be seen that such a wheel, of itself, is sufficient for smoothing out the peaks and for creating a constant demand on the supply.

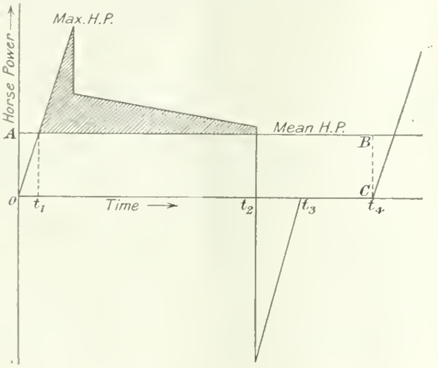

FIG. 1.—LOAD CURVE.

Since the energy stored in a flywheel varies as the square of the speed, it follows that if the speed be reduced, say, 20 per cent., the energy stored will be reduced by $100[1^2 - (1 - 0{\cdot}2)^2] = 36$ per cent. Thus, if in a wheel running at normal speed the energy stored is, say, 27×10^6 ft.-lb., then for a 20 per cent. reduction of speed the energy given out is $0{\cdot}36 \times 27 \times 10^6 = 9{\cdot}7 \times 10^6$ ft.-lb., and if such change of speed be effected in 10 seconds, energy is given out at the rate of $0{\cdot}97 \times 10^6$ ft.-lb. per second, which corresponds to 1,768 H.P. A 550-volt dynamo driven by the wheel would yield a current of 2,400 amperes.

Determination of Weight of Flywheel.—It will now be shown how to determine the weight of wheel required for balancing the load.

Let V_1 and V_2 be the upper and lower limits of speed, in feet per second, of a point at the end of the radius of gyration, then when the speed of the wheel is reduced from V_1 to V_2, the change of kinetic energy

$$\Delta(K.E.) = W(V_1^2 - V_2^2) \div 2g \text{ ft.-lb.} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In one of the most widely used equalisers it is customary to allow a speed reduction of 15 per cent. Therefore, by substituting $0{\cdot}85V_1$ for V_2 in equation (1), we find that

$$\Delta(K.E.) = 0{\cdot}00435WV_1^2 \text{ ft.-lb.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Although cast-steel wheels have been run at peripheral speeds of 20,000 ft. to 22,000 ft. per minute, we shall here assume a speed of 18,000 ft. per minute, or 300 ft. per second, as representing average conditions for such wheels. The radius of gyration of a cast-steel wheel is approximately 0·78 times the radius of the wheel, hence $V_1 = 0{\cdot}78 \times 300 = 234$ ft. per second, and from equation (2)

$$\Delta(K.E.) = 0{\cdot}00435W \times 234^2$$
$$= 238W \text{ ft.-lb.},$$

which is a convenient expression to remember.

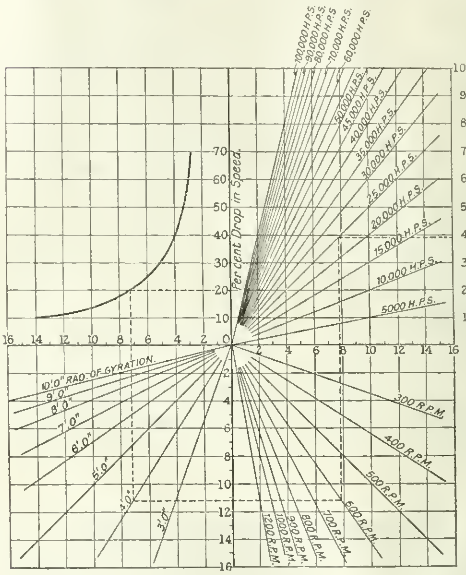

FIG. 2.—CURVES FOR OBTAINING THE WEIGHT OF A FLYWHEEL FOR A BALANCING SYSTEM.

By equating this and the foot-pound equivalent of the peak to be compensated, namely, the shaded area in Fig. 1, the weight of the wheel can be obtained.

Example.—It is required to determine the weight of a flywheel for compensating a peak of 25,000 H.P.-seconds, having given that the radius of gyration of the wheel is 4 ft., and that the maximum and minimum speeds of the wheel are 600 and 480 revs. per min. respectively.

The maximum speed V_1 at the radius of gyration $= 2\pi \times 4 \times 600 \div 60 = 251{\cdot}3$ ft. per second, and the minimum speed V_2, also at the radius of gyration $= V_1 \times 480 \div 600 = 0{\cdot}8V_1$, which corresponds to a speed reduction of 20 per cent. A peak of 25,000 H.P.-seconds is equal to $25{,}000 \times 550 = 13{\cdot}75 \times 10^6$ ft.-lb.

Inserting these values into equation (1) we get—

$$W = 13{\cdot}75 \times 10^6 \times 2 \times 32{\cdot}2 \div 251{\cdot}3^2(1^2 - 0{\cdot}8^2),$$
$$= 39{,}000 \text{ lb.}$$

Graphical Method of Determining Weight of Flywheel.—Of the several graphical methods which have been given for finding the weight of flywheel, one of the most convenient is by means of a chart described by Messrs. D. B. Rushmore and K. A. Pauly.* This chart is given in Fig. 2. Having decided upon the radius of gyration in feet, and the speed in revs. per min., the weight of a wheel required to deliver any number of horse-power seconds from 0 to 100,000 with any change of speed from 10 to 70 per cent. may be obtained by the use of this diagram. To find the weight of a wheel, begin with the curve in the upper left-hand corner of the diagram, and follow the line corresponding to the per cent. drop in speed until it intersects the curve and then vertically downwards until it intersects the line corresponding to the radius of gyration of the wheel, and so on as indicated by the dotted line, which assumes a wheel having a radius of gyration of 4 ft., running at 600 revs. per minute and delivering 25,000 H.P.-seconds with a 20 per cent. drop in speed. The effective weight of the wheel is approximately 39,000 lb.

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* "Transactions," Am. Inst. E. E., Vol. XXIX., p. 249, 1910.

A discussion on the many problems connected with the flywheel load equaliser falls outside the scope of the present work. Those in search of information on the mechanics of the equaliser will find that the literature on the subject is extensive. Of particular interest is an article by Mr. R. H. Collingham,* in which the constants of an equaliser for an electric winder are determined. It should be mentioned, however, that the speed reduction allowed by Mr. Collingham is much smaller than that which is usually allowed, with the result that the flywheel is heavier than would be the case with a larger speed reduction. But this does not detract from the value of the article.

We shall here briefly describe three systems that have been devised. Before doing so, however, it is necessary to refer to the windage losses of flywheels, and to mechanical details connected with the equipment.

Windage Losses of Flywheels.—Dr. L. Becker † gave a formula which was deduced from experimental data furnished by the Siemens-Schuckert-Werke. In British units the formula is :—

$$\text{Horse-power loss} = 4{\cdot}70 \times 10^{-8} \times V^{2.5} \times D^2(1+0{\cdot}465B^2), \quad . \quad . \quad (1)$$

in which V is the peripheral speed in feet per second, D is the diameter of the wheel in feet, and B is the width of the rim in feet.

Particulars of the six wheels examined by Dr Becker, together with the observed losses and the losses computed from equation (1) are given below :—

Diameter. in.	Width. in.	Speed. R.P.M.	Peripheral speed. ft. per sec.	Observed loss. H.P.	Calculated loss. H.P.
78·7	3·94	1,000	344	4·7	4·6
141·7	16·9	500	308	19·9	21·2
102·4	14·2	600	268	6·6	6·6
173·2	29·5	375	283	50·4	50·4
106·3	18·9	600	278	9·9	10·2
157·5	31·5	350	240	30·7	30·4

In an article entitled "Formulæ for the Windage of Flywheels," Mr. E. Buckingham ‡ points out that serious objection may be made to the form of equation (1), since it does not satisfy the fundamental condition of having all its terms of the same dimensions, and he proposed alternative expressions.

Windage losses of as much as 74 H.P. have been observed, and in order to minimise the loss the wheels should be highly polished, and enclosed in cast-iron or sheet steel cases. In some of the early installations it was customary to run the wheels in vacuum, but, apart from the cost of the air-tight casing, in many cases it was found that the maintenance of the vacuum necessitated an expenditure of energy which was greater than the windage loss of the open wheel.

Mechanical Details.—At one time it was thought that trouble would be experienced with the bearings owing to the heavy loads and high peripheral speeds, but the doubt was quickly dispelled. It is usual to allow a specific pressure of about 75 lb. per square inch of projected area of bearing surface for bush-type bearings lined with white metal. The bearings are generally about 2½ diameters in length, and to avoid undue strains they are of the self-aligning type.

Lubrication is effected by oil rings and by oil under pressure from motor-driven pumps (in duplicate), or from an elevated tank into which the oil is pumped. Many installations are provided with water-cooling arrangements for each of the main bearings. Pressure lubrication is very useful for starting purposes. When the wheel comes to rest the oil film is squeezed out of the bearings, and unless this film can be established again before starting a heavy torque is required to move the set from rest. It has been found that the oil pump quickly re-establishes the film.

In order to facilitate the starting of a flywheel set, a pneumatically or electrically-operated barring-gear may be used. This is arranged in such a way that it is put out of action automatically when the set reaches a speed of about three revs. per min.

Since the whole of the energy stored in the wheel has to be dissipated before the set can be brought to rest, it is usual to fit braking appliances for effecting a quick stop. Experiments show the retardation due to frictional resistance to be such that the energy stored at 560 revs. per min. will rotate a 40-ton wheel for about three hours after the current has been interrupted. One method of braking is to excite, with continuous-current, one phase of the driving motor. Other less common methods are by means of eddy currents in the rim of the flywheel or by water-cooled mechanical brakes.

Flywheel-Generator Set.—This machine is the simplest flywheel equaliser in existence. It floats on the line and furnishes the energy for the peak loads, there being no transformation of the normal energy absorbed by the hoist motors.

A good example of a flywheel generator set is that constructed by the Allis-Chalmers Co., of Michigan, and the following particulars have been taken from a Paper by Messrs. W. N. Motter and L. L. Tatum.*

The load to be handled consists of three ore-bridges having a combined capacity of 10,000 tons of ore in 10 hours. Each ore-bridge is equipped with motors aggregating 1,365 H.P., and power is obtained from the feeders of a 550-volt trolley system some 1,100 ft. from the generating station. The maximum peak load is 1,600 amperes (or 2,000 amperes when handling wet ore), and the arrangements are such that with the maximum current, the line current does not exceed 600 amperes. A flywheel set of capacity sufficient to deliver 1,400 amperes at 550 volts for 15 seconds is installed.

The set consists of a compound-wound interpole machine of 300 kw. 550-volt 600 revs. per min. rating at normal capacity, with an overload capacity of 850 kw. for 15 seconds with a drop in speed of 22 per cent., and a solid cast-steel disc flywheel 9 ft. diameter and 15½ in. wide. The armature and rotating parts weigh 47,275 lb., which at 600 revs. per min. represents 25·7-million ft. lb. of energy stored. At 470 revs. per min. the energy stored equals 16-million ft. lb., or with a 22 per cent. drop in speed, there is delivered 9·7-million ft. lb. of energy. If this change of speed takes place in 15 seconds the energy delivered is 875 kw., or 1,600 amperes at 550 volts, or more than the maximum peak required.

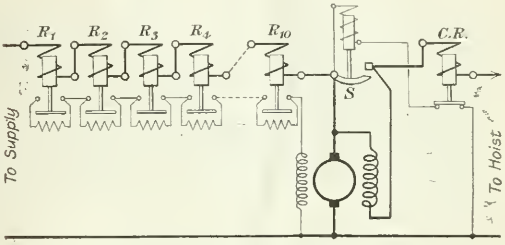

Fig. 3.—Main Electrical Connections of Flywheel Load-equalising Generator.

From the schematic diagram of the main electrical connections, Fig. 3, it will be seen that the series-winding is connected on the load-side of the circuit between the crane and the equaliser. This allows of operation as a shunt motor when the flywheel is taking energy from the feeder, but when delivering energy to the cranes the machine acts as a compound-wound generator. Since the cranes take the average current direct from the feeder, which would at all times partially energise the series winding, a magnet-switch, *S*, is provided to short-circuit the winding. A current-relay, *CR*, controls the magnet-switch opening the short-circuit around the series winding at a crane current of 400 amperes. At 400 amperes the series-winding is suddenly energised, and the counter-E.M.F. of the machine is thereby raised enough to cause the machine to deliver energy to the circuit, instead of absorbing energy from the circuit. To make the machine take the desired proportion of the total load the series winding is so adjusted that the delivered energy is approximately proportional to the current in the series coil. When the demand drops to about 300 amperes the series coil is again short-circuited, thus causing the voltage to decrease so that the flywheel again absorbs energy.

The shunt-field connection scheme is also shown in Fig. 3. On account of the approximately constant line voltage and of the variable speed, it is necessary to adjust automatically the shunt field strength to suit the momentary values of the speed. If the field be too weak, the motor current or rate of absorbing energy would be too high, while if generating, the voltage would be too low to allow the machine to take its proper proportion of the total. In either case heavier loads would be thrown on the feeder. To correct for this, current relays R_1, R_2, R_3, &c. (Fig. 3), are connected in the feeder, and are so arranged as to commutate resistance in series with the shunt-field. These relays are set to operate with different currents, from 400 to 600 amperes. Below the average load, namely, 400 amperes, all the relays are open, thus giving the weakest field, and tending to give maximum speed to the flywheel. Above 400 amperes (feeder current) certain of the relays close, thereby strengthening the field and reducing the motor current or increasing the generated current, depending on whether the series coil is in action or not. Under a sustained peak, the flywheel slows down gradually, and the field is strengthened gradually until, with the wheel at its lowest speed and maximum field strength, the feeder is supplying 600 amperes. The function of the shunt field regulation is, therefore, to maintain the voltage of the flywheel machine approximately equal to the feeder voltage under all conditions of speed, while the auxiliary series field and its short-circuiting switch change the characteristics of the machine from those of a motor to those of a generator. The excellent performance of this set is apparent from the load-current and line-current curves shown in Fig. 4.

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* "Engineering," June 18, 1909, p. 807.

† "Elektr. Kraftbetr. u. Bahnen," Vol. V., p. 485, Sept. 4, 1907.

‡ The Electrician, Vol. LXXIV., p. 501, January 15, 1915.

* "Transactions" Am. Inst. E.E., Vol. XXX., Part I., p. 729, 1911.

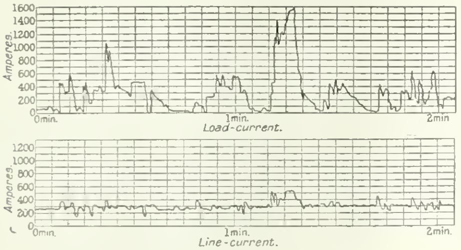


Fig. 4.—Graphical Current Record of Flywheel Load-equalising Generator.

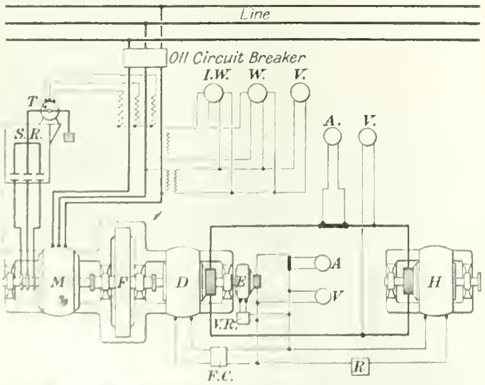


Fig. 5.—Diagram of Connections of Motor Generator Flywheel Set.

A = Ammeter. V = Voltmeter. W. = Wattmeter. I.W. = Integrating Wattmeter. F.C. = Re[illegible] Rheostat. R. = Field Rheostat.

Motor Generator Flywheel Set.—As arranged for use with alternating currents the equaliser takes the form depicted in Fig. 5. The equaliser in conjunction with Ward Leonard control is largely used for electric winders. It consists of an alternating-current induction motor, *M*, with wound rotor, coupled to a continuous-current generator, *D*, which, in turn, is electrically connected to a continuous-current winder motor, *H*. Coupled to the motor generator is a suitable flywheel, *F*, designed to take care of the peak loads. The fields of the hoist motor and generator are excited separately by a small exciter, *E*, mounted on an extension of the motor generator shaft. A voltage regulator, *VR*, is provided for automatically maintaining the exciter voltage constant when the speed of the set varies. The speed of the motor-generator set is controlled by means of an automatic slip regulator, *SR*, operated by the line current.

When the load on the induction motor exceeds the mean value for which the slip regulator has been adjusted, resistance is automatically introduced into the rotor circuit of the induction motor, so as to cause a reduction of speed, thus enabling the flywheel to give out some of the energy stored in it, and thereby assisting the motor *M* to drive the generator *D*. The speed is automatically reduced so as to maintain constant input to the three-phase motor until the flywheel has given out all the energy required in excess of the mean value. When the load falls below this mean value the regulator cuts out the resistance in the rotor circuit causing the set to increase in speed, thus storing energy in the flywheel, and keeping the demand on the line constant.

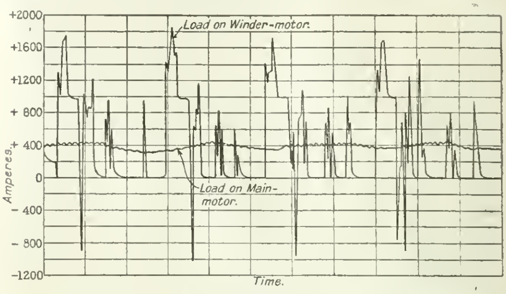


Fig. 6.—Current Curves of Electrically-driven Mine Hoist.

From the foregoing it will be seen that the whole of the power used by the winder is transformed, whereas in the flywheel-generator set the equaliser only furnishes energy for the peak loads. On the other hand, with the motor-generator set, when there is only one motor, the control arrangements are of a simple character, and there are no rheostatic losses at starting. The use of resistance in the rotor circuit of the induction motor introduces a certain loss which will average half the slip between maximum and minimum speeds, but, as a rule, this loss is small in comparison with the output of the plant.

The large fluctuation which takes place on the winder motor, and the correspondingly small fluctuation on the power system when equalised in this manner is shown in Fig. 6. These curves were taken at the test, in 1902, which was made on the first electric winder to be equalised on this system. From the diagram it will be noticed that although the current taken by the winder-motor varied between +1,850 amperes and −1,000 amperes, the current input to the main motor was held practically constant at 400 amperes.

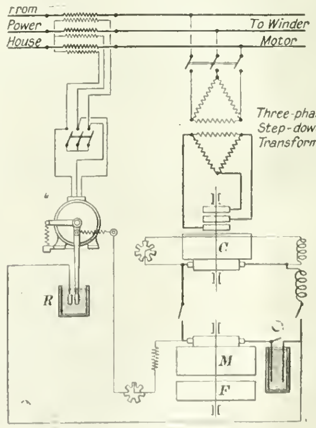


Fig. 7.—Converter Load-equaliser.

Converter System.—Another system of importance, suitable for alternating current, is that known as the converter system, the principle of which is entirely different from that of the motor-generator equaliser described above.

Fig. 7 shows the connections of the converter system as applied to three-phase hoisting equipments. The hoist motor is of the induction type, with a wound rotor, and is started by means of a liquid rheostat in the rotor circuit. In order to equalise the demand on the line the equalising set is connected in parallel with the generating station. It consists of a rotary converter, *C*, and a continuous-current machine, *M*, to which is coupled a suitable flywheel, *F*. The operation is as follows :—

The rotary converter acts only as a connecting link between the alternating-current system and the equalising set. The shunt-wound field of the machine *M* is controlled by a regulator, R, operated by the main line current. At the beginning of a trip the flywheel is running at full speed, and when the load exceeds the mean value the regulator automatically strengthens the field of the equalising machine, so that it acts as a generator driven by the flywheel. The amount of energy given to the rotary converter and thence to the line will depend on the requirements in excess of the mean, as the regulator will continue to cut out resistance as long as there is any tendency for the line current to increase above the mean.

When the demand drops below the average the regulator will weaken the field, causing the equalising machine to run as a motor, which taking energy from the line through the rotary converter, speeds up the flywheel. The rate at which resistance is introduced into the field circuit depends on the difference between the demand on the line and the mean load. In this way energy is stored in the flywheel, and the line load is kept constant. The rotary converter charges either continuous current into alternating current or *vice versa*, depending on whether the flywheel set is giving out or absorbing energy. It will be seen that the speed variation is obtained by field regulation, so that the loss is negligible. A relatively high speed reduction can thus be economically obtained and the weight of the flywheel is thereby reduced. The machines of the equalising set need only be large enough to deal with the loads which exceed the mean value, and as a rule the capacity will not be more than about one-half that of a motor-generator set for the same duty. Since the equalising equipment is independent of the hoisting motor, it can be out of service and the only difference will be that the peak loads will come on the line.

SPRINGS.*

BY C. E. SQUIRE.

A spring can be made from many different materials; steel, bronze and indiarubber being those generally used. It can be made in many different forms, and be used for many purposes, but there are six principal kinds :—

1. *Cylindrical or conical helical springs subject to axial loading*, the material being mainly subject to torsional stress. This is the form that has the widest application; it is used largely on railways and tramways; for many kinds of valves and a variety of engineering purposes; for upholstery, *e.g.*, sofas and mattresses; and also the form generally used in measuring instruments, such as spring balances

2. *Cylindrical helical springs subject to torque about the axis*, in which the material is subject to bending. This form is not much used, but as examples there are balance springs of best chronometers, springs in tumbler switches, and the motive power of spring roller blinds and some cheap mechanical toys.

3. *Flat spiral springs subject to torque about the axis*, the material being subject to bending, such as are used for watch and clock main and balance springs. It is the form generally used where it is required to store energy, *e.g.*, gramophone motors.

4. *One or more straight or curved pieces subject to bending*, used in a great variety of cases, *e.g.*, railway and road vehicle springs, and generally where it is required to absorb shock; many kinds of instruments, such as the small springs in firearms, pocket knives, latches and locks, and many other uses; in fact, class (4) with class (1) include the great bulk of springs used.

5. *Indiarubber springs, generally subject to compression, but sometimes to tension.*

6. *Gases in closed vessels*, such as pneumatic tyres and the chambers on pumps.

Springiness comes into all sorts of problems. According to the definition of Prof. Perry: "Any contrivance that can store energy as strain energy and give it out again readily is a spring."

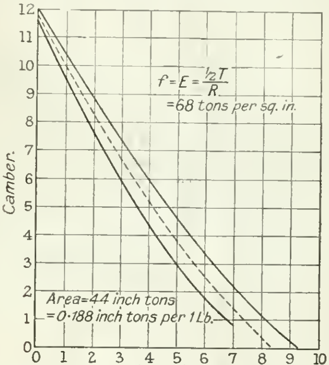
Steel was introduced for the springs of crossbows about the tenth century, and the wheel lock was invented in Nuremberg in 1517.

Nuremberg was also the place where the next step was made in the invention of watches at the end of the fifteenth century. It was in connection with watches that the first scientific work on springs of which there is any record was done. Robert Hooke, who first formulated the law we know as Hooke's Law, in his work, "De Potentia Restitutiva" (London, 1678), says that he first found out the theory of springs 18 years before, but did not publish it because he wanted to obtain a patent.

The first record of the use of springs on railways is George Stephenson's patent of September, 1816. The first locomotive with steel springs was the "Agenoria," built by Foster & Rastrick in 1820, and now in South Kensington Museum. This had laminated springs on the leading wheels. By 1830 the use of springs had become fairly general.

In the manufacture of laminated springs the rolled bars are first cut to length, then generally, but not always, the spring plate is "speared" (*i.e.*, the corners are cut off) and nibbed and slitted (*i.e.*, a little stud or nib is pressed into the plate fairly near the end which fits into the slit in the next plate, so as to prevent relative movement sideways of the ends of the plates and a hole or stud put in the centre.

As the greatest bending moment is at the centre, the method of fastening the spring together is rather important. The usual way is to put a rivet right through the centre and through the buckle. This is quite satisfactory, as the buckle is generally not less than 3 in. wide, and is pressed on hot, and so makes up for the loss of strength by the rivet holes in the centre of the spring plate. It is essential that the holes, whether drilled or punched, should be kept as small as possible—say, $\frac{1}{16}$ in. less in diameter than the thickness of the plate. To reduce the effective section of the plate at the centre as little as possible the rivet hole is sometimes made $\frac{3}{4}$ in. by $\frac{1}{4}$ in. lengthways of the plate, and another method is to nib the plate, the nib fitting into a corresponding depression in the next plate and to fasten the buckle centrally by a set screw, but it is questionable whether either are worth the cost.



STANDARD BUFFING SPRING 5′ 10½″ LONG STRAIGHT 14 PLATES 3″ × ½″ 234 LB. WEIGHT.

Sometimes the plates are of varying thickness, but generally this is not economical, as it reduces the range of the spring to that suitable for the thickest plate, and one is not so certain of getting a uniform working stress in all the plates. It is better to have one thickness only, except in special cases, and even then it is very rarely that a difference of more than $\frac{1}{16}$ in. should be used.

The plates are next heated and bent to the required curvature and hardened. The old way is to bend the longest plate by hand work to fit a cambered plate, which is used as a sort of templet or jig. This back is then hardened and tempered, and the second plate bent to fit the back plate, and so on. No matter how much care is exercised in bending and hardening, there is always a certain amount of warping in the hardening which has to be corrected by hand fitting afterwards.

The tempering is done in a furnace, the operator withdrawing the plate from time to time to judge the temperature. He does this by rubbing a piece of hard wood on it, which smokes when the plate is about 550° F. At about 650° F. it leaves a number of bright particles on the plate which burn without flame, "sparkle," as it is called, and at about 800° F. the wood bursts into flame. It seems rather a crude way, but it is surprising what skill and accuracy the men attain by constant practice. A second method is to bend the plates in bending rolls one at a time, and a third to bend all the plates for one spring together at one time between dies under a hydraulic press and to harden them at the same heat, which can, of course, be done in the rolling process also. In both these cases the tempering and hand fitting follow as in the first method.

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* Abstract of Paper read before the Junior Institution of Engineers.

Perry says: "I think carriage spring makers and buyers are too particular in their wishing to have all the plates lying very tightly together when bolted up. There is too much of such tightness. Usually, too, in actual use a carriage spring never becomes unloaded, and its plates are, therefore, much more tightly pressed together than when the spring is examined unloaded." He further indicates how the amount of regulation may be calculated so as to obtain a uniform stress in all the plates.

Every spring is tested under a steam scragg to about twice its working deflection, where possible, and about 3 per cent. tried for deflection under load, in a compression testing machine.

The springs are taken apart and the plates painted, and then an iron buckle put on hot and closed up with a press.

Coil springs are of two main types, helical and volute. Helical springs are made of either circular or rectangular section, and it should be remembered that a section of bar that is to be rectangular after coiling, will not be rectangular before. The shape of the rolled bar not only varies with the shape of the finished section, but also with the diameter of the mandrel on which it is coiled. As a very large number of shapes have to be rolled the cost is generally more than for the round bar.

After coiling, the ends of the spring are trimmed up by a smith, and it is then "set up," *i.e.*, pulled out to the proper height for hardening. It can sometimes be coiled at the proper pitch, but generally the pitch is so steep that there is a great tendency for the section to lay over on its side. The spring is then hardened in whale oil and tempered in a bath of molten lead and then scragged. The ends are ground up square with axis, and it passes much the same inspection as a laminated spring.

Testing.—Sometimes a spring is given 100 severe blows, taking it through its whole, or nearly its whole, range. This test is directly opposed to the principles set up by the researches of Wohler, Baker and others, and the only information it gives is that the spring has stood 100 blows, but it does not make one any more certain that it will not break at the 101st; in fact, rather the reverse.

The author is convinced that to press a spring home smartly two or three times is quite effective in bringing to light any latent defects and that further testing shortens the life of the spring and is detrimental, especially where the spring is of indifferent design. To make a good spring three things are necessary—good design, good material and good workmanship. As far as the last two are concerned, Sheffield can more than hold its own with all competitors, but it is a question whether we are not rather behind on design. It would be impossible to fix the responsibility for this, but if engineers spent one-tenth of the money they pay for checking the material and workmanship in checking the design, the results would more than justify it.

Characteristics of Spring Steel.—The following table shows the properties of the spring steel generally used for railway work. The figures are not for any particular test-piece, but are the average of some hundreds of tests of steel by several different makers.

Characteristics of Spring Steel.

	Laminated springs.		Coil springs.	
Analysis—				
Carbon	0·60	0·45	1·0	0·8
Silicon	0·08	0·10	0·05	0·09
Sulphur	0·029	0·050	0·029	0·050
Phosphorus	0·031	0·051	0·031	0·051
Manganese	0·63	0·87	0·60	0·8
	As rolled.	Hardening and tempering.	As rolled.	Hardening and tempering.
Tensile Test—				
Max. stress, tons per sq. in.	46	81	59	—
Elastic limit, tons per sq. in.	30	75	-	—
Elongation, per cent. in 8 in.	17	4	9	—
Reduction of area, per cent.	42	12	11	—
Modulus E	13,500 tons per sq. in.			
Torsion Test—				
Max. limit stress, tons per sq. in.	—	—	—	70
Elastic limit, tons per sq. in.	—	—	—	43
Modulus N	5,000 tons per sq. in.			

The two analyses show steels that correspond with the two British Standard Specifications. There is not much difference between the physical properties of the two grades, but springs made from the purer material should have a longer life.

Unwin gives 3 as a factor of safety for material subject to static loads; 5 when subject to fluctuating stress; and 12 when subject to shock. Taking 5 as the lowest we can use for such purposes as springs, and assuming that it refers to the working stress, the working stress for coil springs would be 14 tons per square inch and the proof stress about 28 tons per square inch, or in very exceptional cases it might be as high as 42 tons per square inch.

In practice the stresses are much higher, and there is a variety of opinion as to what really is the maximum safe stress. Some authorities adopt a uniform stress for all sizes of bars, while others decrease the stress for the larger bars. The author thinks the latter is correct, and for this reason. Hardening very much alters the strength of the steel, and depending as it does on the rate of cooling, a difference of seconds in hardening makes a great difference in the strength of the material. It is obvious that a large bar will not cool so quickly as a small one, and, what is of more importance, will not cool so uniformly. So the final material is not homogeneous, and has a less average strength.

Stresses.—This difference in rate of cooling is most marked in the case of volute springs. The inner coils are almost completely shielded from the hardening medium, and in practice the author finds that for satisfactory working a volute spring should always have a lower stress than a similar helical spring due to this cause.

Actually the stress is generally in the neighbourhood of 50 tons per square inch, but one is often asked for springs in which the stress works out to 60 or 65 tons per square inch, and a few weeks ago an inquiry was received for a spring in which the stress would have been 140 tons per square inch.

The stresses are worked out in much the same way as for a beam or a shaft, but all the theory of design is based on the assumption that the elastic limit is not exceeded, and yet the very first thing the spring maker does to the completed spring is to give it a very considerable permanent set, *i.e.*, he exceeds the elastic limit.

In a bar subject to bending or torsion the stress is not evenly distributed and is zero at the neutral axis, so that all the fibres do not reach the maximum stress at the same time. When some of them reach the limit, set takes place accompanied by a new distribution of stress, so that a larger number of fibres are now subject to maximum stress. One can calculate the dimensions, loads and deflections with a greater degree of accuracy than one can make the spring. When a material is stressed slightly beyond its elastic limit, a new and higher limit is formed, as in wire drawing, and the same thing occurs with springs, in a way one might say that one then starts afresh.

In calculating the stress we use the deflection of the finished spring only, and not the total initial deflection, and in spite of the theory being more or less incomplete, the stresses obtained really do approximately represent the actual ones, and in any case do so relatively.

Energy Diagrams.—The results of the deflection tests can be plotted to scale, and Fig. 1 shows results of a test of the buffing spring in an English goods wagon. In a laminated or volute spring there is a certain amount of internal friction, due to the relative movement of the plates. This makes the total deflection less for an increasing load than for a decreasing load—*i.e.*, the increasing load is represented by the upper line and decreasing loads by the lower one. Under a given load, say, 5 tons, the camber of the spring may be anything from 3 in. to 4½ in. The dotted centre line represents the true restoring force of the spring. It will be remembered that the defiintion of a spring is "a contrivance for storing energy." Just as an indicator diagram represents the energy given out by the steam in one stroke of the piston, so the area of this diagram represents to scale the amount of energy stored in the spring, and in this case is 44 in. tons. To make comparisons between springs one wants to bring the results to a common denominator, and to do this one finds out the work stored per unit of spring. The units used by the author are inch tons of work per lb. of spring, and this is the "resilience" of the spring. The term resilience is often used in a very loose sort of way, but it has a definite meaning. It is the amount of work that can be stored per unit volume, and in the case of springs the resilience is the direct measure of the efficiency of the spring. The value of a spring in minimising shock depends directly on its power to store energy. It is seldom possible to use a spring large enough to take up the whole energy of a moving vehicle, and the balance is expended in shock.

Limits in Manufacturing.—There is no need for the author to urge the importance of fixing limits in manufacturing. The use of limit gauges is well known, and their advantages obvious. In considering railway springs, however, it should be remembered that it is a black job, and the limits should be those suitable for smiths' work and not those for the machine shop. Engineers are sometimes a little unreasonable on this point.

A spring is, of its very nature, flexible, and it is impossible to get the same degree of accuracy as with a rigid body. If left unloaded, it will recover part of its initial set, especially if subjected to shocks, such as it will get in transit from the maker's works. A coil spring also increases in diameter when compressed, and clearances should allow for this. The common clause in specifications limiting the total variation in length to $\frac{1}{8}$ in. for all kinds of springs, is not practicable. The manufacturer can often work well inside this, but there are cases when he would have trouble, even if given three times the amount.

Generally speaking, spring makers have now reached the greatest accuracy at present commercially possible, and it is the rolling mill which fixes the limit. If the dimensions of spring bars are within 2 per cent., it is good average rolling. In this the author is not speaking of odd samples, but hard and fast limits within which one can guarantee to work month after month.

What is a fair tolerance for springs? While it is not possible to give a figure that will apply in every single instance, a total variation on any dimension of 3 per cent. covers most cases, and is a reasonable figure for good average work. The clause relating to scragging strokes in the British Standard Specification No. 24 for laminated springs limits the amount of deflection, and consequently the stress, and has had a very good influence on the design and tests of laminated springs. Nothing of the kind is specified for coil springs, and springs are regularly made to inferior designs in which the stress is excessive, and subjected to tests that materially reduce their life.

Proposed Standard "Scragging" Clause for Coil Springs.—The natural question is, cannot a clause be devised to effect the same end as that for the laminated springs? In the author's opinion it can, and he would suggest the following as a basis for discussion.

In place of existing clause 4, specification 7 and 7A, which is never fully carried out, substitute:—

"Each spring shall be tested by being deflected smartly twice by a steam scragg. The amount of deflection should not exceed $W \times K/L$, where W is the weight of the spring in lb., less the weight of one coil. L is the maximum load in tons corresponding to the deflection, and $K=1{\cdot}1$ for compression springs made of circular section, and 0·6 for all other sections. They must then, if required, stand being deflected again three times in quick succession without showing any permanent set. Springs shall also be tested under varying loads to determine the range and deflection per ton."

This clause would limit the proof stress to about 58 tons per square inch. It has been simplified as much as possible and consequently is not absolutely accurate, but it is sufficiently so for the purpose.

It is not suggested that 58 tons per square inch is the ideal figure for the maximum proof stress, but is probably the lowest that would have any possibility of general acceptance in view of many existing standard designs.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(Continued from page 586.)

XIX. EFFECT OF COMPOUNDING ON LOAD IN ARMATURES OF ROTARY BALANCERS.

In Fig. 22, a set of curves is shown connecting values of C_5 and C_6, for certain values of B, with the corresponding value of C_3; it is really a summary of one part of Figs. 14, 15, 16, and 17. The four values of B chosen are again $+1/10$, 0, $-1/10$ and $-1/5$, and the figure shows how the value of A must vary with C_3 in order to maintain these conditions. When A is great, the compounding is bad, and vice versa, but, on the contrary, the nearer A is to unity, the more nearly equal are C_5 and C_6. That is to say, in a set designed for level compounding or over compounding, C_6 is always greater than C_5, and the proportional difference increases with increase of load. Therefore, in the case of a heavy overload or a short circuit, the armature carrying C_6 tends to become very much more overloaded than the other. The very fact of the field being weakened makes armature reaction all the more serious a trouble, and there is very great danger in extreme cases of a flash over, or other serious commutator trouble. Fig. 22 shows graphically the important fact that, when $B=-1/5$, that is, when A is always unity, C_5 and C_6 remain equal to each other and the two fields are of equal strength, so that both machines are equally able, or the opposite, to stand up to the overload, and one is not overtaxed compared with the other. In practice A can be made unity by cutting out any series winding which there may be on the fields, and, further, by disconnecting the middle point of the shunt windings altogether from the middle wire, so as to excite both fields from exactly the same number of ampere turns. Even if the middle wire be not disconnected, cutting out the series windings has the effect of bringing A nearer to unity than before, and so of making C_6 more nearly equal to C_5 and saving the situation to a certain extent, at the sacrifice, for the time being, of good compounding of the system. But there is a further advantage in increasing A in emergency; curves of R_3 are shown in Fig. 22 for the four values of B, indicating what value R_3 must have, as B changes, to get a given value of C_3 with the value of V_3 then existing. $R_3=V/C_3+BV/100$, and, therefore, for a given value of C_3, two curves of R_3, for $B=B'$ and B'' respectively, are separated vertically by a distance $(B'-B'')V/100$, which means, in Fig. 22, that since $B'-B''$ is always 0·10 for adjacent curves, each curve is vertically above the one below it, throughout its length, by 0·25 ohms. This means, further, that for a given value of R_3, C_3 actually diminishes as A is increased, since V_3 diminishes and $C_3=V_3/R_3$. Not only, then, does an increase in A make C_5 and C_6 more nearly equal to each other, but it actually diminishes the total amount of current flowing, and so, for a double reason, makes the balancer more able to work under difficult conditions. This point becomes important during the consideration of the actual production of flux.

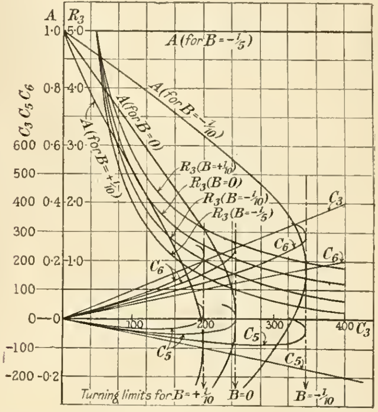

FIG. 22.—CURVES OF A AND R_3 AND C_5 AND C_6 DEPENDENT ON B AND C_3.

The figure also shows, conversely, what values the compounding will have, as C_3 alters, should A not remain on the curve corresponding to a constant value of B. It is possible, by suitable choice of field windings, to maintain B practically constant over a comparatively long range of C_3, but eventually a point comes when the change in the field conditions, with the new value of C_3, no longer gives the correct flux ratio for maintaining the specified value of B. Fig. 22 gives an approximate idea of the new value of B under these conditions; as only four curves are plotted, it is not possible to say very exactly what the value is when the curves are far apart.

Fig. 23 deals with the same set of variables in a somewhat different form. It has a scale of C_3 at the top of the chart and one of R_3 at the bottom, C_3 diminishing as R_3 increases. There is a scale of A from zero to unity at the left-hand side, and four curves of A are drawn for the same values of B as previously. These are, in the first instance, plotted against R_3 in rectangular co-ordinates; but, in addition, lines are drawn across these four curves, so that reference may also be made to the values of C_3 corresponding to those of R_3. The curve for $B=-1/5$ is a straight line through $A=1$, and coincides with the axis chosen for C_3; the others have varying values of A for varying values of C_3 or R_3. The cross lines, which are very nearly, but not quite, straight, cut the four curves at distances apart, on the R_3 scale, of 0·25 ohms for any given value of C_3. The curves of A are not related to C_3 by rectangular co-ordinates, but by co-ordinates inclined to each other at a varying angle as C_3 changes, the angle being indicated each time by the nearest lines cutting across the four curves, if the point in question is not actually on one of these lines.

For example, $R_3=4\frac{1}{2}$ ohms corresponds to the point vertically above it on the C_3 scale—namely, 50 amperes—only for the condition $B=-1/5$, as then $q=-1/10$, $V_3=225$ volts and $C_3=225/4·5=50$ amperes. The same value of R_3, if applied to a circuit where $B=+1/10$, corresponds to a point, on the curve for this value of B, having $A=0·7$, and to get the corresponding value of C_3 a direction must be taken from this point practically parallel to the inclined line through $C_3=60$, indicating that C_3 is about 58 or 59 amperes. Thus the points where the inclined lines cut the curves are a scale of amperes marked off along the course of the curves, the correct point being obtained in every case by reading vertically up from the R_3 scale to the curve having the desired value of B. As the working range of the set is probably up to about 100 amperes, the four curves drawn are flat enough to allow reasonably correct interpolation for other values of B than those chosen, and the figure gives a fairly complete account of the behaviour of the set.

Suppose it is desired to overcompound the system up to 265 volts with $C_3=80$ amperes. Then the overcompounding is 15 volts or 6 per cent., so that $q=+6$, and $B=+6/80=+0·075$, which is three-quarters of the distance between $B=0$ and $B=+0·10$. R_3 for $B=0$ is 3·10, and for $B=+0·10$ is 3·35, and for $B=0·075$ its value is exactly three-quarters of the distance between 3·10 and 3·35, since $R_3=V/C_3+BV/100$. Hence the value of R_3 is $3·1+0·75\times0·25=3·29$ ohms, which, on the 80 ampere line gives $A=0·63$. This is the most exact way of interpolating, because the relation of R_3 to B, for a given C_3, is a straight line one. Conversely, for a given value of A, the resultant value of the compounding can be discovered for any given value of R_3 or C_3. $R_3=3$ ohms and $A=0·80$ gives 80 amperes for C_3 and $-1/20$ for B so that $q=BC_3=-4$ per cent., and the value of V_3 is 96 per cent. of 250=240 volts.

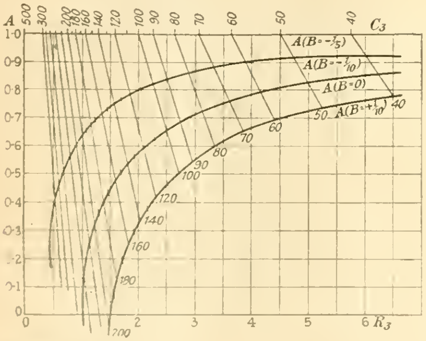

FIG. 23.—CURVES CONNECTING A, C_3 and R_3 FOR VARIOUS VALUES OF B.

As R_3 becomes small the curves become crowded, so that this diagram is not suitable for a determination of the conditions on short circuit; but these have already been fully discussed from a more convenient point of view.

It is naturally not suggested that it would be profitable to prepare a series of curves such as have been discussed for each set that has to be designed; but the full consideration of one numerical example in connection with the various processes which take place, has been useful in giving a typical instance of what happens under all conceivable conditions, and the necessary points for any specified case that happens to occur in practice can be taken out of the more elaborate treatment which has been necessary to cover the complete theory of the action of balancers. The precise shape of the various curves will be affected by the relation between the various constants of the circuit; but the results obtained from the consideration of a set with the values shown in Fig. 13 give a qualitatively correct impression of what happens, even though quantitatively they apply only to one hypothetical, and in some respects rather exaggerated, case.

XX. TYPES OF FIELD WINDINGS FOR ROTARY BALANCERS.

In what has already been said, the interdependence of the various parts of the circuit has been fully treated except in one particular, namely, that of the actual values of the fluxes on the two sides of the system. It has been shown that, with $2V$, R, C and e_0 known, C_3 as an independent variable determines, when B (and therefore q) is specified, a set of values for all the other variables, V_3 and V_4, R_3, A, e_3 and e_4, C_5 and C_6, C_1 and C_2, and φ_4/φ_3, the last-named ratio being the same as A, or e_4/e_3. But while e_3 and e_4 are definitely determinable in terms of other quantities, φ_3 and φ_4 are not similarly determinable, because so long as their ratio remains right their actual values do not matter in regard to the balance of the system. For, if φ_3 and φ_4 be changed, keeping their ratio unchanged, e_3 and e_4 will change, and this will upset the torque balance of the set, causing change of speed of such an amount as will bring back the old values of e_3 and e_4, because only with one definite pair of individual values of e_3 and e_4 for a given value of the ratio e_4/e_3 will the system be stable. If, for instance, each flux be reduced to 80 per cent. of its old value, A is unchanged, and e_4/e_3 is unchanged; but this will not satisfy the condition for stability, because e_4 and e_3 will only be 80 per cent. of what they were, and hence C_5 and C_6 will be different from what they were. If, as usually happens in a practical case, e_3, C_5 is a generating system, and e_4, C_6 is a motoring system, a decrease of e_3 will decrease C_5, while a corresponding decrease of e_4 will allow C_6 to increase. Hence $e_3\,C_5$ is no longer equal to $e_4\,C_6$, and the system adjusts itself under the influence of the unbalanced torque. The same general kind of change will take place even if e_3, C_5 and e_4, C_6 are not generating and motoring systems respectively, but have some other relation to each other involving balanced torques. Now V_3 and V_4 are fixed when q is fixed, and q depends only on A, in addition to fixed quantities in the system; hence, since A is unchanged, V_3 and V_4 must remain the same when stability is restored; but C_5 and C_6 must also remain the same, since V_3 and R_3 are fixed, fixing C_3, to which C_5 and C_6 are related through the unchanged A only. Hence, since $e_3=V_3-CR-C_5R$ and $e_4=V_4+CR-C_6R$, e_3 and e_4 are fixed in value for stability of the system, and the speed of the set will rise 25 per cent., since $1/0·80=1·25$. This corresponds with what has already been said, namely, that the speed depends on $\varphi_0/(\varphi_3+\varphi_4)$. If φ_3 and φ_4 are changed in some other way, so that A is changed also, the speed will still adjust itself until two new values of e_3 and e_4 are reached such that the conditions of stability consistent with the new value of A are reached, and the necessary speed change will take place to produce these actual values of e_3 and e_4, the ratio of e_4 to e_3 having already been fixed by the new value of $\varphi_4/\varphi_3=A$. The interdependence of all these quantities should now be abundantly clear, as should also the fact that the fixing of certain quantities in the system is sufficient to fix the others in dependence on them in a completely definite way.

There is, then, only one solution of the problem for each set of variables as far as the external circuit is concerned; that is, the fixing of A for a given value of R_3 really fixes everything else. But for the balancer itself, in regard to its speed, there is an infinite number of solutions of the same problem, because only the ratio, and not the individual values, of φ_3 and φ_4 need be fixed. The speed of the set does not concern the external circuit at all, as all that is demanded there is certain relations between V_3 and V_4; hence really the infinity of possible solutions of the problem are all perfectly legitimate, and are, in fact, producible in a pure shunt-wound hand-regulated balancer set, because the attendant watches only V_3 and V_4, as shown on voltmeters, and may thus arrive at the necessary value of A in a multitude of different ways.

In actual practice, balancers are so designed that they automatically produce correct values of V_3 and V_4 by causing the dependent variable C_3 to act, through series field winding, on the field ampere-turns in such a way as to produce for each value of C_3 or R_3 the value of A required to give the specified value of B. Each machine has a shunt winding occupying the greater part of the field coils; and, in fact, early balancers were pure shunt-wound machines. A consideration of the action of a shunt-wound set forms a suitable preliminary to the discussion of a compound-wound set. Fig. 24 shows in (*a*), (*b*) and (*c*) three possible arrangements of shunt windings. In the case of (*a*), each winding is excited from the voltage on that side of the system on which its own armature is working. When C_3 is switched on, say with a positive value, C_5, as usual, passes through its armature in a generating direction, to allow which to occur the general current distribution in the system must be such that either e_3 must rise or V_3 must drop. There is nothing to tend to make e_3 rise, but rather the opposite. V_3 falls, reducing the excitation which produces φ_3, and at the same time V_4 rises, increasing φ_4. This means that A is greater than unity. The system is, therefore, very much undercompounded, and the arrangement can only be regarded as a crude first approximation to correct balancing.

The second stage (*b*) is to leave the shunt windings disconnected from the middle wire altogether, and have them excited in series across $2V$, so that the ampere-turns are the same on each of them, and φ_3 and φ_4 are equal. This is the case, already frequently referred to, when e_3 and e_4 are equal always, and its characteristics are now well known. The system is still undercompounded, as $B=-1/5$ in the numerical case chosen; but C_6 and C_5 are always equal, the speed never changes, except in so far as φ_3 and φ_4 are reduced from their original value, φ_0, by armature reaction, and in the emergency of short circuit, as has been shown, this is really the most favourable connection of all for getting the machines to stand up to the overload. Owing, however, to the considerable undercompounding, which cannot be altered at all by field regulation, since A is unity under all circumstances, the arrangement would not work sufficiently well in practice for it to be adopted as a standard. The third stage (*c*) is to excite the shunt of each machine from the voltage on the opposite side of the system, so that V_3 produces φ_4 and V_4 produces φ_3. This means that the fall which is necessary in V_3 relatively to e_3 is obtained at a higher value of V_3 than before, because φ_3 has actually been increased, which increases e_3; and, similarly, the fall which is necessary in e_4 relatively to V_4 to allow the correct C_6 to pass is obtained at a lower value of V_4 than before, because e_4 is itself decreased by the decrease in φ_4. That is to say, A, being now less than unity as soon as any load comes on, makes the system more nearly level compounded than before, the value of B depending on the fixed characteristics of the machines. If, for example, the fields are well saturated, then the change in flux will be very small, and A will remain nearly unity. If, on the other hand, the fields are worked on the lower straight part of the magnetisation curve, $\varphi_4/\varphi_3=A$ will be about equal to V_3/V_4, which will give less undercompounding. Crossed shunts alone will never make the system level compounded, because level compounding implies $V_3=V_4$, which would mean $A=1$, and $A=1$ can never give $V_3=V_4$. Shunt winding alone will always give undercompounding of the system, though under favourable circumstances the amount may be so small that the set is good enough without series winding. If it is necessary to have exactly level compounding, or overcompounding, it becomes necessary to increase e_3 and lower e_4 by such amounts that V_3 and V_4 need not alter in the one case, or that V_3 must become greater than V_4 in the other case, in order to satisfy the conditions of stability. So the device is arrived at of fitting compound-wound field coils on the balancer. Such an arrangement is shown diagrammatically in Figs. 25 and 26. The series winding is arranged so that it assists the shunt winding when the corresponding armature is generating and opposes it when it is motoring. Once arranged so, everything remains correct, for when C_3 becomes negative the series ampere-turns change over from what they were before to their opposite, and consequently A passes from a value less than unity through unity to something greater, the shunts remaining excited always in the same direction. There are two methods of coupling up the series windings; that shown in Fig. 25 has each series winding carrying the whole current of the armature on the opposite side of the system, that is, the series windings carry C_2 and C_1 respectively; that shown in Fig. 26 has each series winding carrying the whole of the current in the middle wire, so that the ampere-turns of the two windings are equal, while those in Fig. 25 are unequal, because C_2 and C_1 are never equal The series windings are crossed in Fig. 25, because, in the event of heavy overload, C_1, which determines the opposing ampere-turns on the motoring side, remains much less than C_2, which determines the assisting ampere-turns on the other side. Hence φ_4 is not decreased so much as it would be if the series windings were not crossed, and there is less danger of the field vanishing altogether. This is rather more favourable than the case of Fig. 26, because in the latter both series windings have the same number of ampere-turns, so that the motor field is bound to be weakened more than it is in the case of Fig. 25. Otherwise the two arrangements are practically equivalent to each other.

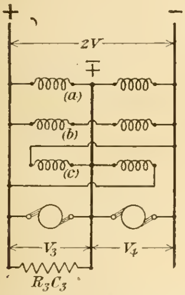

Fig. 24.—Various Arrangements of Shunt Windings for a Rotary Balancer.

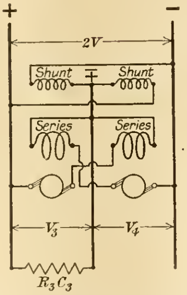

Fig. 25.—Compound-wound Rotary Balancer with Crossed Series Windings.

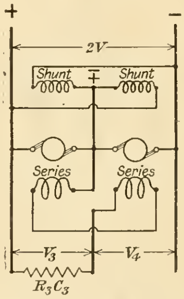

Fig. 26.—Compound-wound Rotary Balancer with Series Windings in the Middle Wire.

In level compounded systems, with $B=0$, it ought not theoretically to matter whether the shunt windings are crossed or not, but it is better in practice to cross them. The tendency is always for a level compounded system eventually to become under compounded as the load increases beyond a certain point, and when that occurs the shunts, if uncrossed, will add to the under compounding tendency, whereas, if crossed, they will not let the system down so far. Further, on an over compounded system, with B positive, owing to the lower value of A required, it is advisable to arrange to cut out the series windings on heavy overloads, in which case if the shunts are uncrossed the arrangement is the very worst possible, being the same as is shown in Fig. 24 (*a*), while, if they are crossed it remains at the much better stage shown in Fig. 24 (*c*). And if it can be arranged to disconnect the shunt windings from the middle wire altogether in case of further emergency, it does not matter whether they are crossed or not. Hence, on the whole, the safe rule is always to have the shunts crossed, even though in a system with B positive the other arrangement would actually give the required value of A more easily, and more series winding must, therefore, be used with crossed shunts in this case than with uncrossed shunts in order to pull down the value of A sufficiently. This may necessitate a somewhat larger size of machine being used, to find room for the extra winding, but reliability is, in the case of a balancer, worth a little extra initial cost, as if it should fail, tremendous damage may be done on the consumers' part of the system. Even to resort to the cutting out of series windings, except in case of absolute emergency, is bad, because it is bound to upset the compounding of the system, and will probably cause dissatisfaction on the part of some consumers, if not actual damage to their lamps. Interpoles will help greatly in cases of overload, as they will keep the commutator right, though when the overload becomes very great they may have a tendency to cause unstable running or hunting of the balancer, owing to their leakage effect on the vanishing main field, and it is then that it becomes advisable to convert the balancer temporarily into a shunt wound set. Interpoles must, as usual, always be connected directly in series with the armature on which they are acting, and are consequently not crossed.

XXI. Design of Compound-wound Fields for Rotary Balancers.

The actual process of designing the field is simple. After selecting a frame size on the basis discussed in an earlier section, the larger part of the field winding space is devoted to shunt coils, which produce by themselves the flux φ_0 in each field. Then, from the known constants and requirements of the set and system, the value of A is found for, say, full load. The value of the brush contact resistance corrresponding to the value of C_3 chosen for the calculation of A must be included in R, as otherwise the subsequent calculations, based on A, will not give exactly correct results. The values of C_1 and C_2 can be immediately calculated from C_3, when A and C are known, and a few trials will determine the number of series turns which, with C_1 and C_2 passing round them suitably, will so alter the original ampere turns as to make φ_4/φ_3 have its required value, A. If the arrangement of Fig. 26 be used, it is not necessary even to know C_1 and C_2, as C_3 produces the whole effect. If, for example, it should be found that in such a set, to deal with $C_3=40$ as normal full load, with $B=0$, the shunt ampere-turns alone are 12,000 per machine, and A has to be 0·88, then with 40 amperes in each series-winding, one adding ampere-turns to 12,000, and the other subtracting ampere-turns from it, the fluxes must be such that $\varphi_4/\varphi_3=0{\cdot}88$. The magnetisation curve of the frame being known, the following would be the process, the value of φ_0 being, say, 1 megaline per pole

Proposed series turns per machine	0	10	20	30	40	50
Series ampere-turns per machine	0	400	800	1,200	1,600	2,000
Total ampere-turns producing φ_4	12,000	11,600	11,200	10,800	10,400	10,000
Total ampere-turns producing φ_3	12,000	12,400	12,800	13,200	13,600	14,000
φ_4 (with full-load armature reaction)	0·940	0·920	0·900	0·880	0·860	0·840
φ_3 (with full-load armature reaction)	0·940	0·960	0·980	1·000	1·010	1·020
$\varphi_4/\varphi_3=A$	1·00	0·96	0·92	0·88	0·85	0·82

Therefore, 30 series turns per machine are just right, designed to carry 40 amperes at full load.

For the case of Fig. 25, suppose C is 1·5 amperes, then, as C_3 is 40 and A is 0·88, C_5 is $=40\times0{\cdot}88/1{\cdot}88=18{\cdot}7$ amperes, and C_6 is $40/1{\cdot}88=21{\cdot}3$ amperes, so that C_1 is 17·2 amperes, and C_2 is 22·8 amperes. The calculation table is then as follows:—

Proposed series turns per machine	0	20	40	60	80	100
Ampere-turns opposing, due to 17·2 amperes	0	340	690	1,030	1,380	1,720
Ampere-turns assisting, due to 22·8 amperes	0	460	910	1,370	1,820	2,280
Total ampere-turns producing φ_4	12,000	11,660	11,310	10,970	10,620	10,280
Total ampere-turns producing φ_3	12,000	12,460	12,910	13,370	13,820	14,280
φ_4 (with full-load armature reaction)	0·940	0·930	0·910	0·890	0·870	0·850
φ_3 (with full-load armature reaction)	0·940	0·960	0·980	1·000	1·020	1·030
$\varphi_4/\varphi_3=A$	1·00	0·97	0·93	0·89	0·85	0·82

Thus, rather more than 60 turns per machine are required in this case, probably about 70, to carry an average current of 20 amperes. The values 17·2 and 22·8 used above are true only for the finally used correct values of the fluxes, which means that none of the other columns in the calculation are consistent, as they correspond to a value of A which would not give 17·2 and 22·8 amperes as stable values. The method is, however, a correct one as far as its purpose goes, as it is used to discover a column of consistent values, containing the correct solution, and actually succeeds in doing so.

A set of about this size, with frames well rated up on full-load, should carry 100 per cent. overload comfortably for a few minutes, say, 80 amperes in the middle wire, and at the same time automatically keep level compounding within ½ per cent. of V throughout, without the use of any shunt regulating resistance, so that, if V be, say, 200 volts, V_3 should lie between 199 and 201 volts right up to $C_3=80$. In the above calculation only the ratio of fluxes has been considered; the actual values of the individual fluxes may be what they will, and all that happens is that the speed adjusts itself to suit. The adoption of the device of making C_3 control A has reduced the possible number of complete solutions of the problem from infinity to one, but fortunately the one can be easily determined, and speed does not matter, so long as it does not become excessive. The actual values of φ_3 and φ_4 depend on the shape of the magnetisation curve of the frame, and this is the additional factor which has now been brought in and allows the problem to have one definite complete solution.

Referring to Fig. 14, it will be seen that for B to continue to be zero, the curve of C_5 gradually bends upwards again towards zero at the turning limit, and C_6 becomes equal to C_3 nearly. Now if this were the distribution of currents in the series windings φ_3 would certainly be greater than φ_0, but φ_4 would not be appreciably less than φ_0, because the series winding would be carrying only C, which has practically no effect. Hence, instead of being zero, as it should be for B to be zero, A will have some positive value less than unity, which means that the system will have become under compounded. At what point this starts will depend upon how soon the curve of C_5 begins to turn upwards, but, as has been said, it is easily possible to get 100 per cent. overload in the middle wire with practically perfect results as regards compounding of the system, and if the interpoles and brushes were specially carefully adjusted to avoid hunting, still greater overload capacity with good compounding could probably be obtained. A similar consideration will show that a set designed for any other sort of compounding with B constant will generally not maintain that amount of compounding indefinitely, but will tend towards a lower value of B. Fig. 14 and the other similar diagrams, therefore, do not, as a whole, represent cases of automatic working; they merely show how to get a given value of B under certain circumstances by somehow making A follow a certain curve, say by using hand-regulated resistance in the shunt field circuit. In practice, B can, by careful design, be maintained constant for a long enough range to cover all ordinary loads, and the balancer works satisfactorily, therefore, in actual use.

(*To be continued.*)

FREQUENCY CHANGERS.

At the meeting of the Institution of Electrical Engineers on Thursday, the 8th inst., the following discussion took place upon Mr. R. Townend's Paper on the above subject. An abstract of the Paper will be found in our last issue :

Mr. G. W. PARTRIDGE said he was sorry the author had not referred to phase changers. Could not the distribution of the load be effected by the use of automatic regulating transformers instead of shifting the stator, which appeared to be a question of altering the inductive drop on the particular set ? The alternative method of paralleling by switching off the motor would cause a rush of current when the motor was re-connected to the circuit and in all probability damage the end coil of the stator winding. He had known that to happen. His motor generators were now switched in through a water resistance. Moving the stators might be satisfactory with small sets, but he thought it hardly practicable with very large ones. The synchronising and switching-in of the sets might be possible by means of a water resistance in the first instance, gradually bringing it into phase, and then short-circuiting it by means of an oil switch. Such apparatus could also be used for switching the set out if there was any disturbance on the two supplies which were being dealt with. He was not clear as to whether the author advocated the synchronous or the induction high-frequency changer. He said in regard to the linking-up of stations in South Wales the use of synchronous sets was undesirable, because the capacity of the stations was large. Did that mean the capacity was large compared with that of the frequency changers ? He (Mr. Partridge) thought the induction frequency changer simpler to work, though he admitted the subject of the synchronous frequency changer was more interesting. The size of the frequency changers required, and also the capacity of the different systems, would probably increase greatly, and he thought the induction frequency changer would be preferable ; there would be less danger of its falling out of step, it would be simpler to work, simpler in design and stronger mechanically. He had had a set working satisfactorily for the last six years. The particulars of this set were as follows : Capacity, 1,500 kw. ; speed, 365 revs. per min. It consisted of a three-phase induction motor with a wound rotor, having 8 poles connected to a single-phase synchronous machine, which had 28 poles. The synchronous machine was provided with a damper winding, so that it could run as a motor if necessary. Slip of motor on full load, 2½ to 3 per cent. Overall efficiency of set 86½ per cent. It was made by the Westinghouse Company, and he thought the author was the designer. It came up to the company's guarantee. Either side of the set was used to generate current. It was synchronised by running up on the induction motor, and then varying the speed of one or other of the sets of prime movers before synchronising. It normally ran with three-phase current as a motor driving the synchronous generator. This single-phase generator was provided with a Tyrrill regulator, and this one set kept the whole of the lighting system constant, no matter how many generators were synchronised with it. As soon as the switchman synchronised the steam set he had nothing further to do in regulating the systems, as the pressure was kept constant by that motor generator.

Mr. J. S. HIGHFIELD said in considering the question of linking-up one always came across the question of varying frequencies. In quite a small area there were frequencies of 90, 60, 40, 50 and 75. To link-up, some of these would have to be changed, or else frequency changers must be employed. The problem of frequency changers was not simple. It was desirable that the link should enable either station to supply the other. One of the main advantages of linking-up was to enable the plant at one station to be run at a greater load, so that the other station could be shut down for repairs, and if the supply was not reciprocal that advantage was lost. He thought linking-up two different frequencies involved the use of synchronous plant. He doubted whether the induction generator would prove very successful, and he thought that in practice a frequency changer consisting of two synchronous sets would be required. If two stations some distance apart were tied together through the shaft of the motor generator and there was any violent change—as there was sometimes in reciprocating plant—the force had to be transmitted through the shaft. With the ordinary low-speed reciprocating engine he doubted whether it could be done in commercial practice. There was the difficulty of putting the machines in step and synchronising them. It might be all right with one big unit which, once it was put in, was not taken out except when absolutely necessary, but he doubted whether it was possible to work a great number of those frequency changers tying together a number of different systems. It seemed to him odd frequencies, such as 75, 60 and, perhaps, 40, should be done away with, so that there should only be one frequency or at most two frequencies to deal with. He regarded frequency changers as a temporary expedient, except, perhaps, that with two large systems at, say, 25 and 50 frequency it would be impracticable to change the whole of one of them and in that case the frequency changer might prove of great and lasting value.

In reply to the discussion, Mr. TOWNEND said he had not referred to phase changers because he had heard another member had partly written a Paper on that subject for the present session, but he had since heard it would not be read until next session. If it was required to get a single-phase from a three-phase supply without unbalancing the three-phase system or to get a three-phase balanced supply from a single-phase system, it could not be done with transformers. There must be some rotating apparatus, because a single-phase load went from a maximum down to zero and back to a maximum, and it was a pulsating load, whereas a polyphase load was a continuous load. Care must be taken of those pulsations by means of inertia in the moving parts of the machine. When a single-phase load was taken from a polyphase system it distorted the phase relation of the polyphase system, and any polyphase motor, either synchronous or induction, connected to that system would have a balancing effect—*i.e.*, the phase of the motor connected across the high voltage phases of the system would draw more than the phase connected to the low-voltage phase of the system, and if the power taken from the high-voltage phases was in excess of the power required by the motor it would deliver power back again. It therefore worked as a balancer, and the amount of balancing it could do depended on the inductive drop in the windings. The motor having this balancing effect unbalanced its own voltages, and therefore there must be impressed on the motor a voltage of such a value and phase that it would cause this balancing current to flow in the motor or to overcome the inductive drop by this unbalanced current, and by this means a perfect balancing machine would be obtained. The synchronous motor had the advantage that it could convey the magnetising current from the line and could also be used to improve the power factor if necessary. A polyphase motor connected across the single-phase supply would operate as a transformer, and generate current in the second phase of the motor. There was a series converter, used principally for converting the whole of the power from three-phase to single-phase or vice-versa, and a shunt converter, used to bring the load back to a balanced state. The shunt converter was a three-phase motor coupled to the circuit, and in series with the stator windings was connected a booster mechanically driven by the main converter. Then the voltage and direction of voltage were added to the stator windings of the converter in such a way as to balance the load. An unbalanced three-phase load consisted of a balanced three-phase load, plus a single-phase load. When considering problems in connection with a single-phase load it was convenient to say a single-phase current could be resolved into two single-phase currents with opposite rotations. A current had to be impressed on the system having a phase rotation in the opposite direction to the normal phase rotation of the system, with a voltage of such a value and phase-angle that it would exactly neutralise the counter-rotational load. This was done with the shunt-type converter, by taking a three-phase synchronous motor, connecting it to the mains and then in series with the stator windings, and connecting a booster in which a voltage with the desired value was generated with a phase rotation opposite to the normal rotation of the 'bus bars, the phase of the impressed voltage being also dependent on the amount of out-of-balance. The voltage of the booster was obtained by separate excitation and the voltage could be changed as desired. The phase of the booster voltage could be changed by mechanically moving the stator or, as was usually done, by having two field coils in the booster, and by exciting the two fields to different values any phase displacement could be obtained on the booster. He did not think there would be magnetic leakage on the series system. With regard to Mr. Partridge's suggestions that transformers might share the load with synchronous sets, he did not see what advantage would be obtained. There would have to be choke coils run out to the transformers. When using the rotatable stator, which he (the author) thought should be fitted either to the motor or generator, the two machines might be mechanical duplicates, but a third machine had to be fitted, and it could not be made a mechanical duplicate of the two previous machines. He had seen 2,000-kw. machines fitted with rotatable stators. In some cases the rotation was controlled by a small motor controlled from the switchboard. The shock when an induction motor was switched in would be no worse than when switching the full voltage on the machine at a standstill. It was desirable, however, to build up the voltage gradually by means of a water resistance. He had seen a specification for automatic means of moving the stator continuously in either direction by means of a motor, with the object of limiting the load to a safe load for the synchronous converter, but he had not heard of such a machine being built. It would be troublesome and would involve slip-rings for what was usually a stationary part. He had never heard of magnetic coupling being used between two machines, and he did not know that it was necessary, as it was generally considered not safe to link up two systems with frequency changers of less than half the capacity of the smaller of the two systems, though he thought in many cases the frequency changer was much too big. The size of the frequency changer was not limited by the capacity of the station, but by the variation of the load on the stations. He did not think there would be a great deal of trouble in regard to paralleling the generators. The whole problem was solved if one machine was fitted with a rotatable stator. The machine was rocked back until the machines were in phase, then the stator was rocked backwards again until it took the load. The induction frequency changer had advantages in synchronising the generators, but it had a great disadvantage when it was necessary to run inverted with induction machines generating. There must be a large kilovolt-ampere capacity on the synchronising set in paralleling induction machines. There was also the drawback of change of frequency between full-load and no-load.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Depreciation and Wasting Assets and their Treatment in Computing Annual Profit and Loss." By P. D. Leake. (London : Messrs. Sir Isaac Pitman & Sons, Ltd.) Pp. xxiv.+233. 10s. 6d. net.

"Alternating Currents," by C. E. Magnusson, M.S. (London : The Hill Publishing Co., Ltd.) Pp. xv.+525. 17s. net.

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THE ABUSE OF PROSPERITY AND THE MISUSE OF MAN POWER.

Given access to a sufficiently long purse, or having well-nigh unlimited credit, an incompetent person could, for a time, gull others of greater ability into the belief that he was an exceedingly shrewd man of business. It would be possible for him to continue the deception till he had to produce his balance-sheet or to face his creditors. In exactly the same way, but with greater ease, is it possible for the statesman to claim that he possesses the business instinct to a marked degree. Incompetence in the one case means that relatively few people suffer, and in the other that the entire community suffers. It were idle to say that in the above we refer neither to a particular statesman nor to a particular country; but the gullibility of a people seems to bear a direct relation to the age of the country in which they live.

It is the prevailing fashion in a certain section of the Press to lay the blame on the shoulders of the late Government for the existing and truly awful state of affairs. With this view we have little sympathy. The foundations on which the coming victory will rest were well and truly laid two and a half years ago by a mere handful of men, directed by those who have since been hounded out of office. In those stirring times of unpreparedness mental effort triumphed over brute force, as it has triumphed on every occasion when the two have been put to the test. In our opinion, the present unenviable position is due not so much to Government as to prosperity. As a result of our prosperity we allowed ourselves to become inefficient, and faced with the possibility of less prosperous years in the near future it is now sought, by means of committees innumerable, to better the conditions. The greater the difficulty of keeping body and soul together the hardier and more efficient is the race, and we venture to think that but for the industrial prosperity during the war, which is like a curse on the country, an entirely satisfactory peace would, long since, have been arranged.

The most recent and by far the most striking example of inefficiency is that of the National Service scheme, which was launched little more than a week ago, and which is now making its trial trip. When the time comes—as it assuredly will come—for compulsory national service, the time that is now being wasted in an endeavour to raise the necessary number of workers under what is called the voluntary system will be bitterly regretted. For not only does wasted time in the present cost us considerably more than [illegible] sterling per day, but it also makes the possibility of [illegible] labour an ideal of the remote future.

Notwithstanding the fact that most of the present schemes are merely a reincarnation of older schemes not [illegible] the present ministry of all the talents affects to despise the advice and criticism that is offered by the lay press, and to ignore altogether the technical press. We agree with Mr. NEVILLE CHAMBERLAIN that the will to make a thing work is very often half the battle, but we deny that the will is in itself sufficient to ensure *efficient* working. It is of importance to the country that the National Service scheme should work, and it is at least equally important that the Scheme should work economically. The absolute necessity of quick action is the very best of reasons why any and every scheme should be well considered before putting them into practice. Ill-considered action spells Gallipoli and Mesopotamia.

That compulsory national service will have to be instituted can be shown by means of simple arithmetic. During the present conflict it has been found that from three to five workers are required for the supply of the necessaries required by every soldier. Our own troops number several millions, and a conservative estimate shows that 12 million workers are required for supplying necessaries. To this number must be added another big number to represent those whose business it is to supply necessaries to the workers. Nor is this all, for in order to wage the war the export trade of the country must be maintained. The latter imperatively demands the employment of many workers. Therefore any scheme of national service to be successful calls for workers in numbers commensurate with the number of persons at present in the country who are able to work, which means every fit person from 16 to 60 years of age. This is to provide the necessaries for our own fighting men, and to continue our export trade. In addition to our own, other troops have to be provided with necessaries, and although in the past America has been able to lighten our burden very materially, the likelihood of America having to help herself must not be overlooked.

That the skill of many of the workers in the country is not yet directed into proper channels is evident from an inspection of the goods displayed in the shops in all the large towns. It is common knowledge that there is an unparalleled boom in most non-essential trades, and the said boom will continue as long as Parliament allows non-essential goods to be manufactured, and as long as people imagine that because they have the money they have the right to spend it as they wish.

Since August, 1914, the people of the country have discovered that they are musical, and as a result pianos are at a premium. Jewellers say they "cannot complain." We take it that when a business man says he cannot complain he really means that he is doing well. Never to our knowledge have so many people (of both sexes) been seen wearing furs as during the present season. Although sugar can only be obtained with difficulty for domestic purposes, anyone having money sufficient can buy sweetstuffs by the cartload. A glance in the windows of any "fashionable" boot shop lends colour to the theory that the desire nowadays is to use a maximum amount of leather per pair of boots. Reckless extravagance is equally noticeable in the drapery and allied trades. The reader can furnish other examples by the score.

The manufacture and sale of these baubles, bearskins, butterscotch, boots, blouses and the like takes up the whole time of a vast army of workers, as well as an equally vast army to provide them with foodstuffs and with the materials required in their several trades. Instead of bringing peace nearer, every man hour thus spent delays peace by one man hour. We are glad to note that the PRIME MINISTER has prepared the country for the inevitable by saying that if the voluntary system breaks down compulsion will be necessary. This may be taken as an indication that many workers are required. In some respects we think it would have been better to state the number of workers likely to be required, and to announce daily the number of volunteers.

Nothing in the foregoing can be called destructive criticism. We have reserved this for the last, and, unfortunately, we shall have to be brief. It may be possible however, to deal with what we consider to be rational national service when it is found that compulsion is necessary.

There are parts of the Scheme which fill us with astonishment. If we understand the matter rightly, the classification is to be done by the officials in the local employment exchanges, and volunteers will be examined by these officials. It appears that provision has been made for examining elsewhere those who are averse to going to the labour exchange (we purposely give this excellent though ill-managed institution the name by which it is generally known, notwithstanding the fact that to many anything connected with labour is so common). This pandering to the whims of the public is a sign of weakness. The classification of the volunteers into trades by the very superior and, from the labour standpoint, totally incompetent and oftentimes very young officials of the labour exchange means that the work will have to be done a second time. In our opinion, the apology for the minimum wage was sadly out of place. We have yet to see the recruiting sergeant who adopts an apologetic tone to the man who risks everything for a shilling a day. What the man in the street wants to feel is that in his absence on national service his less patriotic neighbour will not be allowed to deprive him of his business, and that the State will not allow some inoffensive alien to fatten at his expense. What the engineer wants to know is: "What does Mr. NEVILLE CHAMBERLAIN mean by an engineer?" We should like to know in how many of the hundred branches of engineering are volunteers specially wanted? The machinery already exists for supplying volunteers in many of these branches. By means of this machinery, which is more stable even than the Cabinet, it will be possible quickly to find engineers qualified to fill engineering appointments, and to find real engineers to take the place of the *pseudo* engineers now in our midst.

THE PARALLEL OPERATION OF STATIC TRANSFORMERS.

BY J. LINDLEY THOMPSON, M.SC., A.M.I.E.E., AND
S. AUSTEN STIGANT, A.AM.I.E.E.

(*Concluded from page* 576.)

Summary.—The authors deal first with the aspects of voltage ratio, impedance and polarity, as affecting the operation of single phase transformers in parallel. Comparative tables are given showing the effect on loading of varying ratios of resistance and reactance and also of unequal impedances. Formulæ are given to determine the transformer current values and phase angles under these conditions. Polyphase transformers are then treated in a similar manner, but with the inclusion of a study of phase rotation. The "phasing out" of three-phase transformers is described, tables and diagrams being given which show possible voltage measurements obtainable. Results of paralleling dissimilar groups of transformers are described, and in conclusion the effects of position of junctions to 'bus bars or main cables, temperature and power factor are discussed.

POLYPHASE TRANSFORMERS.

In dealing with polyphase transformers it will be seen that the treatment of the subject of paralleling is on similar lines to that of single-phase transformers, but is necessarily extended to cover the diversity of possible connections. Before attempting to operate any two or more polyphase transformers in parallel, the internal connections should be carefully studied to ascertain whether parallel connection on both primary and secondary sides is permissible.

Fig. 4 shows the complete range of possible connections. The interconnected star-delta connection is not included, as it has no utility and no advantage over a delta-delta connection.

It will be noticed that Fig. 4 is divided up into four main sections. The pairs of connections enclosed in the left-hand upper and right hand lower sections indicate permissible internal connections for parallel operation, as their primaries and secondaries are both in phase. The pairs of connections enclosed in the left-hand lower and right-hand upper sections indicate those internal connections which are not suitable for connecting in parallel. In these cases the secondaries are all 30 deg. out of phase, as shown by the dotted lines joining the pairs of secondaries.

1. *Voltage Ratio.*

2. *Per cent. Impedance Voltage.*—These two factors have been adequately enough treated in the case of single-phase transformers and need no further attention.

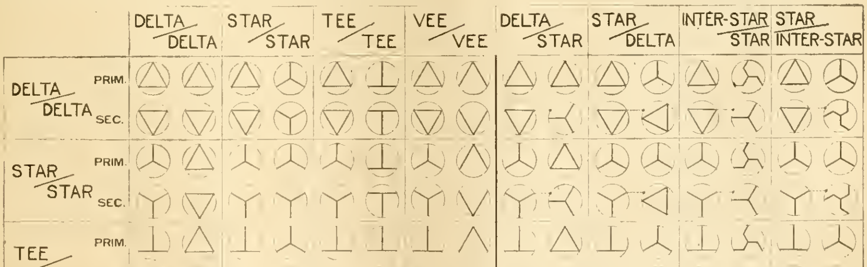


FIG. 4.

3. *Polarity.*

4. *Phase Rotation.*—As stated previously, the procedure adopted to determine the correct junction of the terminals of two or more transformers is termed "phasing out." In the case of polyphase transformers, however, it is essential that both the polarity and phase rotation of paralleled units shall be the same, so that both of these requirements come under the general term of "phasing out." A brief definition of the meaning of "phase rotation" will doubtless be of assistance. A concise definition is given by Mr. E. C. Stone in the "General Electric Review" of August, 1915, and is to the effect that "phase rotation is that angular direction which in a polyphase system represents progression of the maximum value during a sequence of time." This, of course, applies to either current or voltage and may be either in a clockwise or counter-clockwise direction. The ultimate determination of the correct polarity and phase rotation of polyphase transformers is frequently a laborious procedure and in any case is much more complex than that of single-phase transformers. This is due to the numerous possible connections, both as regards polarity and phase rotation. With care, however, the correct polarity can be accurately determined and the following remarks and diagrams indicate the methods used.

Assume that we have two three-phase transformers having the same ratios and impedances and that their internal connections correspond to one of the permissible connections given in Fig. 4. Fig. 5 shows the two transformers X and Y, and in this first case we will assume that the windings are unearthed. This being the case, the terminals of the two transformers may or may not be at the same potential above earth. In consequence they may be said to be "floating" at their own respective potentials above earth. Now, transformer X is connected across the 'bus bars on both primary and secondary sides and transformer Y is connected across the bars on the primary side. Before taking any voltage measurements it is essential to fix the potential of the two transformers to the same value above earth. This is effected by connecting one of the secondary terminals of transformer Y on to the same 'bus bar as is connected what might be thought to be the corresponding terminal of transformer X, *i.e.*, say, those lettered *D* and *D'*. Now measure the voltage across *E.E'* and *F.F'*. If the voltage measurements in both instances are zero, the transformers are of the same polarity and phase rotation and may be permanently connected across similar 'bus bars. If, however, the voltages measured across *E.E'* and *F.F'* are twice the normal line voltage then the transformers are of opposite polarity, but have the same phase rotation and paralleling is impossible with their present connections. In order to obviate the necessity for writing out any further all the possible voltages obtainable across various terminals, a detailed summary is given in Figs. 6 to 13 inclusive together with Table III. With this Table in mind and also referring to the concise key included, the following is the procedure usually adopted in order to "phase out" when paralleling transformers of dissimilar manufacture. Referring again to Fig. 5, the transformers have their leads connected as shown and described above. The voltage measurements across *E.E'*, *F.F'*, *E.F'* and *F.E'* should be made. These four values will correspond to one or other of the various conditions of Table III. As a case in point let these various voltage measurements be—

Across $E.E' = 1{\cdot}73$ line voltage.
$F.F' = 1{\cdot}73$ line voltage.
$E.F' = 2{\cdot}00$ line voltage.
$F.E' = 2{\cdot}00$ line voltage.

These measurements will agree then with Fig. 7B, and from the diagram it will be seen that the two transformers are of opposite polarity, opposite phase rotation, and have like terminals bridged. In order to bring these two transformers into line it is necessary to reverse the internal connection of either the primary or secondary windings of transformer Y and interchange the lettering *E'* and *F'*. Having made these altera-

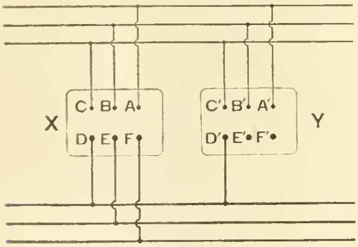
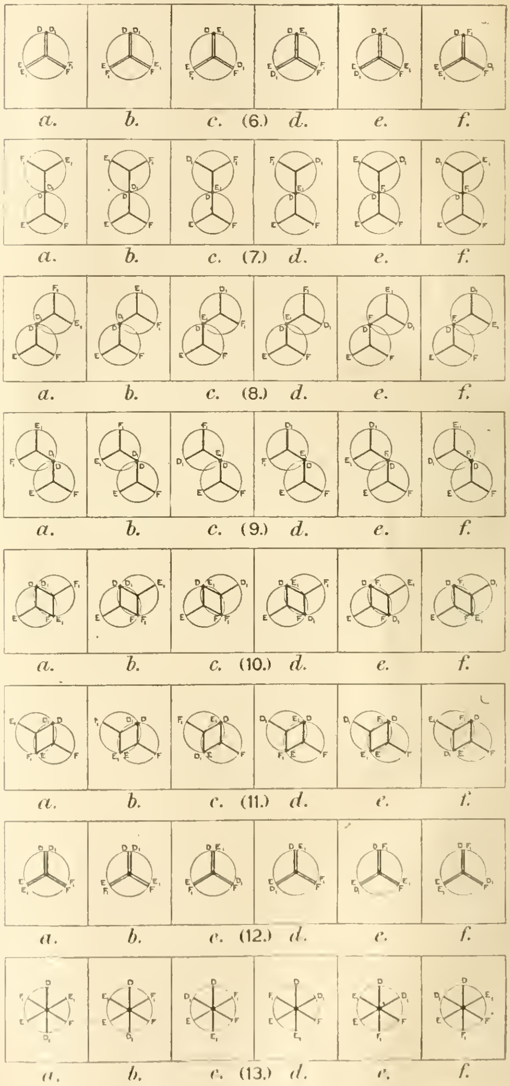


FIG. 5.



FIGS. 6, 7, 8, 9, 10, 11, 12 AND 13.

Table III.—*Possible Voltage Measurements, Phase Rotation, and Polarity Conditions when Paralleling two Three-Phase Transformers of Similar Internal Characteristics.*

Volts across terminals.				Phase rotation.		Polarity.		Phases bridged.		Fig. No.
Trans. X	Trans. Y.			Cor-rect.	Re-versed.	Cor-rect.	Rev.	Like	Un-like.	
	D′	*E′*	*F′*							
E	...	O	V	Yes	...	Yes	...	Yes	...	6*a*
F	...	V	O							
E	...	V	O	...	Yes	,,	...	,,	...	*b*
F	...	O	V							
E	V	...	O	Yes	...	,,	...	,,	...	*c*
F	O	...	V							
E	O	...	V	...	Yes	,,	...	,,	...	*d*
F	V	...	O							
E	O	V	...	Yes	...	,,	...	,,	...	*e*
F	V	O	...							
E	V	O	...	...	Yes	,,	...	,,	...	*f*
F	O	V	...							
E	...	2V	1·73V	Yes	...	...	Yes	Yes	...	7*a*
F	...	1·73V	2V							
E	...	1·73V	2V	...	Yes	...	,,	,,	...	*b*
F	...	2V	1·73V							
E	1·73V	...	2V	Yes	...	...	,,	,,	...	*c*
F	2V	...	1·73V							
E	2V	...	1·73V	...	Yes	...	,,	,,	...	*d*
F	1·73V	...	2V							
E	2V	1·73V	...	Yes	...	...	,,	,,	...	*e*
F	1·73V	2V	...							
E	1·73V	2V	...	...	Yes	...	,,	,,	...	*f*
F	2V	1·73V	...							
E	...	1·73V	2V	Yes	...	Yes	...	...	Yes	8*a*
F	...	V	1·73V							
E	...	2V	1·73V	...	Yes	,,	...	...	,,	*b*
F	...	1·73V	V							
E	2V	...	1·73V	Yes	...	,,	...	...	,,	*c*
F	1·73V	...	V							
E	1·73V	...	2V	...	Yes	,,	...	...	,,	*d*
F	V	...	1·73V							
E	1·73V	2V	...	Yes	...	,,	...	...	,,	*e*
F	V	1·73V	...							
E	2V	1·73V	...	...	Yes	,,	...	...	,,	*f*
F	1·73V	V	...							
E	...	1·73V	V	Yes	...	Yes	...	...	Yes	9*a*
F	...	2V	1·73V							
E	...	V	1·73V	...	Yes	,,	...	...	,,	*b*
F	...	1·73V	2V							
E	V	...	1·73V	Yes	...	,,	...	...	,,	*c*
F	1·73V	...	2V							
E	1·73V	...	V	...	Yes	,,	...	...	,,	*d*
F	2V	...	1·73V							
E	1·73V	V	...	Yes	...	,,	...	...	,,	*e*
F	2V	1·73V	...							
E	V	1·73V	...	...	Yes	,,	...	...	,,	*f*
F	1·73V	2V	...							
E	...	V	1·73V	Yes	...	...	Yes	...	Yes	10*a*
F	...	O	V							
E	...	1·73V	V	...	Yes	...	,,	...	,,	*b*
F	...	V	O							
E	1·73V	...	V	Yes	...	...	,,	...	,,	*c*
F	V	...	O							
E	V	...	1·73V	...	Yes	...	,,	...	,,	*d*
F	O	...	V							
E	V	1·73V	...	Yes	...	...	,,	...	,,	*e*
F	O	V	...							
E	1·73V	V	...	...	Yes	...	,,	...	,,	*f*
F	V	O	...							
E	...	V	O	Yes	...	...	Yes	...	Yes	11*a*
F	...	1·73V	V							
E	...	O	V	...	Yes	...	,,	...	,,	*b*
F	...	V	1·73V							
E	O	...	V	Yes	...	...	,,	...	,,	*c*
F	V	...	1·73V							
E	V	...	O	...	Yes	...	,,	...	,,	*d*
F	1·73V	...	V							
E	V	O	...	Yes	...	...	,,	...	,,	*e*
F	1·73V	V	...							
E	O	V	...	...	Yes	...	,,	...	,,	*f*
F	V	1·73V	...							
D	O	V	V	Yes	...	Yes	...	...	...	12*a*
E	V	O	V							
F	V	V	O							
D	O	V	V	...	Yes	,,	...	...	...	*b*
E	V	V	O							
F	V	O	V							
D	V	O	V	Yes	...	,,	...	...	...	*c*
E	V	V	O							
F	O	V	V							
D	V	O	V	...	Yes	,,	...	...	...	*d*
E	O	V	V							
F	V	V	O							
D	V	V	O	Yes	...	,,	...	...	...	*e*
E	O	V	V							
F	V	O	V							
D	V	V	O	...	Yes	Yes	...	...	...	*f*
E	V	O	V							
F	O	V	V							
D	1·15V	0·578V	0·578V	Yes	...	...	Yes	...	...	13*a*
E	0·578V	1·15V	0·578V							
F	0·578V	0·578V	1·15V							
D	1·15V	0·578V	0·578V	...	Yes	...	,,	...	...	*b*
E	0·578V	0·578V	1·15V							
F	0·578V	1·15V	0·578V							
D	0·578V	1·15V	0·578V	Yes	...	...	,,	...	...	*c*
E	0·578V	0·578V	1·15V							
F	1·15V	0·578V	0·578V							
D	0·578V	1·15V	0·578V	...	Yes	...	,,	...	...	*d*
E	1·15V	0·578V	0·578V							
F	0·578V	0·578V	1·15V							
D	0·578V	0·578V	1·15V	Yes	...	...	,,	...	...	*e*
E	1·15V	0·578V	0·578V							
F	0·578V	1·15V	0·578V							
D	0·578V	0·578V	1·15V	...	Yes	...	,,	...	...	*f*
E	0·578V	1·15V	0·578V							
F	1·15V	0·578V	0·578V							

Key to the above Table.

Phase rotation.	Polarity.	Phase bridged.	Figs.
Correct	Correct	Like	6 *a.c.e*
Correct	Correct	Unlike	8 *a.c.e.*, 9 *a.c.e.*
Correct	Reversed	Like	7 *a.c.e.*
Correct	Reversed	Unlike	10 *a.c.e.* 11 *a.c.e.*
Reversed	Correct	Like	6 *b.d f.*
Reversed	Correct	Unlike	8 *b.d.f.*, 9 *b.d.f.*
Reversed	Reversed	Like	7 *b.d f.*
Reversed	Reversed	Unlike	10 *b.d f.*, 11 *b.d.f.*

tions, similar voltage measurements should again be taken and these will now be found to be—

Across $E.E'$=zero.
$F.F'$=zero.
$E.F'$=line voltage.
$F.E'$=line voltage,

i.e., the corresponding diagram is now Fig. 6A, and the transformers now possess the same polarity, same phase rotation and have like terminals bridged. The above method can be followed in dealing with any of the cases specified in Figs. 6 to 11. It will be noticed that these diagrams also take into account the bridging of dissimilar phases. The various conditions of connections shown in Figs. 6 to 11 are also applicable to any of the combinations shown in diagram, Fig. 4.

In the case of transformers connected star-star a simpler method is available. In order to fix two such transformers to the same relative potentials above earth, the neutral points of the two secondaries are bridged. The following voltage measurements should then be taken, and as a case in point let them equal—

Across $E.E'$=0·578 line voltage.
$F.F'$=0·578 line voltage.
$E.F'$=1·15 line voltage.
$F.E'$=0·578 line voltage.
$E.D'$=0·578 line voltage.
$F.D'$=1·15 line voltage.

These conditions will be seen to correspond with Fig. 13c, which denote that the transformers are of incorrect polarity and correct phase rotation. To bring these two transformers into line it is necessary to reverse the internal connections of either the primary or secondary windings of transformer Y or change the lettering of the secondary terminals of the same transformer as follows :—

E′ changed to *D′*
F′ changed to *E′*
D′ changed to *F′*.

These alterations having been effected similar voltage measurements should be repeated, which will be found to give—

Across *E.E′*=zero.
F.F′=zero.
E.F′=line voltage.
F.E′=line voltage.
E.D′=line voltage.
F.D′=line voltage,

which conditions will agree with Fig. 12A. Permanent connections can be made to the 'bus bars and satisfactory operation will ensue. The same procedure applies to any combination of transformers detailed in Fig. 4, which have star secondaries.

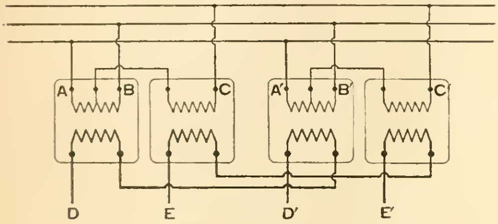


FIG. 14.

When phasing-out for the paralleling of two Scott-connected three to two-phase transformers, care must be exercised that the three-phase windings are symmetrically connected. If this is not so the two-phase windings will be 30 deg. out of phase. The connections are indicated in Fig. 14 where terminal *A′* is connected to the same 'bus bar as terminal *A*, *B′* to the same as *B* and *C′* to the same as *C*. If the connections are correct zero voltage will be shown on measuring across *D D′* and across *E E′* and the transformers may be paralleled. If, however, twice the line voltage were registered across these terminals, then the polarity of the two combinations would be reversed. To correct this reverse the secondary windings of one combined unit, i.e., interchange *D′* and *E′* and also interchange the other ends of the same secondary windings in a similar manner.

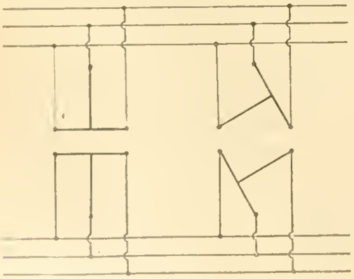


FIG. 15.

If it is desired to parallel two Tee-connected combinations three to three-phase transformation then perfectly symmetrical connection is not necessary. Polarity, however, is all important, and phasing-out is conducted in the same way as with ordinary three phase transformers.

Fig. 15 shows diagrammatically connections of this type.

A further case might be treated which deals with the paralleling of a three-phase transformer with a bank of three single-phase transformers connected in delta-delta. Given that the phase connections of the two units permit of parallel operation, then the procedure is as follows : Connect the three-phase transformers and the three-phase bank in parallel on the primary side as shown in Fig. 16. In this instance each single-phase transformer must be phased out separately. Now connect terminal 3A to terminal 4X via the 'bus bars and measure the voltage across 4A and 5X. If zero voltage is indicated—the conditions being shown vectorially at "*a*"—the connection is correct and permanent connection can be made. Should the voltage measurement across 4A and 5X be twice the normal as shown vectorially at "*b*," then the phases correspond but the connections are reversed. Hence 4A should be connected to 4X, when the voltage across 3A and 5X will be zero and permanent connections can be made. If, however, on joining 3A and 4X and measuring across 4A and 5X, the voltage indicated equals 1·73 times the normal as shown at "*c*" or equals the normal as shown at "*d*," then 3A.4A do not correspond to the same phase as 4X.5X. With 3A and 4X still connected, measure the voltage across 4A and 6X. If zero is given then permanent connection can be made between these two latter terminals, but if twice the normal is indicated, then the phases correspond but are reversed. Should 1·73 times the line voltage or normal line voltage be given the phases do not correspond and 3A and 4X do not belong to the same phase. Therefore, by consecutive reasoning 3A and 4A must be in the same phase as 5X and 6X. This method of elimination is followed throughout with transformers B and C until zero readings are obtained, when permanent connections can be made.

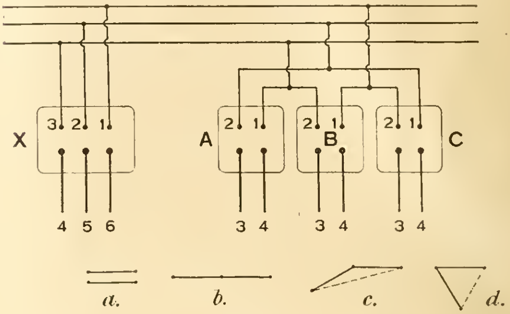


FIG. 16.

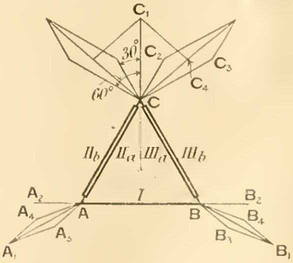


FIG. 17.

As a final example of group paralleling, we will take the case of three single phase transformers connected in closed delta and operating in parallel with two single-phase transformers connected in open delta, all transformers being of the same capacity and possessing the same internal characteristics.

Fig. 17 shows vectorially the resulting conditions. Each group is first dealt with separately as though carrying full-load current and the results combined to obtain the correct value and phase relationship of the currents in all transformers.

Taking first the closed delta : I., II_a., III_a.
CC_2=current value in transformers II_a. and =line current/$\sqrt{3}$ and similarly with transformers I. and III_a.

With the closed delta : II_b. and III_b.

CC_3=current value in transformers II_b. and =line current. Similarly with transformer III_b.

Completing the parallelogram and taking 50 per cent. of the resultant current value, we get CC_4=132 per cent. of the normal transformer current of a closed delta bank, and which is *apparently* the current in transformers II_a. and II_b. As, however the line current divides up inversely as the impedances of the phases of the bank, it is obvious that the actual current in transformers II_a., II_b. and III_a., III_b. is in ratio to the normal transformer current of a closed delta bank as BB_2/CC_4 or as 100/132=0·7615 of the normal transformer current.

The vector AA_4 shows the phase of the current in transformer I, while AA_3 and BB_3 show the phase of the currents in transformers II_a., II . and III_a., III_b. respectively.

To summarise it can be said that when paralleling a bank of open delta transformers with a closed delta bank, the phases each carrying two transformers in parallel will only take 76·15 per cent. of their full-rated capacity when the remaining phase is carrying its normal full-load current. Also that in all the transformers the currents will be out of phase with the voltages as indicated in Fig. 17.

Other factors to be taken into consideration when paralleling transformers are briefly summarised as follows :—

1. That the cables on either side of the main junction are of approximately the same length (in the case of similar banks on either side of the main junction). Or in the case of a heavier bank on one side than the other, the percentage resistance and reactance of the cables should be in the same proportion as the resistance and reactance of their respective banks. Should these very materially differ then conditions will arise as indicated in Fig. 1, *i.e.*, the currents on either side of the main junction will not be in phase, and one bank at least may become seriously overloaded.

When two or more transformers are to be paralleled, whose respective impedances are slightly different, the current distribution may be balanced by a careful selection of the main junction point ; that is by allotting to the transformer with the smaller impedance, a proportionately longer run of cable, so that the total impedance of transformer plus cable is the same on either side of the main junction.

2. Transformers should, whenever possible, be paralleled at the same or nearly the same temperature. Unless, however, there is a very large difference between the temperatures of two or more transformers at the moment of paralleling, no serious damage will result. The tendency will be towards the conditions shown in Fig. 1, as the transformer at the higher temperature will have a greater resistance than otherwise. This will result in increased impedance and consequent unbalancing of current. The increase in resistance obtaining from an increase in temperature of 15°C. to 60°C. is only 18 per cent. As the resistance drop may be normally of the order of, say, 2 per cent. of the no-load terminal volts, the increase at 60°C. would be up to 2·36 per cent., giving an impedance of corresponding increase. The results of this can be judged from Table III.

3. With regard to power factor, it can be definitely stated that the satisfactory parallel operation of transformers is entirely independent of this function : that is, if the transformers do not take their normal proportional share of the load at any one power factor, they will not do so at any other. This can be clearly seen on referring to Fig. 1.

PRINCIPLES INVOLVED IN COMPUTING THE DEPRECIATION OF PLANT.

The following is an account of the discussion on Messrs. Gill and Cook's Paper on this subject before the Manchester Local Section of the Institution of Electrical Engineers. An abstract of the Paper was concluded in our issue of Jan. 26th.

Mr. S. L. **Pearce** said members generally would agree with the definition of the respective functions of the engineer, accountant and financier, and with the emphasis laid upon the need for the closest co-operation. Within the last few years there had been examples of such co operation in connection with electricity undertakings in this country, for instance, at Bristol between Sir Wm. Preece and Prof. Dicksee, and recently at Southampton, where Sir John Snell was associated with an eminent accountant. When all had been said on this point, it remained true that the engineer had to bear the brunt of the correctness or otherwise of the depreciation charges, because it devolved upon him at the start to estimate the factors which determined it—namely, the first cost and the lives of various portions of plant. After making clear what was meant by "depreciation," the authors resolved it into two components—renewals and improvements. The first of these was provided for already in the case of local authorities, who were compelled by statute to form a sinking fund in connection with electricity undertakings ; but everyone did not appear alive to the necessity of making provision against the possibility of having to scrap portions of the plant before the physical life was at an end. It was desirable to emphasise the fact that depreciation was as much a working charge as fuel, and it had to be settled on a well-defined basis, not dependent upon the amount which a company desired to pay in dividends or a local authority to allocate to the relief of rates. Contrary to the authors' opinion, there appeared a fair measure of agreement amongst engineers with regard to the question of the life of plant, upon which, of course, the renewals chiefly depended ; but the trouble lay in the fact that the recommendations and opinions of experts were very often ignored. The question of obsolescence or improvement introduced the realm of speculation, and there was a divergence of opinion as to the percentage allowance for residual values. It was almost impossible at the present time to forecast correctly future progress, or when the scrapping policy would become desirable ; therefore, whilst agreeing with the authors' method from a strictly logical and scientific point of view, it was doubtful whether in practice two sets of elaborate calculations were necessary. One would appear to satisfy reasonably all practical requirements if based on the life of plant, either physical or economic. If the former basis were adopted, it would be prudent to build up a general reserve fund to a substantial amount, which, of course, would depend entirely upon local conditions, in order to provide for the possibility of having to scrap a portion of the plant before the physical life came to an end. Regarding the Local Government practice in granting loans, 10 or 12 years ago it was usual to allow long periods for repayment, periods which were undoubtedly in excess of the economic lives of portions of the plant, if not in excess of the physical lives. Since 1906 the Board seemed to have leaned on the other side, and the periods were unduly short. It was not clear whether the Board now intended to cover both physical and economic lives ; indeed, it was open to doubt whether the new policy was based upon any very definite ideas at all. The bulk of the Paper dealt with the question of sinking-fund method against straight-line method. The former was adopted by municipalities, and a very strong case was made out in its favour. The authors laid undue stress upon the difficulties of carrying out the modernisation of existing plant. Many at the present time were compelled to adopt a big scrapping policy ; schemes were being held up, and engineers had to modernise existing stations so as to increase outputs, and difficulties arose when no provision had been made for an improvement fund. The difficulties were not to be exaggerated, as the practice of local authorities was well established. The Local Government Board would grant borrowing powers corresponding to the full value of the new plant required less the amount outstanding on the old plant. During the period the old plant had still to run the undertaking carried a double burden—the annual charge on the old plant and the annual charge on the new plant. Obviously, every engineer deciding upon the policy of scrapping a certain amount of plant would have to take all these facts into consideration. It had to be borne in mind that the cost of reproducing plant was not necessarily the same as the original cost. The authors were right in making a strong point of the fact that the life of the plant should be reckoned by the work done, and not merely as a number of years. In many electrical undertakings the load factor was going up, and likely to increase still further in the future, and this was to be taken into account in estimating the economic life of the plant. The speaker did not agree that the maintenance costs might be considered not to increase with age of plant. There was no reference in the Paper to the provision, in addition to the fund for expiring capital outlay, of a further fund for the acquisition of new plant without recourse to the raising of new capital, commonly known as the double provision basis. Presumably the authors disagreed with such a policy. Regarding those electrical undertakings compelled to contribute certain sums annually by way of relief of rates, the speaker expressed opinion that, in the event of this policy being abolished, the whole of the benefit accruing therefrom should not go to the consumer. The aim of all undertakings should be self-capitalisation spread over a cycle of, say, 40 or 50 years.

Mr. J. **Beckett** (Borough Treasurer, Accrington), representing the Lancashire and Cheshire Branch of the Institute of Municipal Treasurer, and Accountants, entirely agreed with the authors' view that it was very desirable there should be hearty co-operation between the various officials of municipalities and their organisation in order to promote the best interest of those whom they served in common. The first essential was to find out the facts, and with these at all events there would be agreement. Failing this an approximately accurate basis was desirable, and in fact, must be adopted, but until the facts could be definitely ascertained divergent opinions were neither to be depreciated nor deplored. They were rather a sign of vitality. The authors stated: "It is often said that one cannot say how long a certain plant will last. One must estimate the life if there is to be any attempt towards scientific treatment in planning." It was right here that the deplorable divergence took place and would always arise on the subject of estimates, but over and above individual differences of opinion, there was in practice always some oscillation between physical necessity and financial expediency, between actual present needs and available means. Referring to exhausted plant, the authors stated: "It may be argued that the cost of making them (the charges) should be defrayed by new capital: but this is not always available." The authors suggested this should be part of the annual charges, but the speaker submitted that it was no part of the annual charges in respect of plant. It might be prudent to make provision for it by way of reserve if there was surplus revenue available for that purpose, but it was certainly not true accounting to charge against the plant for any period more than had been taken out of the plant within that period in earning the revenue. Who could fix the charges in advance upon any sort of scientific principle? Who could go into a power house and mark out the parts which would become antiquated or obsolete or need improvement in 5, 15 or 25 years? The proposition was clearly indefinable. The necessity for the charge also depended upon the state of development of the plant and machinery. The true principle appeared to be that plant might be discarded and replaced by more economical plant out of capital when the result of so doing upon the revenue account was not only to maintain a state of equilibrium, but resulted in a positive financial advantage to the undertaking. Local authorities could not give effect to the proposal of the authors, for they had to submit to the limitation and restructions imposed by the Electric Lighting (Clauses) Act, 1899, by which they were restricted to a reserve fund and a surplus revenue of 5 per cent. upon the capital outlay. He did not agree with the authors' definition, and he, therefore, ventured upon another definition, viz.:—

> The charge against revenue of any given period of that proportion of the cost of production during that period which represents the consequent fall in value due to wear and tear of the producing machinery and plant, or the repayment to capital out of the revenue earned during a given period of such proportion of the original outlay as has been absorbed or, consumed in earning such revenue.

More briefly, this was the capital restoration charge. The authors declared that the function of the engineer was to provide the information necessary regarding the plant, such as first cost, residual value and life. Depreciation, as such, was not, as the authors said, a financial operation; it was clearly a physical process, having no necessary relation to finance whatever. Again, from its return, depreciation had no relation whatever to improvements. The fall in value arising from obsolescence, supercession, antiquation or the introduction of improved machinery could not be dealt with along mathematical lines. These things were distinct from depreciation of fixed capital, and, therefore, he (the speaker) was directly at issue with the authors' definition. The primary object of depreciation was the preservation of the original capital, and the measure of the annual charge was the amount of capital annually consumed by the production of the year. Contrary to what was repeatedly stated in the Paper, depreciation had no relation to the return on capital outlay. Supposing a period of trade depression or losses incurred over several years, surely the depreciation would not be suspended meanwhile. It was a fact that some undertakings made an annual loss and were subsidised by rates. The process went on, profit or no profit, and if the authors had kept that fact in mind it would have saved them the necessity of making calculations in the Paper which needlessly took account of the return on capital, because the return on capital had nothing to do with the question of depreciation. The authors stated "the depreciation fund is not required until the end of the life," and the question was raised as to the placing of the annual amounts meanwhile. If the money was not required in the undertaking it would earn interest elsewhere. An accumulating depreciation fund with a fixed minimum rate of interest for the accumulating period came very near the solution of the problem submitted. Meanwhile the fund represented capital, either in a fixed or liquid state, with the true function of restoration. It was difficult to believe that anyone would defend the straight line method for the simple reason that the method extracted from revenue the total amount of capital in the name of depreciation, regardless of interest which properly belonged to the depreciation fund. An accumulating method also provided a flat rate of charge over the whole period of the estimated life, but the fund required and obtained interest earned; the speaker was, therefore, in agreement with the authors on the question of the character of the fund to be employed for depreciation. The purpose of the sinking fund, speaking of municipal accounts, was fundamentally different from the depreciation fund. The sinking fund had to provide capital. The local authority, with a true depreciation fund plus a sinking fund, carried a double burden. The use of both would handicap enormously the initiation of any municipal scheme when compared with private concerns. Regarding maintenance and renewals the frontiers between these were not well defined, and no provision was made in the scheme to meet the cost of this work. In the Paper it was assumed that the cost of maintenance was constant each year. With depreciation fixed upon first cost, and maintenance constant and taken for granted that it would not increase with age, in what part of the scheme was provision made for the items which combined repairs and renewals? In dealing with the subject of average life and equated life the authors seemed to be somewhat confused. The speaker asked for a further explanation of the difference between equated and average life, as he had always understood them to be interchangeable.

Ald. **Walker** said that for many years it had been recognised that the chief engineer of a large electrical undertaking must have more qualifications than the purely engineering ones. There did not appear to be any necessity for two depreciation funds, as proposed by the authors. If it were decided that plant was not to be run for the whole of its physical life, but for a shorter period, termed the economic life, the amount set apart for the sinking fund should be something which at the end of such life fulfilled the object for which it was created. Dealing with the residual values, the authors allowed 2 per cent. on physical life and 13 per cent. on economic life. The economic life was the period after which it was justifiable to scrap the plant: therefore, in the speaker's opinion it was incorrect to estimate for more than scrap value. In the case of distributing systems the value of recovered copper ought to be assumed as the same for both periods. Carefully as the Paper had been prepared, and sound as the system appeared, much still depended upon estimates. In the determination of standards of maintenance opinions, or, at any rate, practices, differed considerably, and plant which had been allowed to suffer in early days in order to earn large dividends would be affected later by the mistake. This was a factor which might upset the original calculation of the economic and physical life. Another point to be borne in mind was that plant should not be thrown out simply because its steam consumption was high; obviously the most economic plant in a station was run with the highest load-factor, and the uneconomic plant was only brought into use during the period of peak load. Consequently any gain shown by replacing such plant might be very small, and it was necessary in such cases to consider the actual contribution of the plant to the total output of the station. At Manchester Mr. Pearce had made a valuation of what he considered to be the true economic life, and in comparison with the values fixed by Sir W. H. Preece at Bristol in 1906, the Manchester table was the more severe. Buildings were taken at 40 years, plant and machinery at 20 years, mains and service 20 years, motors 10 years, which periods were very much shorter than those fixed on former occasions. It was decided to establish a renewals suspense account, and to transfer from revenue account each year the amount which, put into the renewal suspense account, would be sufficient to meet the deficiency in the sinking fund as shown by the calculated shorter life of the plant. The total amount paid into that account had been about £344,000, but certain renewals had been made, and it now stood at £191,000. This was in addition to the reserve fund. The speaker was of the opinion that the latter policy of the Local Government Board in fixing very much shorter periods, and dividing up the loans in accordance with the plant on which they were going to be spent, was bringing the sinking fund itself closely approximate to the economic life.

Mr. W. W. **Cook** replied very briefly to a few of the points raised, and reserved the official reply for the "Journal."

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

Mr. Allcock thinks that critics will do better by suppressing their ideas, so as to put all their efforts into getting Parliament to take an interest in decimal coinage. While admiring the work of the Decimal Association, I fear that the new coinage will get scant help from Parliament until its advocates put forward a scheme acceptable to the great majority of the community. It is out of no spirit of "cussedness" that I have criticised the florin unit, but from a conviction that putting it forward will arouse so much opposition that the whole matter may be dropped for years to come. Neither do I advocate the shilling unit from mere prejudice, for my own bias is towards the dollar of 100 halfpennies. But I have talked the question over with many people, and have found that the shilling is the favourite; indeed, I have yet to meet anyone, outside correspondents in the Press, who are open to accept the florin

Let me give instances. A bank manager of some 40 years' experience, having a very balanced mind, read over a Paper in which the florin and shilling were compared. After two or three weeks he returned the Paper with the remark that he thought the shilling to be the better unit. A professional man of high repute listened attentively while I explained that, with the florin, 7s. 6d. would become F.3·75, and change from half a sovereign would be F.1·25, &c. He gave it as his decided opinion that something simpler than that was needed. A woman having a university degree said the same. Another woman, who might reasonably be taken as representing the average of the middle classes, declared that she would never be able to understand the florin system. A grocer, who has a large business, shook his head vigorously, and said that the florin unit would never do. The vision of a Saturday night during the transition period, when he was trying to explain to all kinds of customers that 3s. 6d. was F. 1·75, and the like, did not attract him.

I have not tried to explain the florin system to working men, but I hope Mr. Allcock will do so, and, after he has got, say, 20 to understand it, that he will write a letter (or a book) relating his experiences. Personally, I would rather undertake to get 1,000 people to understand the shilling unit than to drive the meaning of the florin unit into the heads of 20.

The fatal flaw in the florin unit is that no sums of money expressed in our present coinage are easily recognisable in it. £1. 2s. looks all right as 22s., and £1. 5s. 6d. is not very far wrong as S.25-50; but write them as F.11 and F.12-75 and how many people will recognise them without effort? These are simple cases. When one deals with such sums as 13s. 11d. and 17s. 10d. the conversion to florins becomes quite impos- to at least 90 people out of 100.

Lastly, the shilling is quite as good, if not better, than the florin for foreign trade. In Europe the franc is by far the most familiar coin, and the shilling is near enough to it to be easily understood. In America the shilling would pass as about equal to a quarter dollar, which would be quite simple. Taking everything into account, the case for the shilling appears to be overwhelming.

Tynemouth, Feb. 8. C. TURNBULL.

TO THE EDITORS OF THE ELECTRICIAN.

I should like to bring to the notice of your readers a paragraph from Brook-Smith's "Arithmetic." The book is very old, but, unfortunately, my copy has lost its title page, so that I cannot give the exact date. I quote in full:—

> The following decimal system has been recommended by a Committee of the House of Commons, and has received the general assent of those arithmeticians and men of science who wish to see the introduction of a decimal system into England; there is little doubt, therefore, that should a change take place this system will be adopted and sanctioned by Parliament.
>
> In it the pound or sovereign as at present defined will still be our unit of money: its sub-multiples will follow the decimal system, and take the names of florin, cent and mil, so that
>
> 10 mils (m) = 1 cent (c)
> 10 cents = 1 florin (f)
> 10 florins = 1 pound or sovereign (£).
>
> Hence £25. 7f. 8c. 9m. may be written £25·789, and may be operated on as easily as the decimal 25·789.

Apart from the name of cent, I believe the above system will cause less confusion and trouble on all sides than any of the other systems proposed in the columns of THE ELECTRICIAN. Since a Parliamentary Committee has already reported on it, it seems to me that half the work has been done, and I heartily join with your other contributors in urging on the decimalisation of our coinage.

Rugby, Feb. 12. A. E. HILL, B.Sc. (Lond.).

TO THE EDITORS OF THE ELECTRICIAN.

With reference to this question, it seems to me that the pound is the only logical unit to take for business purposes. Ordinary business men think in pounds, and in book-keeping the number of digits is much less than would be the case if the shilling, or that abomination the florin, were the unit. Imagine the number of figures involved in accounts running into thousands of pounds and the increased risk of a mistake. If the shilling or the florin be adopted as the unit then an extra "decimal point" ought to be introduced for separating the large number of figures representing the integer.

London, Feb. 10. H. C. SILVER.

TO THE EDITORS OF THE ELECTRICIAN.

There is a misprint in the following sentence in my letter in your last issue:—"In all these cases it would be much easier to divide or to multiply always by 2 than by 1 and by 12 and by 20, as must be done at present." The "2" ought to be "10."

London, Feb. 10. JOHN JOHNSTON.

PHYSICAL SOCIETY.

A meeting was held on the 26th ult. at the Imperial College of Science, Prof. C. V. BOYS, F.R.S., President, in the Chair.

A Paper, entitled

"A Clock of Precision,"

was read by Mr. C. O. BARTRUM.

The principal feature of the author's arrangement is the employment of a "slave" clock to do the great part of the work, leaving the master pendulum no function beyond that of controlling the rate of the other. The master pendulum swings freely except for a short period (about one-fifth of a second) every minute, during which it receives an impulse from a small falling pallet electromagnetically released by the slave clock. At the end of its fall the pallet closes a second circuit and is restored to its initial position. These two electric circuits also energise parts of the mechanism in the slave clock by which the latter is kept in time with the master pendulum. The lagging of correction behind error, with the resulting periodic fluctuation in the rate, is reduced almost to the vanishing point by the introduction of a "negative backlash" in the control mechanism.

The Paper contains a mathematical discussion of the best working conditions and of the possible magnitude of errors which might arise from various causes.

The PRESIDENT said the subject was one in which he had the keenest personal interest, and he congratulated the author on the efficient way he had dealt with the problem and the successful result which he had obtained. Of the numerous elements which went to make up the clock, that which he thought he most admired was the device for abolishing "hunting" by means of negative backlash. With regard to the most suitable arc of vibration, it was possible that this could best be determined experimentally, as it had been with escapement clocks, for here, as elsewhere, there are the counteracting advantages of improving isochronism with reduction of arc and improving stability of amplitude with increase of arc. Such tests could only be made usefully under the most perfect conditions for the master pendulum. As in the case of all new inventions, it was certain that the few people who were interested in the production of the perfect clock would immediately see other ways of doing the same thing. There was no merit in this comparable with the original invention, but some of the modifications might be useful. He had himself found it impossible to avoid thinking of devices alternative to some of those employed by Mr. Bartrum.

Prof. Boys then proceeded to sketch out an alternative method of maintaining isochronism between the master pendulum and the slave clock without giving the pendulum of the latter as much work to do. A full account of his contribution will appear in the "Proceedings."

Mr. DUDDELL said that at the Paris Observatory there was a standard seconds pendulum in a chamber 60 ft. below the surface of the ground. The temperature was constant, and there were no pressure variations, as the pendulum was in a vacuum. It was driven electrically, and maintained a perfectly constant rate, requiring no attention whatever. It gave a signal in a telephone every second.

A Paper on

"The Effect of Water Vapour in the Atmosphere on the Propagation of Electromagnetic Waves,"

by Dr. FREDERICK SCHWERS, was taken as read, on account of the lateness of the hour.

The author discusses the probable influence of moisture in the atmosphere on the refraction of electromagnetic waves round the earth's surface. The conclusion of Kiebitz that the presence of moisture does not affect the dielectric constant by more than 10 per cent. is shown to be erroneous, being based on the assumption that the Clausius-Mossoti formula, $\frac{k-1}{k+2}\cdot\frac{1}{d}=$ constant, holds when passing from the liquid to the gaseous state. Examples are quoted to show that this law fails in many cases, especially where the dielectric constant is high in the liquid state.

In the absence of more accurate data for ordinary temperatures, the author prefers to assume a value for the dielectric constant of water vapour obtained by extrapolating the results obtained by Baedeker for higher temperatures. The extrapolated value is almost certainly too low.

From this result, and the average conditions of the atmosphere over the ocean with regard to temperature gradient, &c., deduced from meteorological data, it is shown that the lowest layers of the atmosphere (1,000 to 1,500 metres approximately in depth) refract electromagnetic waves towards the earth, so that the greater part of the space waves will reach the receiver, contrary to the conclusion of Kiebitz.

Dr. C. CHREE (communicated remarks): The author, presumably unaware of their existence, does not refer to the somewhat numerous upper air data which have been published in this country by the Meteorological Office. A study of this data as to the temperature gradients would I think, have proved useful. Inversions are not confined to the lowest layers, but in these layers they are exceptional, and do not suffice to reduce the average temperature gradient to such low values as the author has taken for the first and second kilometres. For these, 5 deg. or 6 deg. per kilometre would not have been too high, especially for tropical regions. If the empirical exponential formula for vapour pressure be assumed, the pressure at any given height varies directly with that at ground level, and so in temperate latitudes is much lower in winter than in summer. It thus seems rather a fundamental point whether wireless phenomena in temperate latitudes show a marked annual variation corresponding with that of vapour pressure at ground level.

LEGAL INTELLIGENCE.

Alien Enemy Patent.

In the Patents Court last week Messrs. H. Clarke & Co. applied for a licence to use patent No. 26,941 of 1906, granted to Max Meirowsky, of Cöln-Ehrenfeld, Germany, for a method of forming electric insulation tubes by means of a mandrel around which the material to be wound is passed perpendicularly to the axis of the mandrel, as distinguished from spirally. The fibrous material, which may be wound together with insulation material, and is of breadth equal to the length of the tube to be formed, is powerfully stretched before being wound on the mandrel, so that the fibrous material during the winding operation itself forms the outer pressure mould, or former, and the materials are wound with perfectly uniform tightness while dispensing with a stationary pressure support or roller. In another claim the stretched fibrous material, before being wound, is led between two heated rollers, and the freely movable independent mandrel is during the winding operation pressed uniformly against the surface of the hot rollers.

Mr. WORSNUP (for applicant) said his client had been in the employ of the patentees (Meirowsky & Co.), who had branch works at Manchester. At the outbreak of the war they were represented there by a Mr. Schultz. In Oct., 1915, Mr. Clarke commenced business on his own account, and later Mr. Schultz visited him at his invitation to look at a machine he had built, and threatened proceedings for infringement. When asked what was their authority, Mr. Schultz's firm replied that they had control of the patent by permission of the Public Trustee. The applicant was told by the Public Trustee that he had given no authority whatever. Mr. Clarke was advised by his patent agent that he was not infringing. He, however, thought it proper to come to the Court and ask for a licence.

Mr. MORITZ (for Mr. Schultz) pointed out that those tubes were used for protecting high-tension electrical mains, and could only be manufactured in short lengths.

Mr. H. CLARKE said it was possible to make tubes of that character without using any specific machine. He knew of no method of making insulation tubes except by winding them round the mandrel.

Mr. MORITZ explained that Mr. Geo. Schultz had changed his name to Scott, and was now Capt. Scott, of H.M. Forces. Capt. Scott had conducted the English business of Meirowsky, and with the outbreak of the war the English liability of carrying on fell on Capt. Scott. It was a partnership between Capt. Scott and Meirowsky. When Capt. Scott joined the forces he invited Messrs. Schultz & Co., whose managing director was his father, to go to Manchester, take up the English business of Meirowsky & Co., and manufacture. Capt. Scott was an English-born son of Mr. Schultz, who himself was born in the free city of Hamburg, and was naturalised in this country in the early sixties.

Answering Mr. Moritz, Mr. CLARKE said the experience he gained in his employment guided him in building a machine, and it wound perpendicularly upon the mandrel, and employed heavy pressure and hot rollers. The stretched fibrous material was micanite. He should say that in broad principles the machines were not the same. He did not wind the tubes under heat and "great pressure"; there was a certain amount of pressure but not pressure caused by stretching the fibrous material. In all the time that he was with Meirowsky & Co. he did not know that there was a patented machine. There was no mark upon it. It was by pure inadvertance that when he began he placed on his note heading "late G. Schultz & Co. (Ltd.)." It should have been "late of," and when his attention was called to the mistake, which he admitted was careless, he at once remedied it.

Counsel insisted that Messrs. Schultz & Co., under the new arrangement, could supply all public requirements, and having regard to all the circumstances this was not a case where the Court should interfere, and so encourage every English employee of a German firm to start independently, go and build a plant and then come to the Court for licence. The Board of Trade had a record of what had been done by Capt. Scott. The firm had done considerable work for the Admiralty. The Board of Trade had [illegible] that they proposed to consider that business. Messrs. Schultz proposed to shift the necessary plant to their London works, where they would carry on, and then he supposed the Board of Trade would wind up the business of Meirowsky & Co. If they did Messrs. Schultz & Co. would apply for the patent and acquire it. They had done trade with the Admiralty of £3000 or £4000 a year in these tubes. Capt. Scott was the person entitled to manufacture in this country under his agreement, and the arrangement could be called either an agency or [illegible] partnership. It dated from Sept., 1912, and was to terminate next December. The patentee gave the agency for carrying of the manufacture in England. There was a clause to the effect that if Capt. Scott's father died or left the business the son was to be [illegible] of the partnership with power to go and take up Schultz & Co. The [illegible] transaction was to be carried out in the name of Meirowsky & Co., and Capt. Scott was to have the full use of English patents.

The CONTROLLER: It is quite conceivable that that agreement was suspended by the war. The Courts have held that an agreement of that kind was put an end to. Capt. Scott's agreement was with a purely German firm. People left in that position with an agrement have come here to ask for a licence, and have produced their agreement, and said, "We want to carry on," and we have given them a licence in dozens of cases. We have said, "We cannot give you an exclusive licence, but if you are fulfilling the needs of the country you have a right to come here and say so." It would have been very much better if Capt. Scott had come here for a licence in the first instance.

COUNSEL: They have laid it before the Board of Trade, and the Board of Trade said "Go on."

The CONTROLLER: The Board of Trade should not have done so. We shall have to consider this case.

COUNSEL: In the meantime the Board of Trade intend to wind up Meirowsky & Co. Messrs. Schultz intend to manufacture in London, and have sold some of the machines.

Mr. TEMPLE FRANKS observed that applicant's method might be called sharp practice. It was constantly done. He might have felt that the company who had employed him were destined to be wound up.

Mr. GEO. SCHULTZ said he was managing director of Schultz & Co., whose subscribed capital was all English. Both his sons had assumed the name of Scott. When he himself went to Manchester and took charge of that business he informed the Board of Trade and they approved. He had that day received a notice that the Board of Trade were going to look into the affair of Meirowsky & Co. It was in the autumn of last year that he found the Manchester works very inconvenient. They had calls from the Admiralty, and had recently brought to the notice of the Admiralty a speciality in connection with mica tubes which overcame one of the difficulties in connection with micanite tubes. It had been arranged that one firm should manufacture for the other.

Mr. ARTHUR WM. SCOTT, brother of Capt. Scott, stated that the firm of Meirowsky & Co. had a contract with the Admiralty to supply them with so many tubes for three years. They called them micanite tubes, and they were to be made to Admiralty specification. When the Admiralty wanted tubes of particular measurements he (witness) proceeded to devise a special machine, for which Geo. Schultz & Co. now held the patent. The specifications of the patent now being asked for were in request at the time for consultation. It was necessary that he should see he did not infringe that, and he should say that Mr. Clarke ought to have been acquainted with the patent which was the firm's principal stock-in-trade.

The CONTROLLER OF PATENTS: Of course, I don't want to advise you, but it seems to me that if you have been carrying on the business of Meirowsky & Co. you ought to have been paying over your profits to the Public Trustee as custodian.

Counsel intimated that the business had been carried on at a loss since the outbreak of the war.

Answering the Controller, counsel said the tubes were largely used for wireless apparatus, and it might be that the Admiralty conditions were of so searching a nature that the only thing which would produce the tubes as they required them was that machine.

The CONTROLLER: We shall have to think about it. You may call it sharp practice, but you have to remember what the company was. Meirowsky & Co. was an alien enemy business, and the question is whether the Court should overlook such sharp practice for the purpose of facilitating the trade of the country.

Counsel observed that when Capt. Scott came back he would legitimately expect to have anything that was going in the way of Meirowskys' business, and the Controller answered that it might appear that Capt. Scott was the agent of Meirowsky. He added: We shall have to consider the case of Meirowsky, and look into the details. He would report to the Board of Trade on the hearing, and Mr. Clarke would eventually be notified on the subject of the licence. He had taken note of the applicant's offer of a royalty of 5 per cent.

Counsel said his clients would similarly apply for a licence and offer 5 per cent.

PATENT RECORD.

SPECIFICATIONS PUBLISHED

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

1[illegible],103 WESTINGHOUSE METAL FILAMENT LAMP CO. Filament winding machines. (29/12/14.)

1916 SPECIFICATIONS.

2,283 M-L MAGNETO SYND. & WATSON. Dynamo-electric machines. (15/2/16.) 102,846.

2,345 BERRY. Electric heat radiators. (16/2/16.) 102,846.

4,962 CROCHAT. Electrical driving, particularly for motor vehicles. (4/4/16.) 102,864.

5,769 AUTOMATIC TELEPHONE MFG. CO. & GREEN. Signalling systems and apparatus therefor, more particularly for use in mines. (20/4/16.) 102,869.

6,982 JEFFERSON. Terminal seal for batteries. (21/5/15.) 100,534.

8,633 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Alternating-current commutator motors. (19/6/15.) 100,743.

The armature and cross-field winding of an alternating-current motor are connected to a supply transformer through a control circuit, whereby the applied voltage may be increased in the usual manner, and auxiliary exciting means are provided whereby the current supplied to the main field winding will be automatically adjusted in accordance with the voltage supplied to the armature and the cross-field winding.

8,794 KETTERING & CHRYST. Electric ignition systems for internal-combustion engines. (16/7/14.) (Divided application on 7,758/15.) 100,747.

9,09[illegible] IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Means for controlling electric motors. (28/6/16.) 102,889.

Relates to means for controlling a single electric motor or a plurality of electric motors whose relative electrical arrangements are invariable, and comprises the employment in combination with other switches of series lockout switches for effecting automatic acceleration from one of a plurality of speeds to the next higher speed in response to the operation of a manually operable master switch.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The War Loan. The president of the Institution of Electrical Engineers (Mr. C. P. Sparks) announced at the meeting last week that the Council had purchased £5,250 worth of the new War Loan and the Benevolent Fund was taking up £700, in addition to the conversion of the existing amounts invested in Government funds.

Among other large contributors may be mentioned the following: British Electrical Federation (£355.000), Bolckow, Vaughan & Co. (£500,000 new), Dunlop Rubber Co. (£350,000), Marconi's Wireless Telegraph Co. (£200,000), Mather & Platt (£100.000), I. Frankenburg & Sons (£67,000 new), Marconi International Marine Communication Co. (£50,000), Auckland Electric Tramway Co. (£50.000), British Mannesmann Tube Co. (£50,000), Vulcan Boiler & General Insurance Co. (£50,000), Nettlefold & Sons (£25,000), Scottish Tube Co. (£25.000), Para Electric Railway & Lighting Co. (£25,000), Lodge Sparking Plug Co. (£20,000 new), Huddersfield Tramways Committee (£40,000), Huddersfield Electricity Committee (£10,000), O. C. Hawkes (Ltd.) (£20,000 new), S. Gratrix jun. & Bro. (£15,000 new), Sir David Salomons (£13,000 new), Boving & Co. & Electro-Metals (Ltd.) (£12,000), W. F. Dennis & Co. (£10,000 new), Petters (Ltd.) (£10,000).

* * * *

Lead Supplies. By an order of the Minister of Munitions dated Feb. 2 no sale or purchase of lead can take place, except in accordance with a licence or for the purpose of carrying out a written contract existing prior to the date of the Order.

Until further notice there must be no use of lead for manufacture without a licence, unless for necessary repairs, involving the consumption of not more than 1 cwt or for type-casting from lead already in that form or previously purchased for that purpose. Monthly returns of lead in stock, &c., and contracts and orders, will have to be made, unless the total stock in hand or order for future delivery has not exceeded 1 cwt. The object of the Order is to conserve and, as far as possible, divert all supplies of lead to war purposes.

Applications for licences must be made to the Director of Materials, Hotel Victoria, Northumberland-avenue, W.C.

* * * *

Excess Profits Duty Decision. The Board of Referees, on the application of the Thermo-Electric Ore Reduction Corpn. (Ltd.), Luton, have increased the statutory percentage for the business of manufacturing and preparing tungsten, molybdenum, chromium, tantalum, vanadium and their alloys so far as the same are used in the manufacture of high-speed steel, to 12 per cent. in the case of companies, and 13 per cent. in the case of other businesses.

* * * *

Conditions in Written Contracts. Disputes frequently arise over conditions on the backs or margins of contracts, especially if they are in small type or placed in inconspicuous places. An interesting case of this character recently came before a Divisional Court on appeal from the Wolverhampton County Court.

It appeared that a builder named Roe got into touch with a firm of timber merchants at Warrington. The traveller of the firm called on Roe in February, 1916, with a price list of various kinds of timber, and said that he might have any item at the price fixed. Roe then marked a number of items which he would take, and the traveller took the marked list away with him. Nothing was said then about the contract being in any way conditional, but on Feb. 12 the traveller called again and left a written contract. Roe glanced at it and saw that the quantities of timber appeared to be correct, but he did not read the whole document carefully, and he did not see that on the side there was printed in small type a note to the effect that goods were sold only on condition that they were in hand at the moment when the order was received. When the order reached the firm part of the timber wanted had already been sold, and eventually Roe sued for breach of contract in failing to deliver.

The County Court Judge held that the contract was contained in the document; that defendants did not take reasonable steps to bring the condition to plaintiff's attention, and that, in fact, the plaintiff never saw it; that a suggested custom of the trade had not been proved; and that plaintiff had not waived the breach of contract. He therefore gave judgment for the plaintiff. It was now argued that if the contract was embodied in the document it must depend on the whole document; plaintiff could not rely on part of it and repudiate another part. It might be that as the parties never had been ad idem the document was not a contract at all. For plaintiff it was submitted that whether there had been a contract or not was a question of fact for the Judge.

The Court allowed the appeal, on the ground that it was not clear that the County Court Judge had considered the real question. In the course of his judgment, Mr. Justice Bailhache said that defendants had, no doubt, more than one traveller, and they carried on business at headquarters as well, so in their contracts they quite properly protected themselves by a clause that goods were sold subject to their being in hand when the order for them reached their head office. The contract sued on was entered into verbally with the traveller: no sold note was given at the time, but at a later date the traveller called and left a sold note, on which in very small print appeared the notice that sales were conditional on the particular goods being unsold when the order reached the head office. Plaintiff looked at the note, and saw that the prices appeared to be correct, and he did not trouble to read the rest. The County Court Judge found that defendants did not take reasonable steps to bring the condition to the notice of plaintiff, and that plaintiff never knew of its existence. The question was whether the Judge had properly directed himself. When parties to a contract exchanged bought and sold notes or a vendor handed to a purchaser a sold note which was accepted as the contract there was no duty on the seller to request the buyer to read the note or to call his attention to its contents. If the buyer accepted the note and failed to read it he would do so at his peril, and would be bound by the conditions, even if he had not read them. The ticket cases cited were not quite the same; indeed, there was a broad distinction between such cases and the present case, where there was no obligation on the seller to draw the attention of the buyer to the conditions in the document, and the buyer was bound by the conditions, though he had not read them. To that rule there was an exception that if the sold note was misleading, either because its terms were ambiguous or because the condition relied on by the seller was so placed in the document that an ordinarily careful man would not expect to find it there, *e.g.*, if a strike clause were inserted among a list of articles dealt in by the seller, the buyer would not be bound by the condition. And it might be that the buyer would not be bound if the condition was printed in such small type as to be unreadable to a person of ordinary eyesight. The question there was whether the clause at the side of the document was so printed that an ordinary careful business man, reading the document with proper care, might reasonably miss seeing it. In order to escape from being bound by the document plaintiff must be able to show that it was misleading, within the sense of that word which he had stated, and it was a question of fact for the County Court Judge to decide whether the clause was so printed and placed that a reasonably careful business man could be held justified in saying that he had never seen it and could not have been expected to see it. It was not clear that this question had been considered by the Judge, and the case must go back for a new trial.

* * * *

Yorkshire Electric Power Co. The report of the Yorkshire Electric Power Co. for the past year shows that considerable progress has been made under difficult conditions.

Notwithstanding the higher cost of coal and all materials, the labour and other difficulties, the net profit (£35,800) shows an increase of 35 per cent., and the directors state that the check received from the outbreak of war has now been recovered from and normal progress resumed. Owing to the great demand for power the generating plant has had to be increased. It is also reported that there is an increasing demand from textile mills, collieries, &c. The gross receipts were £116,600, against £93,300, and the surplus, after meeting interest charges, is £29,100, compared with £21,200. It is proposed to pay 3 (against 1) per cent. on the ordinary capital—the highest return it has yet received. It is proposed to place £12,000 (against £7,500) to reserve, and to carry £3,900 forward.

* * * *

Organisation in Selling Engineering Specialities. There are welcome signs of activity among electrical manufacturers for the organisation of the sale of their products, both among the Entente Powers and in countries in which the German salesman is going to hustle after the war. There are admitted faults in our system of trading in specialised engineering products with customers overseas. The greater proportion of this business has been done by merchant agents, who, as a rule, are not engineers, and have no technical staff; they have made no attempt in the past to sell the goods on their special merits, and always referred back technical queries to the manufacturers themselves. In the past the merchant agent was the best weapon the British producer had to compete against organised selling methods conducted by expert engineers, who took the specialised goods right up to the consumer and explained direct why he should buy them. The results of this latter method were apparent before the war, and now the British producer is evidently determined to take no more chances. A noteworthy instance of this determination to conduct sales on an organised plan, so far as certain electrical specialities are concerned, has this week been brought to our notice by Mr. H. C. Siddeley, the managing director of British Switchgear (Ltd.). This company, the formation of which (capital £42,000) we announced last week, will undertake the sales of the switchgear products of Brook, Hirst & Co. (Chester), Erskine, Heap & Co. (Manchester) and Electric

Control (Ltd.) (Glasgow) in those countries in which electrical manufacturing is already established, and in which it is desirable to introduce British switchgear specialities. Were these three firms to attempt to maintain three distinct selling engineers or agencies in these countries the cost would be out of proportion to the return, and any attempt to work on these lines would end in failure. Through the medium of a company like British Switchgear (Ltd.) the three firms are enabled to repose the responsibility of marketing all their specialities upon a single selling engineer. He will find that on most occasions if he cannot sell motor starters for Brook, Hirst & Co. or switchgear for Erskine, Heap & Co., he can find a customer for automatic gear for Electric Control (Ltd.). The sales expenses of three manufacturers producing somewhat similar specialities will thus be at the disposal of one selling organisation instead of three; the advantages of such an arrangement are obvious. Mr. H. C. Siddeley is also interested in the Electrical Manufacturers Co. of Great Britain, which was registered in Dec., 1915, and whose formation we hailed as a sign of awakening activity in electrical trading circles. This undertaking comprises the following electrical manufacturers: Bruce Peebles & Co., Crompton & Co., Lancashire Dynamo & Motor Co., Allen West & Co., Brook, Hirst & Co., Erskine, Heap & Co., Whipp & Bourne (Ltd.), and Electric Control (Ltd.). Its chief object is to act co-operatively in countries where there is little or no manufacturing, such as Russia, China, South America, &c., in which it is helpful to be able to put forward complete schemes for power, lighting, &c. Here again the co-operative trading idea will ensure an infinitely better chance for the business to come into British hands than if all these firms individually attempted to obtain orders. Co-ordination of selling effort on these lines is capable of extension to other sections of the industry, and with such extension will assuredly come increased power to cope with German methods in the great markets of the world.

* * * *

Registration of Business Names. The Registration of Business Names Act comes into force on Thursday next, and the prescribed forms of application for registration will be obtainable (gratis) from all post offices on Wednesday.

There are three forms, viz., for individuals, for firms and for corporations. The fee [illegible] is to be paid by affixing an adhesive stamp to [illegible] When completed the forms must be sent to or delivered to the Registrar of Business Names, 39, Russell-square, London, W.C.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 3, 1917, *to* Feb. 9, 1917

IMPORTS.

[illegible] Ele[illegible] £480 [illegible] m[illegible] £240 [illegible] Unenumerated, £5[illegible] [illegible] E[illegible] machinery £1,600, unenumerated, £126 [illegible] G[illegible] lamps, £605, unenumerated, £1,0[illegible].

EXPORTS.

[illegible] E[illegible]ner, £69, unenumerated, £1[illegible]. *Me*[illegible] £2,0[illegible] [illegible]nery £513, telephone material £492 [illegible] Elec. m[illegible] £1,862; wire and cable £1,772, tele[illegible] [illegible]rated £784. *Wellington*: Elec. machinery, £110, w[illegible] £[illegible]9. *A*[illegible]: Elec. machinery, £680, unen[illegible] *Chr*[illegible]*h*: Elec. machinery, £8[illegible], wire and cable, £281; telegr[illegible] £44[illegible]. *Brisbane*: Unenumerated, £22. *Dunedin*: Wi[illegible] [illegible] Elec. machinery, £78; unenumerated, £62. *Fremantl*[illegible] £[illegible] unenumerated, £27. *New*[illegible]: Telegraph material, £[illegible] £34, unenumerated £59.

[illegible] Elec. machinery, £1,270, unenumerated, £1,644. *P*[illegible] £42[illegible] wire and cable, £175. *East London*: Elec. machi[illegible] £646. *Durban*: Elec. machinery £1,607, wire and cable [illegible] *Perth*: Unenumerated, £61. *Delagoa Bay*: Ele[illegible]

[illegible] £159. *Port Sudan*: Unenumerated, £39.

[illegible] *Bombay*: Wire and cable [illegible] £1,322. *Calcutta*: Elec. glow lamps [illegible] machinery [illegible], telegraph material £38[illegible] £341. *Ceylon*: Elec. machinery [illegible] £3[illegible] Elec. machinery, £612 [illegible] Unenumerated £734.

[illegible] £4[illegible] *Shanghai*: El[illegible]

[illegible] £2[illegible] *B*[illegible] Ele[illegible]

[illegible] £263 [illegible] unenumerated £33

[illegible] W[illegible] £7[illegible].

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £278. *Bombay*: Elec. lamps, 500 n.o. *Calcutta*: Unenumerated, £93. *Colombo*: Unenumerated, £56. *Bergen*: Unenumerated, £434. *Dieppe*: Unenumerated, £34. *Lisbon*: Unenumerated, £104. *Singapore*: Unenumerated, £19. *Calais*: Unenumerated, £59. *Copenhagen*: Unenumerated, £210.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Robert and John Edward Capper (trading as Fazackerley & Co.), electricians, &c., Market-street, Droylsden, have dissolved partnership. Debts by Mr. J. E. Capper, who continues the business as Fazackerley & Co.

Sale of Shares by Tender.—The Public Trustee invites tenders for the purchase of the whole or any part of 3,679 A shares of £10 each (fully paid) and 1,200 B shares of £10 each (fully paid) of the Tudor Accumulator Co. (Ltd.) which are vested in him as custodian by an order of the Board of Trade. Tenders must be delivered to the Public Trustee, Kingsway, London, W.C., on or before Monday, Feb. 26, and not Feb. 5, as previously advertised. *Further particulars are given in an advertisement.*

The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of April 2. *Further particulars are set out in an advertisement.*

Plant for Sale.—The Madras Electric Supply Corporation (Ltd.) has for immediate disposal in Madras some second-hand plant, including three 500 kw. Davey Paxman-Crompton c.c. sets and two 500 kw. Davey Paxman-Crompton a.-c. sets, with one 250 kw. and one 125 kw. Crompton motor-generators, one 250 B.H.P. and two 110 B.H.P. three-phase motors. Offers to the Secretary, 1, Queen-Victoria-street, London, E.C. *See also an advertisement.*

Messrs. W. H. Allen, Son & Co. (Ltd.), Queen's Engineering Works, Bedford, have for sale a second-hand 150 kw. 2,500 revs. per min., 250 volt, d. c. direct coupled turbo-generator set, with surface condensing plant.

Patent Development.—The proprietors of patents Nos. 12,547 of 1912 and 8,831, 11,177 and 10,864 of 1913, relating to "Telephone lines and apparatus," desire to sell the patents or to license British manufacturers. Particulars from Messrs. Boult, Wade & Tennant, 111-112, Hatton Garden, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barrow-in-Furness.—Last week the Corporation decided to apply to the L. G. Board for sanction to borrow £14,255 for extensions of the electric supply department.

The electrical engineer (Mr. H. R. Burnett) had reported that the great increase had recently taken place in the demand for electricity, and the Electricity Committee had approved his suggestions to extend the works at a cost of £25,800.

In moving the adoption of the report, the chairman (Ald. Smith) said the estimates were merely a repetition of what the Council has already passed. They had been passed on separate occasions. They estimated in January last year for £10,300 and in July increased it by £3,955. In the minutes for July they would find the Council approved, but it was not in the particular form the L.G. Board wanted. They had now sent in a fresh application, and the committee had now the consent of the Board to go on with the work. They could arrange about the details of the loan afterwards.

Battersea (London). The Borough Council is applying for sanction to a loan of £1,000 for extension of mains, &c., in the Nine Elms district.

The following increases of salary of the staff have been approved by the Finance Committee: Mr. F. A. Bond, electrical engineer, from £700 to £725 per annum; Mr. H. F. G. Thompson, assistant engineer, from £285 to £310 per annum; Mr. T. Bennett, station superintendent, from £205 to £225 per annum; Mr. E. S. Colley, Mr. G. E. F. Evans and Mr. H. A. Healy, shift engineers, from £160 to £170 per annum; Mr. W. T. Magrath, mains assistant, from £132 10s. to £150 per annum; Mr. W. Meare, meter superintendent, from £156 to £166 per annum; Mr. A. S. Knight, installation inspector, from £125 to £130 per annum; Mr. J. C. Adams, office clerk, from £107. 10s. to £115 per annum.

Bethnal Green (London). The Borough Council is recommended to apply for authority to borrow £1,000 for house services, &c.

Burton-on-Trent.—As the generating plant is only sufficient to supply consumers already connected and consumers in hand, the Electricity Committee has prepared a scheme of extensions at the electricity works.

Application is, therefore, to be made to the L.G. Board and the Treasury for sanction to borrow £25,000 for plant, &c. Two motors for driving in connection with the supply of power to the English Grains Co. are to be purchased.

Sheffield.—Electric supply mains are to be extended at an estimated cost of £1,255.

The general manager of the electricity undertaking (Mr. S. Edgar Fedden) has been authorised to accede to an application from the Electrical Trades' Union for an increased rate of pay up to 49s. per week for wiremen, cable jointers, and skilled electrical workmen.

The General Manager has also been authorised to engage six temporary draughtsmen and such other technical assistants as he may require in preparing plans and specifications for the buildings and equipment of the new power house at Blackburn Meadows. One 10½ in. lathe and one screwing machine for the fitters' shop at Neepsend station are to be purchased at a price not to exceed £237.

Shoreditch (London).—The borough electrical engineer (Mr. C. Newton Russell) recommends the installation of a turbo-generator set, in place of a reciprocating set, at an estimated cost of £41,000.

Stockport.—At the last meeting of the Council it was announced that the generating plant was working to the utmost of its capacity, and the power supply and the tramways would be affected by a breakdown. The Electricity Committee is, therefore, to urge the Government to grant facilities for providing additional plant.

Wolverhampton.—Two feeder cables are to be laid at an estimated cost of £11,020.

GENERAL.

Exeter.—The Electricity Committee has granted the following increases of salary to members of the electrical engineering staff :—

First shift engineer, £120 to £140 ; second shift engineer, £100 to £120. third shift engineer, £100 to £120 ; foreman engineer, £2. 2s. to £2. 5s. The committee has been empowered to graduate the pay within the scale as it may deem expedient.

Liverpool.—In moving the adoption of the estimates of the electric supply department, Mr. Russell-Taylor stated at the Corporation meeting last week that in 1916 the Corporation sold over 60,000,000 units of electric current, compared with 40,000,000 units in 1912.

In the latter year the Corporation made a profit of £51,000, but last year they almost doubled that, and out of it gave £55,000 to the relief of the rates.

Mr. GATES complained that though the new electrical plant was consuming less coal much than the old plant, the public consumer had had no reduction in price for 15 years.

The motion was then passed.

Manchester.—The accountancy and secretarial branches of the electric supply department are to be separated, but both are to be under the control of the chief electrical engineer, Mr. S. L. Pearce, whose title will be chief engineer and manager.

Monmouth.—Last week the Council were informed that the severe frost had caused damage at the electricity works and to the weir.

The turbines were frozen on one day. The ice on the River Monnow had had to be constantly broken and cleared up to the weir, where it accumulated, and the water, being unable to flow over, caused a much greater pressure than ordinary, the result being that the weir gave way. If they could go on until the spring then they would have to take the matter in hand and complete what was left undone some years ago.

Newport (Mon.).—On Tuesday the Town Council increased the salaries of Mr. A. Nichols Moore, borough electrical and tramways engineer, and Mr. N. J. Young, general manager of the electricity and tramways department, by £100 each per annum.

Worcester.—The Corporation are recommended to sell the existing storage battery, and to purchase out of the proceeds a 25-kw. motor balancer.

TRACTION NOTES.

Dudley.—A collision between two tramcars last week resulted in the death of one of the drivers and injuries to several others.

The inquest on the woman Payne, who was killed in the tramcar accident on Jan. 4, was concluded last week.

The driver of the car, BENJAMIN DAVIES, said he put on the hand-brake and securing chain and went to the messroom at Dudley terminus. Later he was told that the car had overturned.

MAGGIE JENSON, the conductress, said she "gave two bells" and then released the brake, without looking to see if the driver was in his place. She should have received two answering signals before she released the brake, and she admitted that she did not get them.

The CORONER said the jury must have regard to the fact that in these times we had to put up with much that we did not like. They had had the advent of the conductresses. All allowance must be made for the frailties of human nature, and in that particular case for the inexperience of a girl.

The jury found that death was due to misadventure caused by the carelessness of the conductress in releasing the brake without convincing herself that she had received the proper signal. They were of opinion that the tramway company were to blame for not having made some arrangement that would have prevented the accident, and strongly urged immediate provision against a recurrence.

Glasgow.—The Corporation had an important and interesting agenda to go through last week.

The members unanimously agreed to invest £2,000,000 in the War Loan.

Mr. MONTGOMERY, in moving the minute of the Tramways Committee, said they proposed to liquidate the entire debt of the tramways department by transferring from the depreciation and renewals fund to the sinking fund a sum which would make the sinking fund equal to the entire capital expenditure of the department (£3,800,000). It was a matter of great gratification that the Committee were in a position to make such a proposal, and thus to have the system entirely free from debt. That had been achieved in the comparatively short period of 16 years. It was a remarkable achievement, without parallel in the history of any tramway or other municipal undertaking in the United Kingdom, and the result had been arrived at without any cheese-paring or impoverishing policy. They had maintained the entire plant in a state of complete repair. They had carried out a broad and progressive policy, and they had given the citizens a service which for convenience, efficiency and cheapness was unsurpassed by any tramway undertaking in the United Kingdom It was true that at present they had some complaints, but that they were working under abnormal circumstances, and he thought the citizens should be glad they were getting such a service as they had. Some tramways had been compelled to restrict their services and others to raise fares. He hoped Glasgow would not require to resort to those expedients. As to the future finance of the department, he said that last year they provided £174,000 for depreciation and renewals. This year they proposed to lay aside only £73,000, so that on that score there would be a saving of £101,000 in the current year. Next year the sinking fund would also cease to be a charge upon the revenue of the department. That fund amounted to £120,000, so that by 1918 there would be a net saving on the charge against the revenue of something like £221,000. It seemed to him that that opened up a vista of a very substantial surplus for the common good. They recognised that the proud position in which the tramways undertaking stood to-day was due to the sagacity, wisdom and foresight of the men who had guided its affairs since its inception.

The minute was seconded and approved amid applause.

Halifax.—Last week the Council was recommended by the Tramways Committee to increase the tramway fares 50 per cent. and also to reduce the service.

Ald. C. F. SPENCER, chairman of the Committee, in moving the adoption of the minutes, said a reduction in the service of cars had become absolutely necessary. The staff was depleted and overworked, and the cars needed to be overhauled. The present service of cars must be reduced by 25 per cent. It was proposed to run the last cars about 10.30 p.m., and to reduce the number of cars now run during those times of the day when there were fewest passengers. The Committee calculated that if the present fares were maintained, and the service of cars reduced by 25 per cent., there would be a loss in revenue of £14,000 per annum. Besides having to provide £3,000 next year for war bonuses, there would be a payment of £2,400 for income tax, and an increase of £2,500 in interest on loans. Having regard to the increased expenditure, the increase in fares had been recommended. If the Finance Committee would forego the £6,000 devoted to relief of rates, the Tramways Committee might be able to pull through without increasing the fares.

Several members criticised the proposal to increase the fares, and this portion of the minutes was referred back by a large majority.

Hull.—Owing to the decision of the Council to retain halfpenny fares the Tramways Committee has appointed a sub-committee to devise a working scheme.

The manager (Mr. W. J. McCombe) had reported that owing to the great pressure on the staff owing to the half-penny stages the fares could not be collected. War conditions and short stages did not coincide with a revenue proportioned to enormously increased expenses. He suggested four stages on seven routes in place of the original three stages, and the elimination of 48 stopping places.

L. & Y. Railway.—In the directors' report of the Lancashire & Yorkshire Railway Co. it is stated that the electric trains on the Manchester and Bury line commenced running on April 17 last, and the service has since been maintained with every satisfaction.

Liverpool.—The estimates of the Tramways Committee were approved by the Corporation last week.

The chairman of the committee (Mr. E. RUSSELL-TAYLOR), in moving the adoption of the estimates, claimed that Liverpool possessed a unique municipal commercial undertaking in its tramway and electrical departments. Before making their contribution to the rates, the whole undertaking was carefully considered, and the committee felt perfectly justified in asking the Council's acceptance of £125,000 from the tramways. The result had exceeded their most sanguine anticipations. During 1916 they had made a greater profit on the tramways than prior to the war.

notwithstanding that their expenditure had increased by £147,000, of which £50,000 represented increased wages and bonuses to employees. He hoped that the time of low wages had gone by, and he hoped that in return the tramways employees would give them of their best. In 1916 they carried 157,636,595 passengers, or 13,500,000 more than in 1913, which was a record year. Included in those figures were 4,750,000 soldiers and sailors carried free of charge. Having spoken in discouragement of any reduction in fares, Mr. Russell-Taylor mentioned that 1,900 tramway employees had joined the forces and of these 100 had been killed. He agreed that the tramcars were overcrowded, but it was a physical impossibility to prevent that. The people of Liverpool were becoming a greater travelling public. For one thing, more women workers wanted to use the cars than formerly. They must remember that we were at war: their attenuated staff were working at the highest possible pressure. The Committee could not look forward to another year similar to 1916. They had obtained a fair percentage of their increased profit from war and munition work, but they hoped that the war would end in 1917. As to after-war developments, the committee would be able to supply energy for all the new works that would be erected. He warned the Council not to expect the same amount contributed to the rates next year as this year. Ere long a scheme for affording increased travelling facilities, such as were not offered to any other section of the public in the land, would be thought out.

Mr. H. R. Rathbone expressed the view that a report should be submitted, signed by a permanent official certifying that after the large allocation to the rates there was a sufficient reserve to meet depreciation, renewals, repairs, alterations, &c.

Alderman Cohen said that Mr. Barrow, the controller of accounts, had given an absolute assurance to that effect.

Maidstone.—The salary of the tramways manager (Mr. Lambert) has been increased to £300 per annum.

Maintenance of Trackless Trolley Routes.—Serious difficulties are being experienced in connection with the running of the trackless trolley cars of Leeds Corporation between Guiseley and Otley.

During the wet weather which preceded the frost the cars are asserted to have damaged the surface of the roads so as to make them dangerous to ordinary vehicular traffic. Complaint was made to Leeds Corporation, but they replied that inasmuch as they paid three-eighths of a penny per running mile towards the upkeep of the roads, but had been allowed to get into such a shocking state that their rolling stock was being knocked to pieces. Representatives of the County Council agree that the roads are in a terrible condition, but the cost of putting them right would run into four figures, and labour is scarce. Meanwhile the roads are being patched up here and there, and drivers have to do the best they can, but naturally the road is going from bad to worse. Leeds Corporation may stop the service of cars altogether, and they claim that they would be within their legal rights in stopping payment of the contribution to the upkeep of the roads if the roads are not maintained.

Manchester.—A draft report has been prepared by a sub-committee of the Traffic Congestion Committee which was appointed to consider the best means of relieving the great pressure of traffic in the central parts of the city.

The report proposes the use of a portion of the old Infirmary site for the establishment of a tramway terminus and for the erection of tramway and other municipal offices, leaving as an open space the remainder of the site. It is also proposed to use other open spaces and squares in the centre of the city for tramway terminals and to construct six new arteries. To meet the tramway needs the report suggests a reduction of tramway traffic within a prescribed area in the centre of the city, besides the cutting of new streets and the establishment of new terminals, the construction of new thoroughfares, &c. It is further proposed to unite Albert-square and St. Peter's-square with a new street, and then to use these open spaces as tramway terminals. With reference to the Salford side of the city, the Sub-committee suggest that the Manchester and Salford authorities should confer with each other on the question.

Middlesex Tramways.—Finchley Urban Council has asked the Metropolitan Electric Tramways (Ltd.) to give an improved tramway service between North Finchley and Golders-green and Cricklewood and also on the Highgate-Barnet route.

Nelson.—The Electricity & Tramways Committee have appointed a sub-committee to consider upon the proposed alteration of the stages on the Barrowford route and the revision of charges for workmen's tickets.

Sheffield.—Owing to the curtailment of the railway services, there is need for additional tramcars on the Sheffield and Rotherham through service at certain periods of the day, and a meeting is to be arranged with the Rotherham Tramways Committee on the question of a more frequent service.

As the Ministry of Munitions has not granted a permit for the purchase of 25 new tramcars, the offer of the London County Council to sell 10 four-wheeled double-deck cars is to be accepted.

The Tramways Committee has confirmed the action of the City Surveyor in purchasing [illegible] from Brighton Corporation.

The cost of constructing new top covers required for converted single-decked cars (£700), the construction of which is being continued in the department's workshops, is to be paid for out of revenue.

Substituted Tramcar Drivers.—In order to meet the shortage of tramcar drivers the War Office will release from the Army motormen who are not in Class A, in exchange for other tramway workers up to 30 years old who are Class A men.

Torquay.—The dispute between the Council and the local Tramways Co. as to the charge for current for traction has been settled.

The company will pay £250 extra for the period from Aug. 1, 1915, to July 31, 1916, and 10 per cent. extra per unit as from the latter date.

MISCELLANEOUS NOTES.

Conciliation Board for Government Employees.—A Conciliation and Arbitration Board for State Employees has been appointed as follows:—

Sir William Collins, M.P. (chairman), Sir A. Kaye Butterworth and Mr. Harry Gosling. The Board will consider claims for increased remuneration, but they have no power to deal with claims made on behalf of individuals. The secretary of the Board is Mr. G. M. Hodgson, 1, Whitehall-gardens, London, S.W.

Customs Duties.—According to a recent decision, apparatus for transmitting written or spoken messages is subject to import duty under No. 524 *bis* of the tariff as "electrotechnical apparatus."

The transmitter and registering apparatus are considered as one apparatus and the telephone attachment as another. If the parts are imported separately each part is regarded as one apparatus.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding up of 401 businesses controlled by alien enemies.

The latest orders are in the cases of the Brimsdown Lamp Works (Ltd.), Kingsway House, Kingsway, London, W.C., manufacturers of and dealers in electrical lamps and fittings (Controller: H. J. Morland, 3, Frederick's-place, Old Jewry, E.C.) and Coal Distillation Co., Middlesborough, manufacturers of coke ovens and kye-product plants (Controller: G. B. Nancarrow, Royal Exchange, Middlesborough).

The Controller of Maschinenfabrik Augsburg-Nurnberg A.G. has applied for a release. Objections to the Board of Trade before Feb. 17.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country during January, 1917, with increase or decrease compared with January, 1916:—

Electrical machinery, £133,329 (increase £35,824); including generators and motors other than for aeroplanes, motor cars and cycles, £22,653 (increase £6,300); and electrical machinery unenumerated, £110,676 (increase £29,524); telegraph and telephone cables other than submarine, £27,256 (increase £13,848; telegraph and telephone apparatus, £3,098 (decrease £11,651); other electrical wires and cables, rubber insulated, £10,582 (increase £7,858; with other insulations, £1,479 (increase £852); carbons, £7,088 (decrease £4,276); glow lamps, £19,696 (increase £6,181); arc lamps and electric searchlights, £38 (increase £38); parts of arc lamps and searchlights (other than carbons), £11,965 (increase £5,541); primary and secondary batteries, £44,477 (increase £19,832); meters and measuring instruments, £5,264 (increase £237); switchboards, nil (decrease £223); electrical goods and apparatus unenumerated, £45,109 (increase £18,913). Total of electrical goods and apparatus other than machinery and uninsulated wire, £176,052 (increase £57,150).

Exports.—The exports of electrical machinery, material, &c., during January, 1917, with increase or decrease compared with January 1916, were as follows:—

Electrical machinery, £177,024 (increase £74,411); including railway and tramway motors, £2,585 (decrease £559); other generators and motors except for aeroplanes, motor cars and cycles, £881 (increase £233); and electrical machinery unenumerated, £790 (increase £272); telegraph and telephone cables, submarine, £28,825 (increase £9,599); other than submarine, £124,096 (increase £69,891); telegraph and telephone apparatus, £17,357 (decrease £6,606); other electrical wires and cables rubber insulated, £50,066 (increase £11,353); with other insulation, £36,172 (decrease £9,040); carbons £352 (decrease £175); glow lamps, £11,004 (decrease £1,014); arc lamps and searchlights, £86 (decrease £1,872); parts of arc lamps and searchlights (other than carbons), £287 (decrease £479); primary and secondary batteries, £19,929 (decrease £2,770); meters and measuring implements, £14,088 (decrease £453); transformers, £3,208 (increase £121); switchboards, £1,821 (decrease £3,726); electrical goods and apparatus unenumerated, £63,793 (increase £26,322). Total of electrical goods and apparatus, other than machinery and uninsulated wire, £371,084 (increase £91,151).

Radio-Telegraphy in Spain.—A decree has been issued placing all wireless telegraph stations in Spain under official supervision, and henceforth they will be worked under State control.

Will.—Sir Geo. Franklin, a director of the British Thomson-Houston Co., the Lanarkshire Tramways Co. (Ltd.), &c., and Pro-Chancellor of Sheffield University, left estate of the value of £108,167, of which £98,625 is net personalty.

He left contingent legacies of £25,000 to the University of Sheffield and of £5,000 to Sheffield Corporation, the income to be applied by the local education committee in providing scholarships tenable at Sheffield University for boys and girls educated at the Central Secondary School.

TENDERS INVITED.

Railway Stores.

The Great Central Railway Co. invite tenders for the supply during the six months ending Oct. 31, 1917, or during the 12 months ending April 30, 1918, of various stores and Materials, including Asbestos Packing Sheets and Boiler Covering; Carriage and wagon Fittings; Drysaltery, Gas, Water and Steam Tubing and Fittings; Glass; India Rubber; Hardware, Oils; Screws; Signal Materials; Steel Angles, bars, &c.; Sundry Tools; Varnish, Wire, &c. Samples and patterns may be seen from Feb. 26 to March 5 inclusive in the Public Hall of the Conservative Club, Gorton-lane, Gorton, Manchester, and specifications and forms of tender may be obtained from the stores superintendent, Mr. Walter Williams, Great Central Railway, Gorton. Tenders to the secretary, Mr. Oliver S. Holt, Marylebone Station, London, N.W., by 9 a.m. of March 6. *See also an advertisement.*

Electrical and Tramway Stores.

The Electricity Committee of Bolton Corporation invite tenders for Materials and Stores for year ending March 31, 1918, including Lubricating Oils, Joint and Service Fuse Boxes, Jointing Materials, Wire, &c., Meters, Motors, Motor Starting Switches, Transformers, Ironmongery, Stoneware, Cable Troughs, Covers, &c. Specification and form of tender from the borough electrical engineer (Mr. W. J. H. Wood), and tenders to the Chairman of the Electricity Committee, Town Hall, Bolton, by noon March 7. *See also an advertisement.*

Hammersmith (London) Borough Council invite tenders for the supply of stores for the year ending March 31, 1918, including small Engineers' Tools, Metal Steam Tubes and Fittings, Hand Files, Steam Packing and Jointing, Oilmens' Goods, Electric Light Sundries, Insulated Wires, Cable Joint and Fuse Boxes, Insulating Compound, Hardware, &c. Forms of tender and further particulars from the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road. Tenders to the Town Clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W., by 4 p.m. of Wednesday, Feb. 28. *See also an advertisement.*

Bermondsey (London) Guardians require tenders by 6 p.m. Feb. 22 for 12 months' supply of Electric Lamps, Ironmongery, &c. Forms of tender from the Clerk, 283, Tooley-street, S.E.

Tenders are required by first post March 14 for supply of Electrical goods for one year to the Cheshire County Ayslum, Parkside, Macclesfield. Forms of tender, &c., from the Clerk.

The Powell-Duffryn Steam Coal Co. require tenders by 10 a.m. March 7 for supply of Electrical Goods, Iron, Rubber, Asbestos, &c. Forms of tender, &c., from the Stores Manager, Aberaman Offices, near Aberdare.

Croydon Council require tenders by 10 a.m. Feb. 19 for the supply of General Stores to the Tramways Department for three, six and twelve months. Forms of tender, &c., from the Tramways Manager.

Telephone Materials, &c.

Tenders are invited up to March 28 for the supply and delivery to the Postmaster-General's Department, State of South Australia, of Telephones, Telephone Parts, Cords, Line Material, Creed Tape, &c. Specifications, tender forms, &c., can be obtained at the Commonwealth Offices, London. *See also an advertisement.*

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Specification and conditions of contract from the offices of the High Commissioner, 32, Victoria-street, London, S.W., where tenders must be lodged by noon March 8.

Turbo-Alternator and Condensing Plant.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of Melbourne electricity works Tender forms from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Agents for the City Council, Billiter-square-buildings, London, E.C.; tenders to Chairman, Electric Supply Committee, Town Hall, Melbourne, by noon March 5.

Synchronous Condensers.

The Toronto Electric Commissioners invite tenders for Synchronous Condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28. *See also an advertisement.*

Electric Lamps, &c.

The Victorian Railway Commissioners require tenders by 11 a.m. March 21 for supply of 200 Half-watt Lamps, 100 Lanterns and 100 Contact Couplings. Specification, &c., from the Commissioners' offices, Spencer-street, Melbourne.

The Metropolitan Water Board require tenders by 11 a.m. March 8 for three, six, nine, or 12 months' supply of Electric Lamps. Forms of tender from the Chief Engineer, Savoy-court, Strand, London, W.C.

Boiler, Coal Bunker, Conveyor, &c.

The Electricity Committee of Harrogate Corporation invite tenders for the supply and erection of a by-product Steam Boiler, Overhead Coal Bunker, Coal Conveyor and Structural Steel Work. Specifications from borough electrical engineer, Mr. Geo. Wilkinson, M.I.E.E., to whom tenders are to be sent by March 5.

Coal Conveying Plant, &c.

Manchester Corporation want tenders by 10 a.m. March 7 for the supply and erection at Stuart-street station of Coal-conveying and Suction Ash Plant. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Copper Wire.

The Commissioners of H.M. Works invite tenders for the supply of Hard-drawn Copper Wire. Forms of tender from the Controller of Supplies, King Charles-street, S.W., and tenders to the Secretary, Storey's-gate, S.W., by 11 a.m. Feb. 16.

Wiring Conduits.

The Commissioners of H.M. Works, &c., require tenders by 11 a.m., Feb. 16, for the supply of Heavy Gauge Screwed Conduits. Forms of tender, &c., from the Controller of Supplies, King Charles-st., Westminster, S.W.

Train Lighting Cells.

The South African Railways Administration require tenders for the supply of 3,420 Train Lighting Cells, the approximate requirements for the year ending Feb. 28, 1918 (Tender No. 756). A revised drawing of the cells required may be inspected at the Railway Stores at Cape Town, Port Elizabeth, East London, and Durban and at the office of the Chief Railway Storekeeper, Park Station Chambers, Johannesburg.

TENDERS RECEIVED AND ACCEPTED

Sheffield.—The Corporation has accepted the following tenders:—

Electric Construction Co., supply and erection at Newhall-road sub-station of d.c. traction, switchboard, converter and feeder panels; A. Reyrolle & Co., supply and delivery of h.t. 3,000 volt loose sub-station switchgear; Mortimore Lyon & Co., generating set and condenser for charging electric vehicles, £810.

Wolverhampton.—The Council have accepted the following tenders:—

A. Reyrolle & Co., two switch panels with necessary instruments, transformers, &c., £670; Staveley Iron Co., condenser water pipes, £750.

Weymouth.—The Council have accepted the tender of Johnson & Phillips for supplying and laying cables, at £5,520, and also for boosters and switchgear, at £980.

Chascomus (Argentina).—The Municipality has received two tenders for an electrical installation for the town.

The amount of the tender of the Sociedad La Energia Electrica was $170,000 m.n. (about £14,800) and that of the Compañia Anglo-Argentina de Electricidad $150,000 (about £13,000), $30,000 in cash and the remainder in instalments over 10 years.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.).—The gross revenue for the year ended Aug. 31 last was £136,511, against £119,898 for the preceding year, an increase of 17 per cent., compared with an increase of 7 per cent. in 1915. After payment of debenture interest and management and general expenses in London and Adelaide, and after allocating £9,320 7s. 6d. to debenture stock service fund and £3,000 to reserve for excess profits duty, the credit balance is £52,046. It is proposed to pay a final dividend of 5 per cent. (tax free) on the ordinary shares, making 10 per cent. for the year, and a bonus of 2 per cent. (tax free), leaving to carry forward £1,240. With £7,921 brought forward the total credit balance to be carried forward is £9,160.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—At the meeting last week the chairman (Mr. W. M. Murphy) stated that the direct loss caused by the rebellion in Easter week was small, but in traffic, &c., their total loss was about £15,000. Notwithstanding that their gross receipts were £1,435 over those of 1915; in fact, their total receipts (£335,335) created a record. They were able to pay a final dividend of 5 per cent., making 4½ per cent. for the year on the ordinary shares. Their expenses also created a record, being £11,478 over those of 1915, and of this excess coal accounted for £5,219, though the quantity consumed, owing to savings effected by various mechanical and electrical economies, was less by 1,230 tons. The price of coal, however, which averaged 18s. 5d. per ton in 1915, cost 24s. 5¼d. in 1916. They would have to pay a still higher price for coal supplies when the present contracts ran out in about a month's time. The items under "Maintenance" showed an increase of £3,694. The cars had been greatly improved, and new and more powerful car motors and electrical equipments had been fitted in several of the cars. Permanent way maintenance accounted for £1,646 of the increase. The only relaying of track executed during the year was the work at Kingsbridge and Drumcondra-road involved in the alteration of levels of the road by the Corporation. That work cost them £2,254, which was charged against the special reserve for renewals of rails. For rail relaying they were placing £20,000 out of the year's surplus. There had been no increase of fares and the year's result was therefore creditable.

EDISON SWAN ELECTRIC CO. (LTD.)—At a meeting of the holders of the first debenture stock on Monday a resolution approving a scheme of arrangement was passed. The Chairman (Mr. C. J. Ford) observed that the scheme provided for £160,000 of new money being brought into the business, through the medium of the issue of 100,000 preference shares, for the increase of the interest payable upon the first debenture stock from 4 to 5 per cent. per annum, together with the increase of the interest upon the second debenture stock from 5 to 5½ per cent. per annum, for the provision of an annual sinking fund for the redemption of both classes of debenture stock, and the ultimate merging of the second debenture stock with the first debenture stock into one class, bearing interest at 5 per cent. per annum, and for the relinquishment of the security which both classes of debenture stock held on the £2 per share uncalled upon the partly-paid "A" shares.

ELECTRICAL & INDUSTRIAL INVESTMENT CO. (LTD.)—At the meeting yesterday (Thursday) it was reported that the profit for the year 1916 after payment of all management expenses and interest on debenture stocks, was £13,489. 13s. 6d., and with £10,877. 15s. brought forward, the total available was £24,367. 8s. 6d. The directors recommended payment of the dividend for the year on the 6 per cent. cumulative preference shares (£6,000) and a dividend of 5 per cent. on the preferred ordinary shares (£5,000), carrying forrward £13,367. 8s. 6d.

The report and accounts were adopted.

METROPOLITAN RAILWAY CO.—At the meeting last week the chairman (Lord Aberconway) stated that the Government control of the railways would no doubt remain in force until the work of demobilisation [illegible] and the business of the country resumed its normal course. What the actual traffic revenue of the company was the board could not tell, for the ordinary operations of the Clearing House were suspended, and [illegible] debited with the mileage portion of through fares over [illegible] booked at their offices. At the same time, they [illegible] general affairs, and were sparing no [illegible] business. What the position [illegible] would be after the war it was impossible to say. [illegible] guarantee terminated, they [illegible] before the war, [illegible] would be faced with very [illegible] were permitted to take [illegible] would not be [illegible]

UNDERGROUND ELECTRIC RAILWAYS CO (LTD.—The revenue for the [illegible] to Dec. 31 last [illegible] 1915 [illegible] bonds is chiefly due to the increased income-tax and loss in exchange on coupons paid abroad. The revenue shows a reduction of £27,000, while the increased income-tax and loss in exchange exceed £56,000.

YORKSHIRE ELECTRIC POWER CO.—The net profit for the year 191 after payment of mortgage and other interest, is £29,112. 4s. 1d., compared with £21,209. in 1915 and £20,535 in 1914. With £2,477. 18s. 5d. brought forward the total is £31,590. 2s. 6d. The directors recommend payment of a dividend for the year (less tax) at rate of 6 per cent. per annum on the preference shares, and of 3 per cent. on the ordinary shares, the transfer of £12,000 to general reserve fund, carrying forward £3,866. 5s. 6d. Seventy-eight members of the staff are serving in His Majesty's Forces and five have been killed. The directors desire again to recognise the loyal services of the staff rendered under very difficult conditions. The cost of both labour and supplies has been heavy, but the accounts indicate that the Company has now returned to the steady progress interrupted by the war. The advantage of the company's supply is being realised, and to meet demands in every part of the company's area (especially in the southern and eastern divisions where collieries and steel works are being rapidly developed), it has been necessary to order additional generating plant. Owing to urgent requirements for power suplpy £60,000 is being advanced by the Government towards the cost of the extension now being made.

CITY NOTES.

MEMORANDA (Feb. 13).—Consols, 51 $\frac{5}{16}$. Consols Pay Day March 1. Stocks and Shares Ticket Day, Feb. 22. Pay Day, Feb. 23. Price of Silver, 38 $\frac{7}{16}$d.

CENTRAL ELECTRIC SUPPLY CO. (LTD.—The accounts for 1916 show, after including £8 brought forward and paying interest on debenture stock, placing £19,557 to depreciation and writing off £1,257 (one-half), discount on issue of debenture stock, a credit balance of £6 to be carried forward.

CENTRAL LONDON RAILWAY CO.—The directors recommend the following dividends:—On the undivided ordinary stock for the half-year ended Dec. 31 of 1¾ per cent. (making 3½ per cent. for year), on the preferred ordinary stock 2 per cent. (making 4 per cent. for year), and on the deferred ordinary stock for the year 1916 3 per cent., carrying forward £12,079.

CITY & SOUTH LONDON RAILWAY CO.—A dividend of ¾ per cent. has been declared on the consolidated ordinary stock for the six months ended Dec. 31, making 1½ per cent. for year. £17,245 is carried forward.

DAVIS & TIMMINS (LTD.)—The directors propose to pay a balance dividend at rate of 10 per cent. per annum on the Ordinary shares for the half-year to Dec. 31, making 8 per cent. per annum for the year (free of tax), and to pay in addition a bonus of 17 per cent. (free of tax), leaving to be carried forward (but subject to the special taxation of the year) £75,436.

L. & S.W. RAILWAY CO.—A dividend of 3½ per cent. has been declared for the past half-year on the ordinary stock, which, with the interim dividend, makes 5½ per cent. for 1916. This is after placing £20,000 to electrification revenue suspense account.

LONDON ELECTRIC RAILWAY CO—A dividend of ¾ per cent. has been declared on the ordinary shares for the half-year to Dec. 31, making 1½ per cent. for the year. £24,474 is carried forward.

METROPOLITAN DISTRICT RAILWAY CO.—The directors recommend the following dividends:—On the four per cent. guaranteed stock for the six months ended Dec. 31, 2 per cent. (making 4 per cent. for year), on the 4½ per cent. first preference, 2¼ per cent. (making 4½ per cent.), on the 5 per cent. second preference stock, 1½ per cent. (making 3 per cent.), carrying forward £20,688.

NORTH LONDON RAILWAY CO.—A final dividend of 1¾ per cent. making 3¼ per cent. for the year (the same as for 1915) has been declared. £5,000 has been placed to general reserve, and £10,000 (against £8,000) carried forward.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The share transfer books of this company are closed from the 16th inst. to March 2, inclusive, preparatory to the payment of dividends for the half-year ended Dec. 31, 1916.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.).—A dividend of [illegible] per cent. has been declared for the past year and about £1,000 is carried forward.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The directors propose to distribute, in addition to the interim dividend of 5 per cent. paid in July last, a further dividend of 10 per cent., together with a bonus of 12 [illegible] per share. The distribution is the same as in the [illegible] year.

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NOTES.

National Instruction in Technical Optics.

WE reproduce elsewhere a Report just issued by the Sub-Committee appointed by the Conjoint Board of Scientific Societies on Oct. 12, 1916, to consider instruction in Technical Optics. The Report very properly draws attention to the neglect of this important subject. As a preliminary step it recommends the appointment of a supervising representative Council to organise courses of study, operating through a Director of Studies, who will be responsible to the Council. Among other measures advocated are the translation of suitable works on optics in foreign languages, the organisation of day and evening courses at the Northampton Institute, and arrangements for higher instruction at some other institution of University rank. These steps, we gather, are designed to meet the immediate necessities of the situation which are urgent and it seems probable that in the future a National Institute, devoted exclusively to optical work, may be found necessary.

◆

To scientific men the limitations imposed on us by absence of instruction and facilities for research in applied optics have long been manifest. We recall that some years ago a scheme for a National Institute was put before the London County Council, but appears to have been side tracked. Shortly after the outbreak of war, when the shortage of optical appliances and the poverty of resources for manufacture led to very great difficulties, the British Science Guild addressed to the Minister of Munitions a memorandum urging that even at the eleventh hour an Optical Institute should be established. When one considers the vital importance of optical apparatus in the form of periscopes, telescopes, range-finders, &c., in almost every branch of warfare, and the known difficulties of providing even a fraction of the supply needed, it seems incredible that Mr. LLOYD GEORGE in his reply to this memorandum, should have been content to commend this matter to the generosity of private individuals, offering no promise of Government action. We believe that the sum suggested for the formation of the desired Central Optical Institute was very reasonable, indeed meagre; when one sets against this expenditure the loss arising through a single shot finding its mark owing to possible greater optical and range-finding resources on the part of the enemy, it seems extraordinary that the opportunity for developing the study of such optical munitions should have been so lightly dismissed. Optical apparatus, however, while essential to warfare, forms an important element in almost all varieties of scientific work. It enters into medical work, photography, photometry, chemical and physical apparatus. In the glass industry the absence of any widespread effective system of technical instruction has been a terrible handicap. Even now, as the Committee truly points out, years must elapse before an adequate supply of trained labour will be available, even if every nerve is strained at once to meet the deficiency. We can only hope that the recommendations of the Committee will be translated into prompt and effective action and that the coming of peace will find us at least better prepared in this respect than the outbreak of war.

Teachers and Organised Labour.

IN a note on this subject in our issue of the 26th ult. it was stated that one of the conditions of employment under an enlightened body like the London County Council was that all employés, including teachers, who engaged in outside work should hand over to the Council all moneys received. On good authority we hear that, so far as teachers are concerned, this is not the case. We regret that we were misinformed. It appears that teachers under the Council are allowed to engage in outside work provided such work does not interfere with the discharge of their duties, and provided they notify the principal of the college or school as to the amount of the fees they receive in executing such work. There is nothing in the first requirement to which exception can be taken: but, in our opinion, the second requirement falls little short of an impertinence. Why, we ask, should the Council be prepared to allow one of their servants to build up a private practice on condition that he discloses the amount of money he receives from such practice? Irksome restrictions of this kind may be used—not for a moment do we assert that they are so used—for limiting a man's earning capacity either under the Council or outside. It surely would be well to get rid of these "little" things from the resolutions of the Council. Since they disclose the amounts to their principals, perhaps those who have been allowed to engage in outside work will have no objection to disclosing the fact to us; and, perhaps, those who have not been allowed to undertake outside work will place the facts before us. Our desire is to improve the conditions under which teachers in technical institutions, and particularly engineering teachers, follow their employment.

On the Virtues of Gas and Truth

THE clever journalist who contributes the notes on "Electricity Supply Memoranda" in the "Gas Journal" takes exception to a recent note in these columns on the "Development of the Power Load." In the note referred to we said that our thoughts were on all the sinners, including those in the gas industry, who thought they had the right to use extravagantly every ton of coal they purchased, and to destroy everything in the coal except its calorific value. We only mentioned the gas industry because the "Memorandist" observed that we had a "rare good opportunity" of slating those electricity concerns which, through prior negligence, entered into the war period with plants demanding several pounds of coal per kilowatt-hour generated. From the "facts" given in the "Gas Journal" it is obvious that nearly everything in life must to be desired is due to the gas industry. When we said that for many years the gas engineers destroyed most things that were worth anything in coal we referred to the time, and that not very long ago, when illuminating gas, notwithstanding its virtues, was innocent of candle-power, and when the country side was laid bare on account of the non-recovery of the bye-products. The "Memorandist," being a gas expert, can fill in the blanks for himself. We are recommended to study the accounts of the gas engine manufacturers to ascertain whether gas-engine making is a decaying industry. There is no need to study accounts, for there are still some dark corners of the earth where an electricity supply is not available, and some equally dark corners where the demand for electricity supply is so great that the plant installed is insufficiently large to cope with the demand, with the result that many people, contrary to their wishes, are compelled to use gas engines to keep their shafting in motion. Legislative barriers set up by mistaken policies against industry, and from which barriers for years freedom has been sought, are not peculiar to the gas industry. It is on account of such barriers that "plants demanding several pounds of coal per kilowatt-hour generated" are allowed to waste coal; that every one in the country who so desires can generate his own power and not only waste coal but also man power; and that gas engines are allowed to compete with the electric motor. In thanking the "Memorandist" for his leaderette we would observe that uncertainty of motion in foreign territory is not peculiar to members of the electrical profession.

Electric Stabiliser for Aeroplanes. It is stated that a new form of electrical stabiliser for aeroplanes has been invented by Mr. Orville Wright. The idea of the gyroscope is rejected and instead a pendulum swinging in a liquid bath controls the supply of current to a small propeller placed immediately above the pilot's head. The arrangement is said to give automatic stability.

Electrical Equipment of American Automobiles. According to "The Motor" the double unit system of electrical equipment is becoming usual on American cars instead of the single or combination unit system. A separate lighting dynamo and starting motor appear to give the best results. The latest returns show that 81 per cent. of the 1917 cars have the double unit system as compared with 61·7 per cent. in 1916. The 6-volt system is now used on 89·5 per cent. of this year's cars, so that the low voltage may now be regarded as the standard one.

Luminous Efficiency of the Electric Arc. A recent contribution by E. Karrer in the "Journal" of the Franklin Institute describes some tests on the luminous efficiency of the radiation from various types of electric arcs. The measurement was carried out by means of thermopiles which could be shielded by cells containing special solutions transmitting only the luminous rays. The highest efficiency, about 19 per cent., was recorded with yellow flame carbons. This figure refers only to the nature of the radiation and losses in the lamp itself, *e.g.*, in the resistance it must also be considered.

Works Laboratories. A correspondent in "The Times Engineering Supplement" emphasises the importance of works laboratories. It is essential to the success of such laboratories that the physical and chemical problems which arise should be studied with a keen eye on commercial and practical considerations. Therefore the head of such a laboratory should preferably be, not a technical student fresh from college, however gifted, but a man who has had a scientific training and subsequently gained experience in practical work. An important supplement to the work of such laboratories is the methodical collection and indexing of technical information.

Output of Steel in the United States. According to the "Iron Age" the production of pig iron of the United States last year amounted to 39,450,000 tons, which is about 30 per cent. in excess of the output for 1915. The production of steel during the same period was probably in excess of 42,000,000 tons. A total of 103 open hearth furnaces were completed in 1916, and the electric furnace is now making distinct progress, the estimated number contracted for or in operation at the beginning of the present year being nearly double the number in use at the commencement of 1916, and roughly a third of the total number of such furnaces in operation throughout the world.

The S. P. Thompson Memorial. We understand that sufficient support has been secured to ensure the purchase of the library of the late Prof. S. P. Thompson, and that definite steps are now being taken to secure this library for presentation to the Institution of Electrical Engineers. We should like, however, to make a further suggestion. It appears to us that a portrait, which might, perhaps, be appropriately hung in the library of the Institution, might very well form part of the memorial, and would cost a comparatively small sum in addition to that required for the main object. To his old students, and to many others, a portrait would convey very much more than the somewhat necessarily dry bones of ancient literature, however valuable these may be. We all know of the Ronalds' library, but is not Ronalds rather a name than a reality to the members of the Institution? A portrait of the late S. P. T. would do something to secure the reality as well as the name.

Substitution in Reserved Occupations. Recently the Reserved Occupations Committee sent a letter and memorandum on the question of substitution in reserved occupations to the Incorporated Municipal Electrical Association, and the hon. secretary of the Association (Mr. H. Faraday Proctor) has now issued copies of the letter and memorandum to its members.

In his covering communication Mr. Faraday Proctor points out that the committee particularly desire that all electrical undertakers should take action in this matter as speedily as possible, and that disabled soldiers and sailors should be used as far as possible at electric generating stations, but that if a sufficiency of such disabled men is not forthcoming there may be no delay in introducing women for occupation where their services are capable of being used. You will probably be aware of what is being done in the matter of training disabled soldiers and sailors at the Northampton Institute and elsewhere; in which matter the Institution of Electrical Engineers is taking a prominent part. The question of data as to the sufficiency of men for the various positions, as also the question of technical advice in the matter of retaining a sufficiency of skilled operators in electricity works, is receiving attention at the present time."

Board of Fuel Research. A Board of Fuel Research has been appointed by the Committee of the Privy Council for Scientific and Industrial Research on the recommendation of their Advisory Council.

Sir George Beilby, F.R.S., has consented to act as Director of the new organisation, and he will be assisted by the Hon. Sir Charles Parsons, K.C.B., F.R.S., Mr. Richard Threlfall, F.R.S., and Sir Richard Redmayne, K.C.B., Chief Inspector of Mines, as members of the Board.

The Reconstruction Committee of the late Government appointed a strong sub-committee on coal conservation under the chairmanship of Lord Haldane in July, 1916, which has suggested important subjects for research, while both the Admiralty and the Ministry of Munitions have been interested in fuel problems, and have been making tests and investigation. The Advisory Council have conferred with Lord Haldane's Committee and with the British Association Committee for the purpose of co-ordinating all the research at present being undertaken or to be undertaken in future, and complete agreement has been reached. All proposals for research into fuel initiated by the Coal Conservation Sub-Committee will be referred to the Advisory Council for their consideration, and under the new arrangements will stand referred to the Board of Fuel Research, which, if the proposals are approved, will be responsible to the Council and to the Committee of the Privy Council for carrying them out. It is understood that the British Association Committee will transfer all the material they have collected to the new Board, and it is hoped and anticipated that the activities of the Admiralty and of the Ministry of Munitions will also be co-ordinated with those of the Board, for the Director (Sir George Beilby) is already in consultation with the officers of both departments who are concerned in these matters.

It will be the work of the Board to investigate the nature, preparation and utilisation of fuel of all kinds, both in the laboratory and, where necessary, on an industrial scale. Sir George Beilby, with the assistance of his board, will be responsible for drawing up schemes of research into these problems; and when the schemes have been approved by the Advisory Council and the Committee of the Privy Council authority will be given him to carry them into effect.

By arrangement with the Governors of the Imperial College of Science and Technology the Lord President has retained Prof. W. A. Bone, F.R.S., as Consultant to the Board of Fuel Research under the Department of Scientific and Industrial Research. Prof. Bone will continue to hold his chair at the Imperial College, but he will abandon all private consulting work while connected with the department.

OBITUARY.

John Rennie.—It is with deep regret that we have to record the death of Mr. John Rennie, M.I.E.E., Electrician to the Board of Trade, which occurred on Monday last. He was one of the pioneers of accurate electrical measurement and his experimental researches in connection with meters have been of great value to the electrical supply industry.

John Rennie was born at Newton-on Ayr in 1850 and was educated at the Free Church School. On leaving school he entered the service of Messrs. Barclay, Curle & Co., the well-known Clyde ship builders. In 1876 he entered Glasgow University and went through both the Arts and Engineering Courses. He specially distinguished himself in physical laboratory work, gaining a "Thomson Experimental Scholarship," which he held for three years. In 1881 Sir William Thomson (Lord Kelvin) appointed him his secretary and private assistant, a post which he held for nine years. In 1890 he was appointed Electrician to the Board of Trade; his special duties being to superintend the work of the electrical laboratory. In his capacity as assistant to the Electrical Adviser to the Board of Trade he took an active part in equipping and organising the electrical standards laboratory, and carried out the experiments for establishing the various electrical standards and sub-standards.

Although Mr. Rennie's work was of great value to the industry its importance was appreciated by few. He sometimes joined in the discussions at the Institution. He displayed no small gifts as an orator, and his remarks were always helpful and to the point. For instance, we remember him telling meter manufacturers that they should give more finish to the outsides of the meters so as to make them handsome and artistic. The meters would then get better treatment than when they look as if they had been picked off the scrap-heap. We have discussed many problems in connection with meters with Mr. Rennie and we have never met anyone with a wider or more varied knowledge.

Mr. Rennie was very loyal to his old chief, Lord Kelvin, and many of his reminiscences showed him in a very kindly light. As a lecturer at Faraday House, Rennie was a great success. He had great powers of exposition and whether from the scientific or literary point of view his lectures were equally admirable. Inventors as a class are somewhat impatient of criticism and Rennie came across many. He always listened to them with the greatest courtesy, but never hesitated to give his unbiassed opinion on the merits of their inventions. Many of them were grateful and profited by his advice; others, with most crude ideas, only financial ruin could stop.

Shortly after the outbreak of the war Mr. Rennie's eldest son, who was an officer, was killed whilst with the Expeditionary Force in Northern France. He was a young man who had greatly distinguished himself at the City of London School and at St. John's College, Cambridge. The cutting short of such a promising life was a great blow to his father. He had consolations, however, in his other children, one of whom, J. C. Rennie, was lately Chairman of the Students' Section of the Institution of Electrical Engineers. Personally, John Rennie was one of the most modest and unassuming of men, and he will be sadly missed by a very large number of friends and acquaintances. A. R.

J. K. Crow.—We regret to announce the death of Mr. John Ken Crow, D.Sc., F.I.C., late managing director of Messrs. Wilkinson, Heywood & Clark (Ltd.).

A. W. Martin.—We also regret to announce the death of Mr. A. W. Martin, staff engineer of the G.P.O., which took place on the 14th inst. after an operation following an illness of three months.

Deceased, who was 44 years of age, was an associate member of the I.E.E., and served on the Council for 1915-16. The funeral took place at Highgate on Monday, and among those present were Mr. Percy Martin (brother), Sir Wm. Slingo, Dr. R. Mullineux Walmsley, Mr. W. Noble, &c.

Ald. J. Brodie.—The death also occurred on Monday of Ald. Joseph Brodie, Chairman of the Blackpool Tramways and Electricity Committee, and who has been identified with the municipal electricity supply and tramways departments for some years.

APPOINTMENTS VACANT AND FILLED.

A capable draughtsman, accustomed to switchgear design, is required. *See an advertisement.*

A large electrical manufacturing company requires a representative for Scotland. *See an advertisement.*

Messrs. Johnson & Phillips (Ltd.), Charlton, London, S.E., advertise for switchgear draughtsmen.

Mr. J. K. Bruce, deputy chief officer of the L.C.C. tramways, has been appointed traffic manager in the tramway department as from April 1, at the commencing salary of £1,250 a year, rising by annual increments of £50 to £1,500 a year.

Dr. J. Erskine-Murray has been appointed lecturer on wireless telegraphy at Faraday House.

Mr. C. A. Frost, assistant electrical engineer at Bexhill, has been appointed (at a salary of £300 per annum) chief electrical engineer to the Council, in succession to the late Mr. Le Feuvre.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, Feb 27th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Strength and Structure of Metals," by Prof. W. E. Dalby, M.A. (Lecture 1.)

Manchester Local Section, Institution of Electrical Engineers.

7 p.m. At the Engineers' Club, 17, Albert-square, Manchester. Paper on "Some Points in Connection with Engineering Specifications," by Mr. J. Shepherd.

Association of Supervising Electricians.

7.15 p.m. At St. Bride Institute, Ludgate-circus, E.C. Paper on "Modern Power Cables," by Mr. H. Savage, M.I.E.E.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week:—

Officer for the Week.—Platoon Commander A. Gerard.

Next for Duty.—Platoon Commander W. J. A. Watkins.

Monday, Feb. 26th.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.30 to 8.

Wednesday, Feb. 28th.—Instructional Class, 6.15. Platoon Drill, Platoon No. 2.

Thursday, March 1st.—Platoon Drill, Platoons Nos. 5 and 6. Ambulance Class by M.O., 6.30.

Friday, March 2nd.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill, 6.25 to 8.25.

Saturday, March 3rd.—2.45, Commanding Officer's Parade. Uniform.

Sunday, March 4th.—Entrenching at Otford. Parade Victoria (S.E. & C. Railway Booking Office) 8.45 a.m. Uniform, haversacks, water bottles. Midday rations to be carried. Railway vouchers will be provided.

Easter Training will be at *Esher*, where a course has been arranged under Royal Engineer Instructors. Names *must* be sent in to Orderly Room *not later than Feb. 28.*

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills, &c., will take place at Headquarters.

ELECTRICAL SYSTEM OF THE RAND POWER COMPANIES, WITH SPECIAL REFERENCE TO METHODS OF OPERATION AND EXPERIENCE.*

BY BERNARD PRICE.

Summary.—The object of this Paper is to describe the lay-out and operating characteristics of the electrical portion of one of the largest power schemes of to-day, and to place at the disposal of electrical engineers certain experience gained on that scheme during the last seven years. The Paper is confined to a consideration of the electrical system considered as a complete entity.

HISTORICAL NOTE.

The Victoria Falls and Transvaal Power Co., Ltd. (V.F.P. Co.), was promoted in 1906 with the object of supplying power to the gold mining industry and other consumers in the Witwatersrand district and of acquiring the concessional rights to develop the Victoria Falls. It was found that the capital charges of the hydro-electric scheme outweighed the cost of fuel in the steam station, and this, with other considerations, lead to a decision in favour of steam generated power.

In 1907 two small existing concerns were taken over and new stations were erected at Simmer Pan and at Brakpan thus enabling the existing plants to be scrapped and the requirements of new consumers to be met.

In 1908 the largest group of mines decided to electrify its mines throughout and to purchase all its power from the Rand Mines Power Supply Co., Ltd. (R.M.P.S. Co.), a subsidiary company of the V.F.P. Co., one condition being that the mines should also be furnished with a bulk supply of compressed air. Both concerns are controlled and operated by the same management and staff. The supply is furnished to all mining consumers at 2,100 and 525 volts, the necessary step-down transformers and switchgear being provided by the Power Companies while the consumer supplies the sub-station buildings.

LAYOUT OF SYSTEM.

Area of Supply.—The Rand is a narrow strip of country running east and west and following the reef over a length of about 50 miles. Almost all the shafts and surface works lie within a strip of a few miles in width.

The area is particularly prone to severe lightning and other storms and it is probable that there are few localities in the world which offer more severe conditions for overhead working. The lightning [illegible] with the beginning of October and ends in March.

Load Concentration.—Fig. 1 is a skeleton map showing the Power Companies' area of supply and the towns and railways within it. The [illegible] consumers taking power from the Power Companies, and those having white centres the mines (other than those supplied from their own privately owned stations) not connected to the system. The area of the circle in each case is proportional to the maximum sub-station demand, and the circles which [illegible] the estimated demand [illegible] [illegible] connected. The areas are only approximate, but serve to indicate the geographical distribution of existing and possible load.

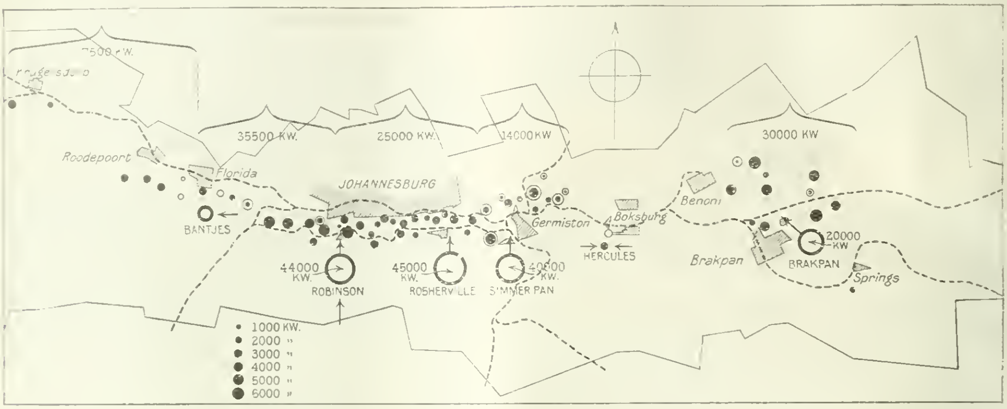

FIG. 1.—AREA OF SUPPLY AND DISTRIBUTION OF LOAD.

Johannesburg has a municipal electrical undertaking having a peak load of about 11,000 kw. and an annual output of about 28,000,000 units. Other towns, in order of size, are Germiston, Boksburg, Roodepoort, Benoni and Springs, all of which municipalities take bulk supply from the company. A few industrial consumers are connected to the system, but the supply taken by the mines represents almost 99 per cent. of the total electrical business.

Out of a total of 84 sub-stations one demands over 6,000 kw., five demand over 4,000 kw., and no less than 39 demand over 1,000 kw. It will be clear, therefore, that the area is typically one which demands large quantities of power at a relatively small number of points distributed over a relatively small but elongated area.

Location of Generating Stations and System Layout.—There are four generating stations, three being situated along the Reef and one at Vereeniging on the Vaal River, some 35 miles south of Johannesburg. The latter station feeds into the Rand system at Robinson which may therefore be treated as a fourth source of output along the Reef. The considerations which led to the selection of Vereeniging as the fourth generating site were two-fold, viz., to secure an adequate water supply and to obtain cheap coal. The cost of freight on coal in South Africa outweighs the cost of electrical transmission for equal energy produced and equal distance covered

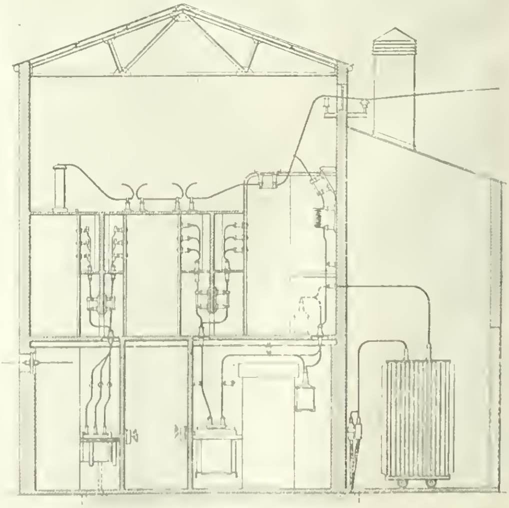

FIG. 2.—CROSS SECTION OF SUB-STATION.

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* Abstract of a Paper read before the South African Inst. of E.E.

Table I.—*Generating and Step-down Stations.*

	Brakpan.		Simmerpan.			Rosherville.		Vereeniging.		Robinson.				Bantjes.	Hercules.
Generators—															
Number	2	2	2	4	2	5		2	2	......				...	...
Speed, revs. per min.	1,500	1,500	1,500	1,500	1,500	1,000		1,000	1,000	....				...	...
Generating voltage	2,250	5,000	10,000	2,250	5,000	5,000		5,000	5,000	...				..	...
K.V.A. rating (summer)	3,750	18,000	3,750	3,750	15,000	12,000		12,000	18,000	...				.	.
Total K.V.A.	7,500	36,000	7,500	15,000	30,000	60,000		24,000	36,000	.					.
Generator Transformer—															
Number	2	6	...	4	6	5		1	6						
Type	*3-ph.	†Single-phase	...	*3-ph.	†Single-phase	*3-phase		‡3-ph.	‡3-ph.						
Secondary pressures	10,500	21,000	.	10,700	[illegible]	21,000		79,000 to 88,000	79,000 to 88,000						
K.V.A. rating (summer)	4,500	6,250	.	[illegible]	5,000	12,500		12,500	9,000						
Total K.V.A.	9,000	37,500	..	18,000	30,000	62,500		66,500							
Step-down Transformer—															
Number	2	6	..	4	...	...		...		1	[illegible]	2	4	[illegible]	2
Type	‡3-ph.	‡3-ph.		‡3 phase		...		..		‡3-ph.	‡3-ph.	†3-ph.	‡3-ph.	[illegible]	3-ph.
Ratio	40,000/10,000	40,000/21,000		40,000/10,000		...		...		42,000/21,000	80,000 to 42,000 and 21,000	80,000/21000	80,000/21000	40,000/21,000	40,000/10,000
K.V.A. rating (summer)	3,750	4,000		3,750		...		..		9,000	6,000	6,000	9,000	4,000	1,500
Total K.V.A.	31,500			15,000		...		..		69,000				16,000	3,000
Compressor Transformer—															
Number	...		...			...		...		6				...	...
Type	...		...			...		...		*3 phase				...	..
Ratio	...		...			...		...		20,000/1,730				...	...
K.V.A. rating (summer)	...		...			...		...		4,000				...	...
Total K.V.A.	...		...			...		...		24,000				...	...
Earthing Transformer—															
Number	2		1			1		...		1 (special)				1	...
Type	‡3-phase		‡3-phase			‡3-phase		...		‡3-phase				‡3-ph.	...
H.T. voltage	10,500		10,000			20,000		...		40,000				20,000	...
K.V.A. rating (summer)	1,500		1,500			1,250		...		1,500				1,250	...
Total K.V.A.	3,000		1,500			1,250		...		1,500				1,250	...
Station Power Trans.—															
Number	2	2	5			3	4	4		1		2		...	...
Type	‡3-ph.	‡3-ph.	*3-phase			*3-ph.	*3-ph.	*3-ph.		*3-phase		*3-phase		...	...
Ratio	10,550/230	10,500/230	10,000/440			21,000/2,100	21,000/525	5,000/500		21,000/525		21,000/525		...	...
K.V.A. rating (summer)	450	500	500			1,250	1,250	2 × 1,250 2 × 1,000		1,000		650 & 500		...	...
Total K.V.A.	1,900		2,500			8,750		1,500		2,150				...	...
Main Switchgear—															
80,000 V. panels	...		...			...		8		8				...	...
40,000 V. panels	8		12			10		...		6				6	6
20,000 V. panels	15		...			15		...		27				9	...
10,000 V. panels	14		24			...		...		...				...	7

* Star-star. † Delta-star. ‡ Star-delta.

SUMMARY.

	No.	K.V.A.	
Generators	21	216,000	
Generator transformers (3-phase)	18	156,000	63 large transformers.
„ „ (single phase)	12	67,500	
Step-down transformers	27	134,500	
Compressor transformers	6	24,000	
Earthing transformers	6	8,500	382,000 K.V.A.
Station transformers	23	19,800	
	92	410,300	

	No.
80,000 V. panels	16
40,000 V. „	48
20,000 V. „	66
10,000 V. „	45
Total No. of H.T. panels	175

Table II.—*Overhead Line Data.*

Section of system.	Power conductors.						Guard wire.	
	Pressure. volts.	Minimum spacing between conductor in inches.	Minimum height of conductor from ground at insulator in feet.	Span on straight in feet.	Insulators. Type on intermediate masts.	Insulators. Type on straining masts.	Heights above nearest power conductor.	Spacing laterally.
		ins.	ft. ins.				ft. ins.	ft. ins.
Vereeniging-Robinson	80,000	108	34 5½	492	Suspension 6 discs in series	...	10 3	14 9
Vereeniging Robinson	80,000	108 vertical	34 5½	492	...	6 discs in series	9 0	6 5
Simmerpan-Brakpan	40,000	47	29 0	328	Pin	Pin 2 in parallel	2 8¼	6 2
Simmerpan-Bantjes	40,000	47	40 11	492	..	4 discs in series	2 8¼	7 0
Bantjes-West	20,000	47	40 11	492	..	3 discs in series	2 8¼	7 0
Brakpan network north	20,000	47	34 1	350	..	3 discs in series	2 8¼	6 10
Brakpan-Rand Collieries	20,000	21	21 8	90	..	2 pins in parallel	1 3	4 0
Rand Collieries-Springs	20,000	29	31 3	200	..	2 pins in parallel	1 3¼	4 0
Simmerpan network	10,000	47	33 8	350	..	2 discs in series or 2 pins in parallel	3 1	6 10½
Radial lines from Simmer East Switch-house	10,000	29	24 8	100	..	2 pins in parallel	1 3	2 6

N.B.—All power conductors are placed triangularly except where noted, and all guard wires are placed in a horizontal plane. None of the power conductors are spiralised.

The four points of output are interconnected by 40,000-volt transmission lines, and the Vereeniging Station feeds into Robinson at 80,000 volts. The 40,000-volt transmission extends west of Robinson to feed a step-down station at Bantjes, and there is a second step-down station at Hercules, midway between the Simmer Pan and Brakpan Stations.

The various distribution networks are all operated at 20,000 volts, excepting that round Simmer Pan and a short feed from the Brakpan Station to the Brakpan Mines, which are at 10,000 volts. All transmission and distribution circuits are overhead with the exception of the networks between Bantjes and Rosherville, which are underground.

The demand imposed by the several networks and the approximate rated capacity of the four sources of output are given in Fig. 1. At Brakpan the plant installed is at present capable of meeting the demand on the local network, while the 40,000-volt transmission enables other stations to feed the Brakpan area when necessary. The gap between this area and the Simmer Pan network is occupied by the mines which take supply from the stations of the E.R.P.M. and Kleinfontein Groups. The generating plant at Simmer Pan is more than sufficient to meet the demand on the Simmer Pan network, and the station normally carries some of the western load. The Rosherville and Vereeniging stations deal with the area between Bantjes and Rosherville, but can always fall back upon the Simmer Pan Station at times of need.

The security of supply from the Vereeniging Station is, of course, dependent upon the reliability of the 34 route miles of 80,000 volt transmission lines, but these lines have proved more reliable than any others on the system. The only other sections entirely dependent upon the reliability of transmission lines are those fed from the step-down stations at Bantjes and Hercules.

EQUIPMENT OF SYSTEM

Numerous tables with regard to the equipment of the system are given in the original Paper. See Table 1.

The main features of the equipment and the size of the system may be gathered from the following summarised round figures :—

Number of generating sets		21
Total rated k.v.a. of do.		216,000
Number of large transformers		63
Total rated k.v.a. of do.		382,000
Number of smaller transformers		321
Total rated k.v.a. of do.		302,000
Number of station h.t. panels	175	
Number of sub-station h.t. panels	412—	587
Number of sub-station l.t. panels		386
Mileage of 80,000 volt overhead 3-phase circuit		136
,, 40,000-volt ,, ,, ,,		82
,, 20,000-volt ,, ,, ,,		93
,, 20,000-volt underground 3-phase circuit		49
,, 10,000-volt overhead ,, ,,		40
,, Miscellaneous l.t. ,, ,,		21
,, Pilot and telephone cable		202
,, Bare telephone overhead		55

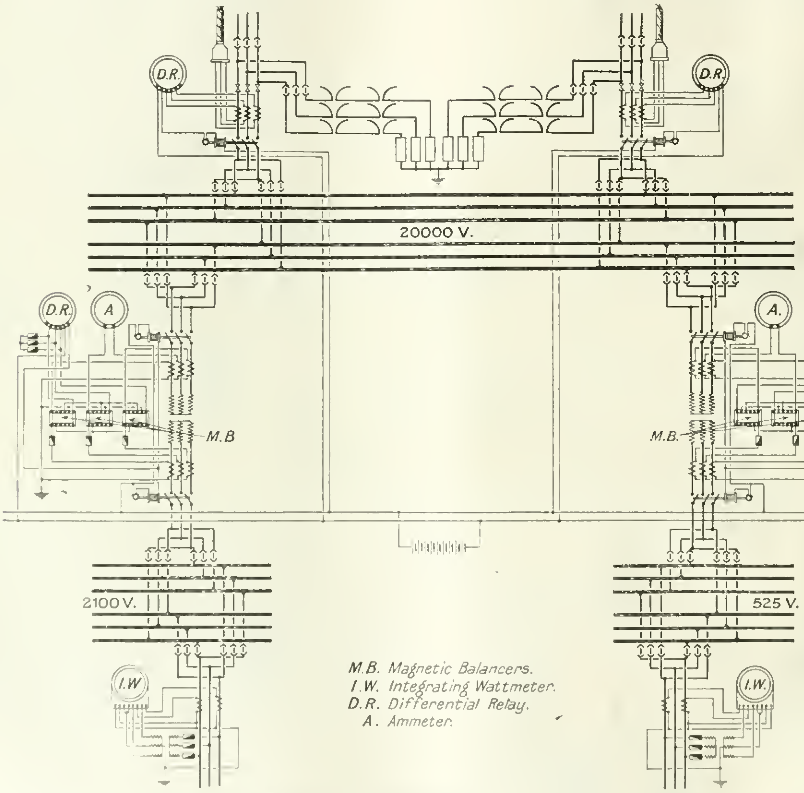

FIG. 3.—DIAGRAM OF CONNECTIONS IN HIGH-TENSION SUB-STATION.

The following general characteristics may be mentioned as bearing upon questions of operation :—

Generating Stations.—At Simmer Pan and Brakpan the control switchboard is situated in the switch-house, which is entirely separate from the turbine room, whilst at the other stations the control board overlooks the generating sets. The busbars, oilswitches, arresters and auxiliary apparatus are placed in separate galleries and the three phases of each circuit are separated from those of adjacent circuits by brickwork partitions. At Simmer Pan and Brakpan the three phases of each circuit are also partitioned off from one another, but this is not the case at the later stations. At all stations, excepting Simmer Pan and the Brakpan 10,000-volt switch-house, the galleries have been sectionalised.

In the case of the 20,000 volt switch-house recently built at Brakpan, the design has been considerably simplified by terminating the overhead lines in an arrester yard, from which point underground cables are run to the switch house some distance away.

All the large generators on the system, excepting those at Vereeniging, have been equipped with reactances inserted between the 5,000-volt generator terminals and the primary windings of the step-up transformers. There is also a 10,000-volt reactance in circuit with the step-down transformers which feed the Simmer Pan distribution network. The generator reactances are designed to reduce the voltage of the circuit about 6 per cent. when carrying full load.

Sub-stations.—Fig. 2 is a sectional view of a standard sub-station, and Fig. 3 a diagram of connections for the same. The various three-phase circuits are separated from one another by brickwork partitions and in some of the larger sub-stations the switch chambers are divided into two parts by an iron door.

Lines.—All transmission and distribution lines, with the exception of low tension circuits and a few isolated high tension distribution lines, are run on lattice masts with earthed guard wires suspended above. The electrical characteristics of the various types of line in use are set out in Table II.

(*To be continued.*)

SOME ASPECTS OF INDUSTRIAL RESEARCH WITH SPECIAL REFERENCE TO AMERICAN RESEARCH ACTIVITIES.*

BY A. P. M. FLEMING.

In engineering, more so than in most industries, the importance of research is paramount and is generally recognised as such. Especially is this the case with electrical engineering, the progress of which led to the birth of the dynamo, has depended almost essentially on scientific investigation and application. For instance, the present state of electrical illumination has been the result of the solution of far-reaching problems in physics. Similarly, wireless work, particularly wireless telephony. The same may be said of many other branches of engineering, as, for instance, aviation, mechanical transport, &c.

While engineers may have clearly defined ideas as to the importance and necessity of research, this is not shared equally by men in other industries, and particularly by the community in general. It is part of the purpose of this lecture to show briefly the bearing that research has on the interests of all classes of the community and to endeavour to propagate the "research spirit."

In its broadest sense research means simply the acquisition and application of new knowledge. Without new knowledge, no industry can continually flourish. In the least organised industries, new knowledge comes as the result of the accummulated experience of the worker. As conditions become more exacting and refinements necessary, the assistance of the technologist is required in seeking and providing scientific knowledge. In the largest and most progressive firms, staffs of men are provided to make and turn to account new scientific discoveries. It is indisputable that an industry must stagnate unless continually kept up to date by some such methods and a firm that effectively carries on research cannot but triumph over its less progressive rivals.

An aftermath of the war will be "footing the bill." Whatever material wealth—if any at all—may be collected from our enemies, I am of the opinion that it will be insignificant compared with the losses to be made up. To meet these losses, we have one main source of supply to draw upon, namely, the latent energy—mental and physical—of every worker of every grade. Education and research are the two channels by which this treasury may be tapped.

Considering the various aspects of research, attention will first be given to that of the manufacturer.

It is clear that to the manufacturer research is of the utmost importance. Possibly its greatest field for usefulness lies in the development of new or improved materials. Examples of what has been accomplished in recent times are optical glasses, tool steels, light steels employed in automobile work, high quality magnetic materials, aluminium alloys of great strength and lightness, and numerous others, ferrous and non-ferrous as well as also organic products.

The next field lies in the development of new and improved processes for cheapening production. In this respect there is no limit, no finality.

Another most important field is afforded by discoveries leading to the development of entirely new products in which priority can be secured and maintained. In this country, while we have sometimes achieved priority we have not retained it. In other cases, having failed to achieve priority at the start, we have made desperate efforts to attain that position, sometimes with success. The importance of achieving and securing priority, however, need not be enlarged upon. In this connection we have often far too limited a vision as regards possibilities of markets and confine our attentions to markets that exist, forgetting sometimes that markets can be created.

The benefit of research is by no means confined to the manufacturer, it is also of interest to the worker. Primarily because any factor which makes for prosperity in industry ultimately makes also for the well being of the worker engaged in it. The question of the adequate division of profits of industry is a domestic one which I need not go into. There is another most important matter in which workers and employers are mutually interested: it is in adaptability to new lines of manufacture which will make for continuity of employment and all that this means to the worker, not only as regards his prosperity but also the conservation of his handicraft skill.

Research is of importance to the financier in that it provides him with new fields for the profitable employment of capital, and as such contributes to the industrial prosperity of the community. Further, by means of research facilities, opportunities are afforded for careful consideration of new financial propositions embodying features of a technological nature which may or may not be on sound lines, and in this manner much investment of a highly speculative character may be avoided. I believe that an analysis of the failure of companies due to unscientific foundation would be of considerable interest. It is not so much a matter that the money subscribed by the public is lost to them as that it is diverted from healthy industrial channels into non-productive ones.

The educationalist is vitally concerned in research because it broadens his scope in all directions. For the propagation of research, increasing numbers of highly trained technologists and scientists are required. Moreover, it is equally necessary that every grade of worker can be educated to appreciate the importance of research, whether of the manual working type or of the employing class.

In connection with the educationalist it is of importance to note that in any enterprise, more especially in research, it is the human element that counts, and that while in this country we have been fortunate in leading the world with our eminent physicists for some generations past, we have not been equally fortunate in the supply of men well trained and progressive enough to apply to the best advantage the discoveries the scientists have made.

Due to the fact that most of the pure science research in this country has been done in the universities and the industrial research largely in the works, a feeling has arisen that there is a very clear line of demarkation between the two phases of the subject. Personally, I do not agree with this. In my opinion the line of demarkation—if one exists at all—is drawn very fine indeed, and the pure science discoveries of to-day may well have industrial application to-morrow. I think the division will become less marked still with the progress that is being made in some of the largest research establishments in the world to carry on both pure science research and industrial research under the same roof.

An idea prevails that research is always a matter of the test tube and chemical paraphernalia generally. This is by no means the case, and some of the researches most important to industry, and especially to engineering projects, have been carried on in contemporary sciences. For instance, the case of the prevention of malaria and the construction of the Panama Canal; the developments of aviation dependent upon the petrol motor. In other directions the research efforts that have been made to curb, for instance, tuberculosis, will, if successful, have marked effect in conserving the man-power and therefore the productive capacity of the community. Physiological researches concerning fatigue and efficiency of working may have far-reaching importance. The researches of Taylor in the conservation of human effort, however mis-applied his results may be, are in principle of very great significance. A research which would solve the problem of dealing satisfactorily with the difference between labour and capital would be of the greatest conceivable benefit to industry. A research which would seriously reduce infantile mortality would add immensely each year to the workers in industry and the probable energy available for production.

International Aspect of Research.—Prior to the war, as is well known, Germany had made great strides in research work. I am unaware of what her progress in that respect has been since the war broke out, but I imagine that it has been at least on a level with our own. In this connection it is important to note that whatever handicap, such as the burden of taxation, may be placed on her industries after the war, she will retain what is after all her most important stock-in-trade—that is, scientific capacity.

In the Far East, Japan has during the past six months voted from the Imperial Treasury considerable sums for the advancement of research, and with the cheap labour and wonderful adaptability of that people we may look to prospects of competition in many lines of products.

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* Abstract of a lecture delivered before the Manchester Local Section of the Institution of Electrical Engineers.

In America, in recent years much progress has been made in research. In addition, she is becoming extremely prosperous, and can afford to add vastly to her research facilities. As some slight offset to this, however, some consolation may be derived from the fact that inflated wages during the war and the lack of intense effort, due to the absence of the stress conditions occurring in Europe, may to some extent weaken her productive activities.

In any international undertaking, such, for instance, as education, it is impracticable to take schemes that have been developed in other countries successfully, and apply them with the same degree of success in our own, due to the fact that human characteristics and environmental conditions are possibly not the same. This also applies to research, particularly so far as the human element is concerned. At the same time, some guidance can be obtained from the work of other people. With this in mind, I propose to outline the research activities that have been carried on in the United States in recent years:—

- American Rolling Mills Co.
- Eastman Kodak Co.
- General Electric Co.
- National Electric Lamp Association.
- Pennsylvania Railroad Co.
- Westinghouse Electric & Mfg. Co.
- National Cash Register Co.
- Fitzgerald Bennie Co.
- Edison.
- Reo Motor Co.
- Canners' Association.
- University of Illinois.
- Mellan Institute.
- Bureau of Standards.
- Forest Products Laboratory.
- Department of Agriculture.
- Carnegie Institute of Industrial Research.
- New York Testing Laboratory.
- Industrial Research Laboratory.

While the figures applying to American research laboratories are very striking, I do not wish to convey the impression that it is only in the States that research work has been done, or that by comparison we are unable to hold our own. A vast amount of research has been and is being done in this country. It would be foolish, however, not to take note of certain features which American research developments indicate. The first is that they have very strongly the "research spirit," and are prepared to spend vast sums of money in this connection. Often this money may be inefficiently expended, and the fact that they have vast aggregations of capital enables them to expend large sums without feeling the financial burden as heavily as would smaller firms. The second lesson is the tendency towards co-operative research.

In America heretofore the market has largely been a home market, and this has tended to the development of individual research laboratories. In this country, while we have a home market, and while this home market will be stronger the more prosperous our industries become, we also have to consider a large export market. America is also considering a large export market, as indicated by financial associations designed to deal with overseas trade, and also the recent formation of a national research organisation linking up the existing individual research efforts. If we are to compete successfully in export markets, it is necessary that our research work should develop on co-operative lines. The general outline of the plan developed some two years ago for the formation of national research work in this country is well known, and while it is not necessary to discuss in detail the lines on which this national effort can best proceed, it is clear that some means will be taken to try and secure co-operation of manufacturers in similar industries and conduct a great deal of research through trade associations. These efforts can hardly be successful unless backed up very largely by the manufacturers themselves. For many reasons research, to be most effective, must be carried out on extensive lines, and from a matter purely of economy, it is not possible for each individual firm to spend the money necessary for this to be done. To achieve successful co-operative working, not only must manufacturers be prepared to forego some of the strong individualistic tendency that has been characteristic of the past, but also steps must be taken to educate the present worker, since every advance in manufacturing refinement demands a corresponding progress on the part of the worker.

Turning to the influence that research has on the interests of the community, it is sometimes thought that the whole of the benefits of research are acquired by the manufacturer, and that the expense should be borne by him. Actually, the manufacturer, the worker, the consumer and the educationist are only the means by which some treasure of nature is secured and converted to the use of the community. For example, modern illumination, conveniences of travel, hygienic conditions, and, in fact, all that makes life worth living, is developed in this way.

From the point of view of national research, it is so necessary to have some strong indications of public opinion before any movement can be made, that every means should be taken to bring to the appreciation of the general public the importance and necessity of research.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(Continued from page 606.)

XXII. Effect of Type of Field Winding on Speed Variation with Change of Load, including Short circuit Conditions, in Rotary Balancers.

Considering now the actual speed change which takes place when C_3 changes, the multiplier of $\varphi_0/(\varphi_3+\varphi_4)$ has already been plotted in Fig. 14 for a case of constant B, namely, when $B=0$, and in Figs. 19 and 21 for a case of constant q, namely, when $q=-100$. In regard to Fig. 14, it may be assumed that φ_3 does not differ very much from φ_0, because the additional ampere-turns produced by C_6 have to compensate for armature reaction, and in any case probably saturation is soon reached. Hence, on the working part of the curve, indicated by letters with single dashes, $\varphi_0/(\varphi_3+\varphi_4)$ is capable of simplification, because $\varphi_4=A\varphi_3$, and, therefore, $\varphi_0/(\varphi_3+\varphi_4)=\varphi_0/\varphi_3(1+A)$, which is simply $1/(1+A)$ if $\varphi_0=\varphi_3$. Hence the actual speed change, for $B=0$, is represented fairly well by dividing the multiplier shown in Fig. 14 by $(1+A)$ at all points. The result is not plotted, but it is obvious that if φ_3 is constant, as has been assumed, the speed curve will follow the same general course as e_3', so that the speed rises gradually to a maximum, when e'_3 is a maximum, of about 20 per cent. more than the light load speed, and then falls gradually down to the light load speed again at the turning point, if A be kept at the correct value to give $B=0$. Thus the variation is not abnormal even over a large range of current change; and in an ordinary way the rotary balancer, especially with interpoles, is really a very stable piece of apparatus.

On short circuit, the conditions of which are indicated in Figs. 19 and 21, q is always -100, and V_3 is always zero. The distribution of current depends upon A, and the speed change multiplier depends on A and C_3 only, being $\{(C_3-500)/245\}\times\{(1+A)(1-A)\}$.

The various cases are shown in tabular form on page 631.

The following notes apply to the various cases under the numbers in the first column of the table.

1. φ_3 disappears because V_3 producing it is zero; φ_1 goes up because V_4 is 500 volts instead of 250; the amount $1{\cdot}3\varphi_0$ is more or less guessed at, as likely to be correct with double the normal volts on the winding and no armature reaction. All the currents are very low, but the speed increases 55 per cent., the ratio being $2{\cdot}02\times1/1{\cdot}3=1{\cdot}55$.

2. φ_3 and φ_4 are equal, and are less than φ_0 because of distortion due to armature reaction: the value $0{\cdot}8\varphi_0$ is again an approximation by guessing. The currents C_5 and C_6 are equal and large. The speed change is not great, being 25 per cent. increase, derived from $2{\cdot}00\times1/(0{\cdot}8+0{\cdot}8)=1{\cdot}25$.

3. φ_3 is produced by 500 volts on the shunt winding, and there is no armature reaction; it will therefore again be about $1{\cdot}3\varphi_0$. φ_1 is produced by no volts on the shunt winding, and is therefore zero. There is a considerable armature current, but if the brushes are neutral and everything is symmetrical this produces no resultant field unless the interpoles, if there be any, cause active flux on account of their leakage. As this amount is uncertain, and in any case not relatively large, φ_1 is put down as zero in the table. C_5 is zero, but C_6 is 195 amperes. The set comes practically to a standstill, turning actually very slowly backwards so as to give the small value of e_3 shown in the table; the speed ratio is $-0{\cdot}02\times1/1{\cdot}3=-0{\cdot}015$.

4. φ_3 is produced by 500 volts on the shunt winding and C_6 assisting it in the series winding. It will therefore be about $1{\cdot}3\varphi_0$ again probably, as the shunt ampere turns will have been reduced in order to make room for series ampere turns on the assumption that the frame size has not been increased. φ_1 is produced by no volts on the shunt winding and is, therefore, again zero. There is no current in the series winding, because C_5 is zero and the armature reaction, as in (3), has no resultant effect. Hence everything is as in (3), and the speed settles down practically to standstill again.

No.	Field winding.	A	φ_3	φ_4	C_3	c_3	c_4	C_5	C_0	C_1	C_2	Actual speed change ratio.
1.	Uncrossed shunts, no series, Fig. 24 (*a*).........	∞	0	$+1{\cdot}3\varphi_0$	+5	0	+495	−5	0	0	+5	+1·55
2.	Shunts across $2V$, disconnected from middle wire, no series, Fig. 24 (*b*)	+1	$+0{\cdot}8\varphi_0$	$+0{\cdot}8\varphi_0$	+500	+245	+245	−250	+250	−245	+255	+1·25
3.	Crossed shunts, no series, Fig. 24 (*c*)	0	$+1{\cdot}3\varphi_0$	0	+495	−5	0	0	+495	+5	+500	−0·015
4.	Crossed shunts, crossed series, Fig. 25	0	$+1{\cdot}3\varphi_0$	0	+495	−5	0	0	+495	+5	+500	−0·015
5.	Crossed shunts, series in middle wire, Fig. 26.	−0·25	$+1{\cdot}25\varphi_0$	$-0{\cdot}3\varphi_0$	+350	−120	+30	+115	+465	+120	+470	−0·39

5. φ_3 is produced as in (4), but the series has C_3 in it, assisting the shunt, instead of C_6. As the series turns are about half of what they would be in (4) and as there is now some armature reaction, probably $1{\cdot}25\varphi_0$ is about the value of φ_3. φ_4 is produced by no volts on the shunt, and C_3 in the series in the negative or demagnetising direction, as it is arranged to work so always. Hence φ_4 is actually negative. Its actual value can only be known when the characteristics of the frame are known. Suppose it be such as to make $A=-0{\cdot}25$. Then $C_3=350$, and C_5 and C_6 are respectively 115 and 465 amperes. The speed is definitely reversed, the ratio being given by $-0{\cdot}367\times 1/(1{\cdot}25-0{\cdot}30)=-0{\cdot}39$, that is, the speed changes 139 per cent. from its light load value in the negative direction.

As regards the comparative merits of the five cases, (1) has all the current values low when the stable condition is reached, but as the speed changes 55 per cent., there will be large accelerating currents during the period of change, and these will be just as bad in their tendency to cause flashing over as if they were there permanently, a flash over being practically an instantaneous phenomenon. Moreover, when the short circuit or heavy overload has passed, the set cannot do otherwise than continue to give under compounding of the system, and is therefore not suitable for practical use as a balancer; (2) divides the currents equally, as it always does, and the speed change is only 25 per cent., so that there is comparatively little disturbance; (3) and (4) are alike, and the sudden tendency of the set to stop, coupled with the enormous overload represented by C_6, make it distinctly bad to allow either of these connections to remain when a very severe overload occurs; (5) has a still greater change of speed, implying a still greater jerk on overload, and C_6 is still very great. On the whole, then, (2) is once more shown to be the most satisfactory arrangement on short circuit or very heavy overload. All the cases refer to absolute dead short circuit, which can never occur, but they show comparatively what will happen in the case of extreme overloads, and are valuable from that point of view, although, owing to the somewhat uncertain values of the fluxes, the actual figures must be taken with some mental reservations. Although (3) and (4) are alike from this point of view, it has been shown that for a less severe emergency (3) is better than (4), because it actually reduces C_3 and makes C_5 and C_6 more nearly equal to $C_3/2$ than they were before; therefore (3) is a useful intermediate step between the ordinary running condition represented by (4) and the emergency arrangement represented by (2). (5) is less good in an emergency than (4), so that although as a running arrangement there is not much to choose between (4) and (5), the general conclusion may be drawn that, on the whole, (4), as shown in Fig. 25, is probably the best standard method of coupling up, with arrangements for changing to (3) and (2) in mild and severe emergencies respectively. This is an additional confirmation of conclusions already arrived at from other points of view.

XXIII. BALANCERS ON LONG FEEDERS AND BALANCERS COMBINED WITH BOOSTERS.

In the case of a balancer feeding into a network, if the distribution point is very distant from the generating point, the balance will not be correct at the far point unless special precautions are taken. Consider the case shown in Fig. 27, where R_0 ohms is the resistance of each outer wire, and R_m ohms is the resistance of the middle wire. If C_3 is positive it flows upwards in the diagram, and if negative, downwards.

$$V'_3=V_3-C_0R_0-C_3R_m\,;\quad V'_4=V_4+C_3R_m-C_0R_0+C_3R_0.$$

The sum of these two is

$$V'_3+V'_4=V_3+V_4-(2C_0-C_3)R_0=2V-2R_0(2C_0-C_3)/2.$$

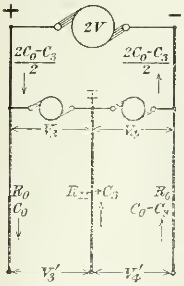

FIG. 27.—DIAGRAM TO ILLUSTRATE BALANCING AT A DISTANT POINT.

Now if C_3 be assumed to divide equally between the two armatures of the balancer, so that $-C_5=C_6=C_3/2$, which is always approximately true, and means therefore that the assumption will introduce only a small error in most cases, the current given by the dynamo is $(2C_0-C_3)/2$. Hence the voltage between the outer wires at the distant point is not dependent at all on the resistance of the middle wire, but is different from $2V$ by just the drop due to the dynamo current in the sum of the resistances of the two outer wires. It is therefore possible to raise the voltage between outers again at the distant point to $2V$, by making R_0 zero or equivalent to zero. Now, if there be introduced into a circuit whose resistance is R ohms, which implies a drop in volts of R volts per ampere, a series wound booster having a straight line characteristic, and giving R' volts per ampere in the direction in which a current is flowing, so that it causes the point towards which the current flows to tend to have a higher potential than the point from which it flows, the resultant drop in volts is clearly $R-R'$ volts per ampere, and, in effect, the resistance is altered from R ohms to $R-R'$ ohms. Therefore, if $R'=R$, the effect is the same as if the circuit had no resistance at all, as far as the current flowing in it is concerned, and if R' is greater than R, the effect is as if the circuit had a negative resistance, giving a rise in volts instead of a drop, when current flows. If, then, a booster be introduced into each outer wire giving R_0 volts per ampere in the direction in which the current flows, the outer wires will have an equivalent resistance of zero, and $V'_3+V'_4$ will be $2V$. It is not possible to raise the voltage between outers by making a balancer overcompounded. V_3+V_4 is always just equal to the volts between outers at the point where the balancer is connected to the system, and therefore the balancer can never add volts into a system as a whole, but can only alter the relative potentials of the outer and middle wires, without altering the total P.D. across the system in the slightest degree. A balancer cannot, therefore, act as a booster, but correct balance at the distant point can be restored, if it has been disturbed, by making the balancer such that it has an overcompounding effect on the system as a whole. If the compounding at the distant point is level, $V'_3=V'_4$, and therefore

$$V_3-C_0R_0-C_3R_m=V_4+C_3R_m-C_0R_0+C_3R_0,$$

or

$$V_3-V_4=C_3(R_0+2R_m).$$

Now $V_3-V_4=2qV/100$, hence, if $2qV/100=C_3(R_0+2R_m)$,

or

$$q/C_3=\frac{100}{2V}(R_0+2R_m),\text{ or } B=100(R_0+2R_m)/2V,$$

then B, so found, will give the necessary amount of overcompounding, at the point where the balancer is connected, to give level compounding at the distant end of the feeder. This is quite generally true, and means that the compounding effect which the balancer must have on the system is determined by the losses in the system. For example, if $2V=500$, $R_0=0{\cdot}10$, $R_m=0{\cdot}20$, $C_0=500$, and $C_3=100$, B must be $100(0{\cdot}10+0{\cdot}40)/500=0{\cdot}10$. The drop on the positive outer is 50 volts, that on the negative outer 40 volts, and that on the middle wire 20 volts. V_3, with $C_3=100$, is 10 per cent. above 250, or 275 volts, and hence $V_4=225$. Therefore $V'_3=275-50-20=205$ volts, and $V'_4=225+20-40=205$ volts, and $V'_3+V'_4=410$ volts, which is 500 volts less $450\times0{\cdot}20$ volts, this being the drop in $2R_0$ due to $(500+400)/2$ amperes. This is without any boosting in the outer wires.

On examining the expression $B=100(R_0+2R_m)/2V$ further, some interesting results are obtained. If R_0 be made equivalent to zero by boosters, as suggested above, the expression becomes $B=100R_m/V$. In the above numerical case, B would therefore be $0{\cdot}80$, giving $V_3=270$ and $V_4=230$. Hence, as there is still 20 volts rise in the middle wire between the supply point and the distant point, $V'_3=250$ and $V'_4=250$, again giving correct balance. From the equation $B=100R_m/V$ it is clear that, if R_m be zero, B is zero. If therefore a booster be put in the middle wire, giving R_m volts per ampere in the direction of the current, R_m will be made equivalent to zero, so that there is no potential difference between the ends of the middle wire, and B will then be zero, or the balancer must be such as to give level compounding. Another way of making R_m zero is to put the balancer at the distributing point instead of at the original supply point, but this usually involves special journeys for attention unless it can be housed along with other gear which in any case needs attendance. To put the balancer at the far end of the feeder saves a third wire, but it will be better, on the whole, to keep it at the supply end, and put in the third wire if other circumstances, such as those just suggested, make it cheaper or otherwise preferable to do so. Then a set giving overcompounding of the system, or a middle wire booster, or both, must be used. If the feeder were very long, involving more overcompounding than can be dealt with conveniently in the design of the set, a middle wire booster might be added, designed so that $B-100R'_m/V=0$, R'_m being the equivalent value of the middle wire resistance, and this would make the balance correct under all conditions. R'_m must therefore be equal to $BV/100$.

For example, if for any reason B were limited to a maximum of $0{\cdot}05$, it would be necessary to make the middle wire have an equivalent resistance of $0{\cdot}05\times250/100=0{\cdot}125$ ohms. That is, the middle wire booster would have to give $0{\cdot}075$ volts per ampere in the direction of C_3. Then V_3 would be $262{\cdot}5$ and V_4 would be $237{\cdot}5$, so that, with $R_0=0$, and R_m giving a rise of $12{\cdot}5$ volts from station to outer end, $V'_3=V'_4=250$ is again true.

A still further possibility is that a middle wire booster may be used to compensate a balancer which gives an undercompounded system, such as a static balancer always does. If, for example, B were $-0{\cdot}05$, V_3 would be $237\frac{1}{2}$ and V_4 $262\frac{1}{2}$, and the middle wire would need to have an equivalent resistance of $-0{\cdot}05\times250/100=-0{\cdot}125$ ohms. Hence the middle wire booster must give $0{\cdot}325$ volts per ampere in the direction of the current, which means $12\frac{1}{2}$ volts drop between the supply end and the distant end, so that, with $R_0=0$, V'_3 again $=V'_4=250$ volts.

As a last example, suppose B were $-0{\cdot}20$, then R'_m would need to be $0{\cdot}2\times250/100=0{\cdot}5$ ohms, which is greater than the actual value of R_m. This means that the booster would have to give $-0{\cdot}3$ volts per ampere in the direction of the current, or $0{\cdot}3$ volts per ampere against the direction of the current, involving a rise of 50 volts from the station to the far end. Then, since V_3 is 20 per cent. more than 250, or 300 V., and V_4 is 200 V., $V'_3=V'_4=250$ is again true.

Hence $B=100(R_0+2R_m)/2V$, correctly interpreted, solves the problem of balancer and booster combinations in a perfectly general way.

XXIV. SWITCHGEAR AND CONNECTIONS FOR ROTARY BALANCERS.

Fig. 28 shows all the essential switchgear for use in connection with a rotary balancer. The armatures, A_1 and A_2, have each their own interpoles, IP_1 and IP_2, in series with them, but their currents, C_1 and C_2, pass through the series windings, S_2 and S_1, on the opposite sides of the system respectively from A_1 and A_2. S is a starter arranged with two resistances, one in series with each armature circuit, so that each half of the balancer starts as a motor on V volts. The shunts, Sh_1 and Sh_2, are crossed, and are arranged in series across the two armature circuits, in such a way that, since S has no off position, a satisfactory discharge path is provided for them. A combined field regulator, R, is arranged so that the motion of the contact arm inserts resistance in one field circuit at the same time as it cuts it out of the other, there being only one resistance for the two field windings. It is not absolutely necessary to have R at all if the system is level compounded, but, if provided, it may be useful for fine adjustments in special cases. The middle wire current is measured on the centre zero ammeter, C_3, and provision should be made for measuring the volts at $2V$, V_3, and V_4, this being most simply and cheaply done by having one voltmeter connected to a three-way double pole selector switch, with its contacts connected to the points indicated by $2V$, V_3, and V_4 on the diagram. There is no no-volt release on the starter, as this would involve having an off position on this switch, with the consequence that the simple discharge path for the shunt circuit, already referred to, has to be modified, and in some cases a separate shunt breaking switch and non-inductive resistance might have to be used. Any automatic features desired should be embodied in the main switches, Sw_1 and Sw_2, which may therefore be, if desired, circuit breakers with no volt and overload cut-outs, or alternatively, ordinary hand-operated switches. From some points of view it is inadvisable to provide automatic features in a balancer circuit, because in a three-wire system the last thing which should be cut out is the balancer, as the consequences of such an occurrence might be very disastrous to consumers' apparatus; if such features are used, they should be so set as to operate only in the very last emergency. If desired, there may be a centre zero ammeter in circuit with each half of the balancer, between Sw and A. The numerical sum of the currents in these two ammeters, less the shunt current, would be equal to C_3. There is no special advantage in having these, however, as if C_3 is within the specified limits, so also are the currents in the balancer itself.

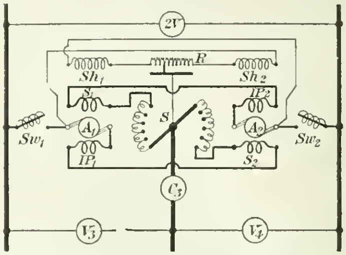

FIG. 28.—SWITCHGEAR AND CONNECTIONS FOR A ROTARY BALANCER.

In regard to cutting out the series windings in an emergency, which may be followed, should the emergency continue, by the disconnection of the shunt windings from the middle wire, as it is desirable that these temporary expedients should not remain in operation after their purpose is served, it is well to arrange for them being carried out by self-replacing switchgear, operated, say, by solenoids. The series windings are coupled up in parallel with diverters, and the part of the circuit containing the winding is opened when the overload occurs. A diagram of an arrangement which would be self-replacing is shown in Fig. 29, and refers to the same coupling up of the series as in Fig. 28. If the series be coupled in the middle wire, the modifications necessary are only of details, and need not be specially illustrated; only one diverter would be required, as both windings carry the same current, and could be cut out by opening one switch in series with them both. The principle in both cases would be that shown in the diagram; solenoid I. would lift its core when the specified overload occurred, and, by means of insulated fingers, open a switch in the circuit of each series winding against a spring which would replace the switch and so allow the winding to become active again when the overload ceased. The solenoid would need to drop its core at a current not greatly different from that at which it lifted, which can be arranged by having a sufficient air gap in its magnetic circuit, even when the core is drawn in, to ensure freedom from prolonged holding up. As the overload would probably come on suddenly, and drop as suddenly again, such an arrangement would work promptly and definitely and well. The scheme illustrated also includes solenoid II., operating at a still higher overload and arranged to open a switch, also against a replacing spring, in the wire which connects the bar of the shunt regulator to the middle wire, thus putting the field windings directly across the outer wires, making $\varphi_3=\varphi_4$ and $e_3=e_4$, and producing all the consequences following therefrom. The exact form which this switchgear would take is immaterial; so long as the principles embodied are those which have been described, or something equivalent to them, the arrangement will protect the balancer from the consequences of severe overload, by first of all cutting out the series windings, and then disconnecting the shunt windings from the middle wire. As a last resort, the overload circuit breakers may be arranged to open, but only at a current still greater than that required to operate the second solenoid.

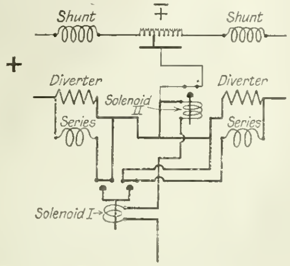

Fig. 29.—Diagram of Emergency Solenoids for Field Windings of Rotary Balancer.

(*To be continued.*)

RATING OF OIL CIRCUIT-BREAKERS.*

BY E. M. HEWLETT.

The variable factors entering into the problem of rating oil circuit-breakers make its solution very difficult.

Up to certain capacities it has been possible to determine definitely what oil circuit-breakers will open. The experience of many years, during which oil circuit-breakers grew from a few thousand volts for a few kilowatts station capacity to 10,000 volts, 40,000 volts and higher voltages for many thousand kilowatts station capacity, coupled with the facility of testing various designs under actual emergency conditions, has crystallised the requirements of circuit-breakers of this kind and the constructive features of commercial design.

However, the capacity of stations is always growing, the forces dealt with are ever increasing, and consequently new types of circuit-breakers must be constantly developed, ratings of which cannot be based on actual past service. To test such circuit-breakers systematically would be beyond the scope of any testing units at the disposal of any manufacturing company.

The possibility of utilising large power stations for the testing of circuit-breakers is very limited, as, in order to carry their connected load, the big operating companies must generally have constant and instantaneous control of all their apparatus.

Thus, new designs of high-duty circuit-breakers must, for the present, be rated mainly upon judgment based on past broad experience. For the engineer, the ideal way of rating circuit-breakers is on the basis of the current which is actually opened in the arc at the operating voltage of the system, as in the present A.I.E.E. ruling. (This current in the arc is not the peak value of the short-circuit current curve, but is that value which prevails at the moment when the circuit-breaker opens, at the point where it is installed.) However, in a rational design of circuit-breaker, other factors must be considered besides current to be ruptured, primarily the power factor at the time of the event and the voltage regulation of the system. In the smaller capacities these factors could be disregarded, as with them it has always been possible to allow very liberal safety factors without sacrificing reasonable proportions. We are, therefore, rating at the present time oil circuit-breakers by arc current and system voltage up to certain capacities. As the capacities of the system and circuit-breakers increase, as spacings and clearances become important design factors, and as materials employed in the construction of the circuit-breakers must be used more nearly to their limits, it becomes necessary to take all conditions into account.

For small stations and industrial service the kilowatt rating is most convenient—*i.e.*, the total generating capacity of the system or its equivalent at the point of disturbance. Generally the kilowatt rating is based on the assumption that the disturbance takes place so close to the generating apparatus that reactance and resistance of connections between generating apparatus and the place of disturbance need not be considered.

If the oil circuit-breaker is located at some other point in the system with considerable line or transformer impedance between the generating apparatus and circuit-breaker, allowance must be made for the current-limiting effect of this additional impedance. Instead of the generated kilowatt capacity, an equivalent kilowatt capacity must be used, which refers to the actual location of the circuit-breaker in the system, and is lower than generated kilowatt capacity by an amount dependent on the characteristics of the intervening conductors and circuits.

The physical dimensions of the conducting copper parts of the circuit-breaker should always carefully be considered. Conducting parts must be of sufficient size to carry the rated current indefinitely without objectionable temperature rise, also be large and strong enough for the maximum current rushes between the instant of short-circuit and the time of opening of the circuit.

The use of current-limiting reactors or reactances in transformers and machines in connection with systems is increasing. The reactor may be in circuit permanently or only when the breaker is opening. Various means have been developed to insert reactors or resistance into the circuit as the circuit-breaker opens. While such arrangements reduce the current which the circuit-breaker opens, they cannot act quickly enough to reduce the instantaneous maximum current and the shock on the system, which is the real point to be considered.

Finally, one man will require the circuit-breaker to open the most severe short-circuits without the slightest indication of distress. Another man may be well pleased if the circuit-breaker protects his more costly machinery even if the circuit-breaker itself is destroyed in doing so. Someone else may expect the circuit-breaker to open two or possibly three times without requiring inspection or repair.

It is thus evident that there is a wide range of opinion as to what constitutes satisfactory operation.

To sum up, I am in favour of rating circuit-breakers on the basis of current in the arc and operating voltage of the system. The term "current in the arc" implies that, in defining its value, all factors have been considered which are necessary to determine the actual work to be performed at the time when, and at the place where, the current is interrupted.

I am not in favour of giving ratings to circuit-breakers in transient peak values which do not exist at the time of opening the circuit.

CHEMISTRY AND EXAMINATION OF LUBRICATING OILS.*

BY ELLIOTT A. EVANS.

Lubricants may be resolved into three classes—liquids, viscous substances and solids—of which the author directed attention to the liquid lubricants. The substances which constitute the class of liquid lubricants are water, oil and emulsified oil. Water is for most purposes nugatory, and emulsified oils were beyond the scope of the Paper. The only oils which may be recommended for lubricating purposes are mineral oils, semi and non-drying fatty oils and liquid waxes. Fatty oils alone as lubricants are obsolescent; their place is being taken by mineral oils. Mineral oils have won popularity by virtue of their comparative inertia, their cost, and to the fact that they can be obtained in almost any degree of viscosity, and so their utility eclipses that of any other type of oil which may be used as a lubricant.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

* Abstract of a Paper read before the Diesel Engine Users' Association.

The differentiation of mineral oils is often a matter of great difficulty, but, speaking generally, one may obtain some criterion as to the origin of an oil by its specific gravity—*e.g.*, Texas oils have a specific gravity ranging about 0·950, Californian oils 0·930 and Pennsylvanian oils 0·876 to 0·910.

Composition of Lubricating Oils.—Lubricating oils may be either hydrocarbon oils, semi-drying or non drying fatty oils or fats, or liquid waxes, either separately or together. Mineral oils are mixtures of hydrocarbons belonging to the various homologous series, ranging from the most saturated normal paraffins to the most unsaturated hydrocarbons of the aliphatic series, saturated and unsaturated cyclic hydrocarbons and aromatic hydrocarbons. In the manufacture of lubricating oils it is the endeavour of the manufacturer to eliminate the unsaturated cyclic hydrocarbons and all the aromatic hydrocarbons from the most expensive lubricating oils, because not only are they of very doubtful lubricating value, but their instability may give rise to excessive carbonisation and acidity of the oil.

Some Californian oils are now on the market, but they cannot be recommended universally as lubricants. Their viscosity diminishes rapidly with rise of temperature. For some purposes they may be blended with Pennsylvanian oils, but where a good lubricating oil is desired Californian oils should not be used.

The Texas oils are used to a considerable extent for many purposes, but owing to the fact that they are chiefly composed of the series C_nH_{2n-2} and C_nH_{2n-4} they are very liable to decompose at elevated temperatures and perhaps at high pressures.

It has been found that if a hydrocarbon oil be heated under pressure decomposition takes place, and lighter oils result. The products of decomposition are generally governed by the temperature and pressure at which the reaction is conducted. When an oil is converted in this manner into lighter oils the lighter oils are said to be "cracked." Strictly speaking, of course, it is the heavier oil which is "cracked" and the lighter oils are the resultant products of the cracking. The term "pressure" is used in its broadest sense, and does not simply relate to pressures greater than an atmosphere. Some oils crack when distilled at a pressure less than one atmosphere, and some cannot be distilled under a pressure of a few millimetres.

The cracking of oils has become an extremely important branch in the technology of mineral oils. By this process very large quantities of petrol, benzene, toluene and lubricating oils are made, but, unfortunately, oils so produced are generally inferior to those obtained by direct distillation—at least, for some purposes.

During the cracking carbon is deposited, and some extremely unstable hydrocarbons are formed which decompose with explosive violence. These unstable hydrocarbons are probably of the olefine series, but as their existence has only been revealed of late the study of them is still in progress. It is quite conceivable that the explosion in an air compressor at Smithfield occurred through the production of these unstable bodies, and that the vapour of the light oils was exploded by the detonation of these very unstable olefines. That the explosion was caused by the ignition of oil fog in the compressor may be a very convenient working hypothesis, but it is a little difficult to understand how ignition was effected.

The suggestion that a compound oil should be used as a lubricant for air compressors must be condemned, and although I recommend a mineral oil consisting of the series C_nH_{2n+2}, nothing has been said as to which members of the series should be used. It is of little importance to ascertain which particular hydrocarbons of the series are present in the oil, because if we know the flash point and the [illegible] of the oil we know approximately which members are present, [illegible] in general sufficient for our purpose. The hypothesis of the *oil fog* has created a belief that an oil with a high [illegible] point is essential. The adoption of such an oil is a [illegible], but an oil with a high vaporisation point has a [illegible], in fact, probably considerably higher than is [illegible] and so unnecessary work is thrust upon the compressor. The vaporisation point as usually determined [illegible] arbitrary standard, as it gives no indication as to the temperature at which vaporisation will take place in the compressor, because the vaporisation point is governed by the pressure of the atmosphere and the rate of vaporisation is dependent upon the concentration of the vapour in that atmosphere; hence whatever vaporisation [illegible] is selected it can only be regarded as an [illegible] in the deep [illegible] of uncertainty.

The author is of the opinion that an oil with a specific viscosity of about 70 (water = 1) or in seconds [illegible], and a closed flash point of about 400 F., can be safely used if the temperature of the compressor be carefully regulated.

L.C.C. TRAMWAY ADMINISTRATION.

An important report on the present position of the London County Council tramways department was presented to the County Council on Tuesday by the Highways Committee.

The question of reorganisation was referred to a sub-committee in August, 1916, financial matters being reserved for the consideration of the committee. Recently, however, another sub-committee was appointed to consider and report upon the financial position of the tramways, but the committee now submits proposals for adoption by the Council. After setting out the present organisation of the department, the report deals with the need for reorganisation. The miles of track open on March 31, 1914, were 144·83 (against 24·375 in 1900), the car-miles run were 59,209,289 (10,208,161), and the passengers carried 522,952,640 (117,992,713). The total revenue was £2,268,668 (£470,098), the total number of employés was 12,232 (2,750), and during the same period the capital expenditure increased from £1,710,056 to £13,028,120. The growth in working costs and the increasing complexity of passenger traffic operation in London would alone justify a review of the organisation, but the present time is particularly opportune for any necessary alterations in organisation, since there are several vacancies in the higher ranks of the department and arrangements for filling some of them are urgently necessary. Owing to departmental conditions the chief officer has hitherto been compelled to devote much time and attention to ordinary executive business, whilst the division of the department into 10 sections has also rendered necessary great efforts in co-ordination. For these reasons he has been hampered in dealing with such important matters as the development and improvement of the system and the consideration of larger questions of tramways working and policy. There is room for considerable improvement in the status of the technical and professional officers in charge of the principal sections, and more effective use could be made of their services. The number of sections into which the department is divided is too large, co-ordination of the work being thus rendered unduly difficult. In the traffic section, in which no risks should be taken likely to prejudice successful working, the Committee say: We find that it is necessary to add to and improve the existing departmental machinery, in order (inter alia) to secure more fully the necessary data for the purpose of effecting improvements. We have observed also that the principal subordinate officers have not sufficient authority to decide executive and disciplinary matters of comparatively minor importance which might well be left to their discretion.

Basis of Reorganisation.

For reasons already indicated the chief officer should be relieved of much work which he now carries out personally. This relief can be effected by a considered system of devolution under which the principal subordinate officers will act in certain matters upon general lines. We are of opinion that the position of deputy chief officer should be abolished as a separate appointment. Under our proposals there will be several officers of sufficient standing who could be called on to discharge the duties of chief officer in his absence, and upon these officers the work hitherto performed by the deputy chief officer will automatically devolve. We consider it undesirable to attach to the position of head of a particular branch the function of deputy, and think it preferable to decide from time to time which officer shall ordinarily discharge the duties of the chief officer in the absence of the latter. Our reorganisation proposes the grouping of the work in five branches. Of the present 10 section the traffic, electrical, rolling stock and permanent-way sections become separate branches in the new organisation. The remaining work of the department, subject to certain appropriations of such work to the four branches above-mentioned, is organised under a general branch. This is the broad effect of the rearrangement as affecting the work to be done in particular branches.

Heads of Branches.—The heads of branches should have a definite status in the department, and it is essential that they should be officers of ability, initiative and experience. There being no intermediary between them and the chief officer, they should be officers upon whom the chief officer could place complete reliance, particularly as much of the work now carried out by the chief officer would devolve on them. They should have designations corresponding to their positions, and we propose the designations (i.) traffic manager, (ii.) electrical engineer, (iii.) rolling stock engineer, (iv.) permanent way engineer, (v.) chief clerk. Their remuneration should be commensurate with their position. It is important that the heads of branches should be relieved of work and responsibility which can safely be entrusted to subordinates, so that, like the chief officer, they can give adequate time and attention to the more important aspects of their work. In this connection we have in mind the desirableness of the chief officer and the heads of branches keeping in close touch with tramway and transport work elsewhere than in London. Arrangements should be made for heads of branches to attend our meetings and the meetings of our sub-committees during the consideration of matters of importance affecting their branches, thus bringing us into closer touch with the officers immediately concerned in such matters. It has been pointed out to us that a considerable part of the time of the principal officers of the department is spent in preparing reports for committees. The attendance of the heads of branches at our meetings will increase the opportunities for information being given orally whether on request or after notice. Reports are necessary, of course, in order to keep the Council informed and to maintain its records; but the main duty of the higher officers is to secure, under the direction of the Council, the proper management and development of the undertaking. The preparation of reports must be subordinate to these considerations.

Arrangements for Relieving the Chief Officer.—There is a great extent of departmental work carried out in accordance with the Council's standing orders and regulations, &c. The most important points for departmental consideration and settlement in connection with this executive work must be reserved for the chief officer, whilst matters less important are decided by the heads of branches, leaving minor matters to be settled by minor officials. There should be departmental records, brief and readily accessible, in form settled by the chief officer, of action taken by officers other than himself. Under the present system a very large percentage of persons taken into employment (other than officers appointed by resolution of the Council) have in practice been engaged by the deputy chief officer personally. We consider that the duty of engaging persons for employment could in a large proportion of cases and without disadvantage be entrusted, under rules made by us, to heads of branches and to officers occupying responsible positions below them. Several officers in the department have a customary power of suspension of employés for a day or two. We think that the periods over which suspension may be ordered by officers of different status should be defined; and that, according to their status, officers of various grades having control of employés should have specified power to deal with disciplinary matters, subject to the individual affected having an indefeasible right of appeal to the chief officer personally. We consider that the heads of branches should keep the records of service of employés in their respective branches, except the records of service of officers appointed by resolution of the Council. We suggest that officers having supervision of sections of the work of the department should submit each year to the heads of their respective branches brief reports on the work of their sections; that the heads of branches should submit each year to the chief officer reports on the work of their respective branches; and that the chief officer should advert to such reports when submitting to us his annual report at the time of the submission of the annual accounts. On the whole we think that the balance of convenience is in favour of the present system, under which all reports to the committee are signed by the chief officer. Where there is a conflict of opinion on a technical or professional question between the chief officer and an officer occupying the position of head of a technical or professional branch, the report to the committee should disclose the opinion of the head of the branch. The heads of the technical and professional branches should be at liberty to conduct in their own names correspondence arising in their branches.

The comptroller of the Council is the financial adviser to the Council and all committees. We propose an amendment of the present rule to provide that in all matters affecting the finances of the tramways in which it is the duty of the comptroller of the Council to advise us, he shall report thereon to us at the earliest convenient moment. In order to afford him all possible facilities in the discharge of his duties, we propose, further, that the rule shall provide that he shall be supplied, as far as possible in advance, with all information required by him for the purpose of any such report. We consider, however, that when he proposes to bring before us matters affecting the finances of the tramways undertaking and occurring to him in the course of his duties, he should acquaint the chief officer of his proposed action so far as it touches the management of the undertaking. The work of the tramways accountant may be divided into (1) work closely identified with the tramways organisation and the working of the undertaking, and (2) work comprising operations similar to those which in the case of other services are undertaken in the department of the comptroller of the Council. The comptroller keeps the accounts of the undertaking, and the receipts and payments are made by him or under his general direction, but the work under (2) above has with his concurrence remained in the tramways department as a matter of administrative convenience, resulting partly from the staff arrangements of the several tramways undertakings acquired from time to time by the Council, and partly from the location of the tramways staff in various offices at some distance from the County Hall. We are of opinion that such accountancy work as is now performed in the tramways department should be merged in the general accountancy work of the Council; but that, owing to present difficulties, the transfer of the work from the tramways department to the department of the comptroller should not be effected immediately. Pending the transfer certain modifications should be made in the present arrangements. The description "Accountant's section" is misleading, and we consider that this should be altered to "Accounts section." Similarly the nomenclature, derived from company management, of the various sub-sections should be altered. These questions of nomenclature are of departmental concern, and the deputy chief officer has informed us that the suggested alterations will be made. Care should be taken in the organisation of the sub-sections to keep accountancy work separate from administrative work, so that the ultimate transfer of this accountancy work to the department of the comptroller may be facilitated.

Organisation of Branches-Traffic.

We propose the reorganisation of the department into five branches—viz., (1) traffic branch, (2) electrical branch, (3) rolling stock branch, (4) permanent way branch, and (5) general branch. Having regard to developments during the past few years in connection with passenger transport service in London, it is vitally necessary for a most efficient staff to be furnished to deal with traffic matters. The traffic problems which constantly confront us, and call for unremitting attention by the chief officer, cannot be dealt with adequately in the absence of an organisation specially designed for dealing with these matters in all their various aspects. Modern traffic conditions call for the application of scientific methods; and the organisation of a service such as that of the Council's tramways, operated under conditions not in their nature constant, should be sensitive to every change, actual or prospective, whether in relation to the requirements of the travelling public or to traffic conditions generally. The traffic assistant and the officers under his direction, whilst fully occupied with essential duties, have been hampered in dealing with many classes of work which must be the subject of study in order to obtain and apply the knowledge necessary for the best results in connection with traffic organisation. Whilst fully appreciating the great services rendered by the chief officer and the deputy chief officer in connection with the work of the traffic section, we feel confident that a strengthening of the staff is essential to secure efficient handling of traffic, adequate dealing with traffic problems and that internal impetus to efficiency and improvement which can be given only by a fully equipped staff constantly watching the interests of the undertaking and the requirements of the travelling public. The successful working of the undertaking must depend largely upon the organising capacity and proved ability of the officer in charge of the traffic. The number of employés in the section at present is over 5,000, and in normal times about 7,000, the salaries and wages paid in the branch amount to about £11,000 a week. Having regard to the magnitude of the undertaking, the complexity of London traffic conditions and the special circumstances arising in London on account of the existence of competitive services, a salary of only £600 a year cannot secure and retain in the Council's service an officer of the ability required. We consider that the change made in 1910, when the position of traffic manager was abolished and the smaller position of traffic assistant established has not proved satisfactory. We have no hesitation in advising that to the important position of traffic manager a salary of from £1,200 to £1,500 a year should be assigned. We have arrived at the conclusion that the work of the traffic branch should be organised in two sections—viz., (1) a development and publicity section, to deal with matters which have not hitherto received adequate attention; and (2) an operation section. The requirements of the public and the possibilities of the tramways undergo constant change, owing to growth and migration of population, growth and decadence of shopping and industrial centres, and other causes. All such changes require to be catered for and, if possible, anticipated, and it will be a primary duty of this section to obtain the necessary data on which action should be based. Moreover, the London tramways have to compete for traffic with other means of transit, and the development of the undertaking on successful lines must to a considerable extent depend on constant and well directed effort to adjust the services to public needs. Such matters as through running, through booking, nature and adequacy of services, fares and fare stages should be dealt with in this section as matters of development. We attach equal importance to the publicity work which we propose should be undertaken in this section. In 1913 a firm of advertising contractors offered to advertise the Council's tramways at £23,150 a year, and in the following year an advertising scheme involving expenditure of about £6,000 a year was submitted by another firm. Those offers were not accepted. The chief officer is of opinion that to advertise adequately the Council's tramways would involve expenditure of £15,000 to £20,000 a year. Whilst not wishing to prejudge the question of the amount which should properly be appropriated for publicity service, we are satisfied that, apart from other forms of publicity, greater use should be made of the press as a means of conveying to the public advantages peculiar to the tramways service. The preparation of time tables should be undertaken in this section, which should also carry out independent traffic checks. The principal officer in this section should be directly responsible to the traffic manager, and be designated the development superintendent, his salary being from £500 to £800 a year. He should have under him at least three responsible heads of sub-sections—(i.) a publicity assistant (from £300 to £400 a year), (ii.) an officer in charge of matters relating to fares and independent traffic check (designation to be determined) (from £300 to £400 a year), and (iii.) a time-tables assistant (from £250 to £300 a year).

The operation section of the traffic branch, under the immediate and close supervision of the traffic manager, would be in effect the present traffic section. The section requires reorganisation for focussing its energies on the work of traffic operation, and economising the time of the principal officers, so that they may give adequate attention to such important matters as obtaining and utilising, by and through subordinates or otherwise, statistical and other information likely to assist in securing the most satisfactory results in connection with traffic operation. There should be a smooth channel of communication from this section to the development and publicity section of statistics and information, and ready and sympathetic consideration of suggestions made by junior grades of traffic officers and others. The principal officer in this section should be directly responsible to the traffic manager and be designated operation superintendent, the salary to be assigned to the position being from £500 to £700 a year. His position would correspond approximately to that of traffic assistant in the present organisation. The designation of the two district traffic superintendents should be altered to divisional superintendents, with approximately similar duties, the salary to be assigned to each position being from £300 to £400 a year. The divisional traffic superintendents below them, on outdoor work, in the present organisation should be designated district superintendents. Their rate of pay should now be fixed. The supervision of the work of the punch repair shop should be placed under the divisional superintendent (southern section).

(*To be concluded.*)

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LARGE ELECTRICAL SYSTEMS.

Large generating stations working in parallel and supplying networks covering extensive areas are now the problem which has to be faced by the electricity supply engineer wherever electric power is making very marked headway. Small stations and small supply areas will become things of the past in the course of a few decades, and we trust that the interval in this transition will not be so very long. This is the obvious line of progress, but at the moment the engineers who handle schemes of this kind are few in number, and we therefore welcome the occasions when such engineers feel free to speak of their experiences. For this reason we are glad to see the Paper read recently by Mr. BERNARD PRICE before the South African Institute of Electrical Engineers. It is a Paper of the greatest possible interest as it deals with the very large system of the Rand Power Companies, more particularly in regard to methods of operation and the experience gained therefrom. In 1913 Mr. A. E. HADLEY read a Paper before the Institution of Electrical Engineers describing the plant and network of the Victoria Falls & Transvaal Power Co., but the present Paper deals particularly with questions of operation, and thus gives an insight into some of the difficulties experienced.

It will be admitted that the conditions in South Africa are much more severe than those found in this country, more particularly on account of violent thunderstorms which subject the overhead system to severe stresses, and which consequently may from time to time cause breakdowns in the plant. Thus it may be said that if a service free from interruptions can be given in South Africa, there should be no difficulty in obtaining a corresponding service in this country.

To give some idea of the size of the undertaking it may be mentioned that there are four generating stations aggregating 216,000 kw., connected with transmission lines, mostly at 10,000 volts, but in one case at 80,000 volts. The overhead network supplies the Rand, which has a length of about 50 miles.

Of the many interesting features a few may here be noted. The large generators are protected by means of reactances between the 5,000 volt generator terminals and the primary windings of the step up transformers. These are designed to reduce the voltage of the circuit about 6 per cent. when carrying full load. It has also been found necessary to protect the transformers when switching out, and special methods have been adopted for this purpose. When possible the large transformers are shut down gradually with a rotating machine and in other instances artificial load is provided, otherwise extremely high pressures may arise. Apart from these precautions, there are, of course, the usual safety devices in the form of automatic cut outs and lightning arresters, but from the point of view of continuity of supply on a large system of this kind it becomes necessary to know just what is happening in the event of any automatic cut out acting at any particular point. This is attained by having a control room at Simmer Pan, and here the control of the whole system is centralised. In the event of the automatic operation of a switch in one of the sub-stations a bell and master indicator in the control room give warning of what has occurred. There are also indicators at the generating stations and step-down stations. The control engineer has a large diagram of the entire system on the wall in front of his desk and on this all switching operations may be recorded by means of coloured discs suspended from pins. Although the information which the control engineer receives automatically through the opening of a switch does not tell him which particular switch or how many switches have opened, he is generally able to gauge what has happened, and he is therefore able to give his directions immediately by telephone.

By means of this centralised control it is also possible to direct the general working of the system so that the maximum economy is attained. To obtain this maximum economy is not a perfectly simple matter, as the cost of coal, which is by far the most important item where the load factor is about 70 per cent., varies widely at the different stations, as well as the calorific value; and there is the further complication that there are two companies in operation. Electric energy may be transferred from one part of the system to the other (held by the two companies), provided that on the whole there is no appreciable balance of energy outstanding at the end of each financial year. On this account the interworking of the power stations is not altogether straightforward, but it appears to give a satisfactory result.

In recent years we have heard a good deal of the correction of power factor and the desirability of using synchronous motors or rotary condensers, as they are sometimes called, for this purpose. It is interesting to note that Mr. PRICE makes use of this method, but only under certain conditions. It is found that it does not pay to use the method merely for the purpose of reducing transmission losses. On the other hand, if the supplying of idle current necessitates the running of a steam turbine which could be shut down by operating an idle generator as a rotary condenser, the improved conditions may pay for the running of this idle machine. Since the steam consumption of a turbo-generator obeys Willan's law fairly closely, it is a case of balancing the no-load consumption of the steam turbine against the loss of power due to running a machine light as a rotary condenser. In one of the cases mentioned the no-load loss of the steam turbine is equivalent to 1,200 kw., whereas that of running the rotary condenser is 600 kw.; consequently, the saving is considerable. As another instance, it pays to run one of the six 3,000-kw. generators at Simmer Pan as a rotary condenser because in this way the power factor of the load carried by the step-down transformers at that point is increased; consequently the output of one of the small generators can be transferred to larger and more economical units at the same station. In the early days of the scheme there was considerable benefit in this way, as the operation of an idle generator to improve the power factor enabled the available plant to deal with a larger load than would otherwise be possible.

It is interesting to note that the load on the machines is regulated by their temperature. We believe this method was suggested some little time ago by Mr. JOHN CHRISTIE as the ideal at which one should aim, but we do not remember hearing of its adoption before the present case. At all the Rand stations connections have been run from each machine to a specially calibrated voltmeter, and these connections can be joined at will to separate brushes on the rotor slip-rings of any set. The rule according to which the plant is run is that on the average the copper temperature shall not exceed 80 C. under normal conditions, and that on emergency it shall not be allowed to exceed 85 C. It is pointed out that this allows a certain margin in the event of parts of the machine getting hotter than the temperature indicated. In other words, the "hottest spot" temperature is likely to be somewhat higher than the indication obtained by the arrangements that have been made. By having this system the generating plant can be loaded up to the maximum safe figure quite independent of the climatic conditions of the moment, which is certainly an advantage.

It is also interesting to note that an investigation is being made to ascertain the effectiveness of applying forced circulation of the oil in combination with an external oil cooler to keep down the temperature of oil-cooled transformers. It is thought that the shell type of transformer will be found to lend itself well to this treatment, because with that type it is relatively easy to obtain thorough circulation of the oil throughout the spaces which surround the windings and core.

In regard to reliability of supply there is one point which seems to stand out somewhat prominently in Mr. PRICE's Paper, and that is the difficulty in handling very large powers by means of oil switches. It is well known that an oil-switch may have its powers very severely taxed in the event of having to deal with a short circuit, and that this is one of the troubles with which engineers have been increasingly faced as the size of their power stations has increased. Mr. PRICE states that on many occasions switches have exploded and ignited the oil, thus causing a fire, "the effects of which can only be appreciated by those who have witnessed them. Dense smoke rapidly fills every gallery of the switch-house, covering insulators with soot and involving much delay in the resumption of supply." It appears that these switch troubles have recently been surmounted, but unfortunately Mr. PRICE does not give any indication of how this happy result has been obtained. In Germany there have been attempts to utilise carbon tetra-chloride in place of oil, so as to avoid the use of such an inflammable material, but the results do not seem to have been very satisfactory. Notwithstanding its inherent defects, oil remains the most suitable cooling medium. Much progress has been made, but it is evident that the switchgear of large generating stations, which has become increasingly important in recent years, still requires the most careful attention of those who are engaged in this class of work.

NATIONAL INSTRUCTION IN TECHNICAL OPTICS.*

Several attempts have been made during recent years to provide systematic training in technical optics, and a scheme prepared by the London County Council will be referred to in this report; but, before discussing the details of any proposals, it is advisable to form a clear conception of the requirements of the optical trade in this respect.

If a perfect organisation for instruction and research in optics could instantaneously be called into being, some years would necessarily elapse before the trade would appreciably benefit by it. Men trained in the scientific principles underlying the proper construction of optical apparatus are not obtainable at the present moment; they will have to be trained, and this requires time. The next few years will determine the future of the industries of the country, and in order to avoid a delay which might prove fatal it is essential that provision should be made at once to give the trade assistance Any scheme adopted should include the appointment at once of a highly qualified scientific man as "Director" who will be charged with the organisation and direction of the whole of the teaching.

A further urgent need is the supply of standard text books dealing with those parts of optics which at present are greatly neglected in this country; this includes practically the whole of geometrical optics and a large part of technical optics. In our opinion, the quickest and most effective manner of dealing with this requirement is by publishing translations of existing foreign books and abstracts of important Papers on the subject.

A knowledge of optics is not confined to those intending to enter the optical trade. The Army, the Navy, the Patent Office and other Government Departments employ optical experts. The Royal Naval College habitually sends some of their ablest young officers to an optical firm to be instructed in the principles and design of range finders, gunsights and other optical instruments. Medical men, bacteriologists, surveyors and nautical men would also in many cases welcome instruction in special branches of optics. The School of Economics presents a certain analogy with the proposed School of Optics. Experience in this case shows that the instruction given has attracted, from much wider circles than was originally contemplated, students desiring instruction in special departments of economics. It is, therefore, well not to take too narrow a view, but to look upon the practical application of optics as being one of the many points of contact between the industries and pure science.

The establishment of an optical institute would concentrate the efforts of all who are concerned with the manufacture or use of optical instruments. It would bring together the several optical societies, who might find a home within its building; would be the centre for the co-operation of the trade with students and teachers, and should contain a library with periodicals and books on optics.

The general direction of the courses of study should—as is the case in the scheme of the London County Council—be vested in an advisory council, on which the trade, as well as the optical and learned societies, are represented, and to whom the director would be responsible. Full courses of instruction, both in day and evening classes, will be required. The day departments would consist mainly of youths between the ages of 15 and 20, who would receive general and technical instruction, including mathematics, physics, chemistry and practical optical work.

The evening work would be adapted to the requirements—

1. Of students engaged in the trade during the daytime;
2. Of advanced students, some of whom would have graduated in science, and would be preparing to occupy the position of managers in optical works;
3. Of other persons interested in learning the scientific construction or use of optical instruments.

Provision should be made for research work not requiring a highly specialised or expensive plant. Special investigations might be referred to the National Physical Laboratory, or any other laboratory suitable for the purpose.

It is also worth considering whether a good journal or paper should not be published devoted to scientific instruments and other matters concerned with optics.

In making provisional arrangements to cover the transition period before the desired institute can be established, regard must be had to the work being done at existing institutions, such as that done at the Northampton Polytechnic Institute and at King's College, London, under the Glass Research Committee of the Institute of Chemistry. In the scheme of the London County Council it is suggested that the Imperial College of Science should institute a separate department of technical optics, and the functions of such a department and that at the Northampton Institute are not sufficiently correlated. However the work be allotted according to the scheme now proposed, the control should be vested in a single body, working through the director of studies.

The chief requirements which require immediate attention may be summarised as follows:—

1. The appointment of a supervising representative council.
2. The appointment, under the proposed supervising council, of an administrating director, with special duties during the transitional period, which will include advice to the trade and the organisation of the different parts of the curriculum.
3. The translation of suitable works and the abstracting of other important publications on technical optics.
4. Pending the erection of a suitable building, the organisation of day and evening courses at the Northampton Institute, and arrangements for higher instruction at some other institution of university rank.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

The correspondence on the new decimal coinage is throwing so much light on what people think that one hopes that the editor will allow it to continue. Decimal coinage is before the nation; hundreds of thousands of our men are learning to use it abroad, Parliament is wakening up to the need for improvement, and all we now want is a good workable scheme, acceptable to the majority and easily understood by the average person.

Mr. Hill revives a plan which has appeared in many forms, using the sovereign, the florin and further divisions. To this one must point very strongly to what is the real difficulty in the way of the immediate adoption of a rational coinage. Almost any decimal system would do, once it had supplanted the present one, but the stumbling block is, how is the nation to carry on during the transition period of some two years or more? Advocates of the florin, &c., speak as if the Mint could turn out sufficient coins to fill our requirements in a few weeks. When one considers the enormous amount of work involved in keeping pace with normal demands on the Mint one must admit that even two years would be all too short to replace either silver or copper. Gold coins fortunately work in with either the shilling or florin unit.

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* Abstract of a report of a Committee appointed at a meeting of the Board of Scientific Societies on October 12, 1916, and consisting of Mr. Conrad Beck, Mr. F. J. Cheshire, Mr. E. B. Knobel, Sir Phillip Magnus, Prof. H. Jackson and Prof. A. Schuster.

Now the only way to carry on during the period of change is to take a new unit which will work in easily with the existing coins. This is where the florin or decimalised sovereign fails. How in the world is Mr. Hill or anyone else going to get the ordinary man and woman to understand that 3s. 6d. becomes 1·75, 5s. 11d. becomes 2·95, and 8s. 4d., 4·17. Let him form a class of people between 30 and 70 years of age, made up, say, of an ordinary woman of the middle classes, a cook, a navvy, a fitter, a lodging-house keeper, a washerwoman, a policeman, and, if he can get them, some society people. Let him explain the conversions to them thoroughly, and see if he can get them to display facility in a month! Probably they will fail to turn up after two or three lessons. I would be willing to guarantee to get them to have some kind of idea of the shilling system by half an hour's tuition. All they would need would be a card giving the copper equivalents, and as for the equivalent of sovereigns in shillings, they know them already as far as ever they need. Tell any man or woman that £1. 15s. is 35s., and you will receive the answer "I know that." Say it is 17·50 florins, and they won't be convinced. Again, with the shilling as unit, we need not withdraw the present silver coins for many years.

Mr. Silver thinks that too many digits would be required in writing down sums in shillings. Other nations do not find this trouble, and a simple example will show that we would not. Take the following:—

£4	8	9	S.88·75
5	12	0	112·00
20	14	11	414·92
3	8	6	68·50
£34	4	2	S.684·17

Mr. Silver thinks that the shilling method would lead to errors in addition, but surely everyone would rather have the shilling system than the present style in the above example. When it comes to long additions, the advantage of the shilling is even greater, as one does not have to divide by 12 and 20. One more case may be quoted. A million pounds in sovereigns is written down with seven digits; in shillings it is written with eight digits. The difference in this respect is so trivial that I am glad Mr. Silver mentioned it. Probably others have had the same idea.

Tynemouth, Feb. 17. C. Turnbull.

ELECTRIFICATION OF WOOD SHAVINGS.

TO THE EDITORS OF THE ELECTRICIAN.

At the aeroplane works here my attention was called to an occurrence which I think exceptional, and may be of interest to your readers. A workman found that the shavings of mahogany which he was planing clung in a remarkable fashion to the plane and had to be pulled off. I was asked to go and see the phenomenon. I found at once that the shavings came from the plane highly charged with electricity; they were attracted to the plane, or bench, or the piece from which they had been planed, but strongly repelled each other, standing out at an angle of 60 deg. from the vertical if approached and being picked up by hand.

The phenomenon was most remarkably persistent. I carried the shavings along a corridor through an office and up a flight of stairs, and the charge though reduced was still operative, and the repulsion witnessed by another observer.

The weather was clear and frosty at the time, but I was not aware of any other peculiar circumstance.

I enclose an envelope-ful of the mahogany shavings.

Leeds, Feb. 11. W. Brooks Sayers.

P.S.—The building in which this occurred is a long, high-pitched one, used as a [illegible] rink in the first period of its existence.—W. B. S.

THEORY AND OPERATION OF SPLIT-PHASE MAGNET.*

BY F. HYMANS.

Summary.—In order to present the subject matter of this article in a clear and concise form, the writer has divided it into separate sections devoted to preliminaries necessary for the derivation of the vector diagram of the split-phase magnet. In Section I. the relation is derived between flux components and the corresponding exciting current components. In Section II. a core structure, similar in magnetic behaviour to the split-phase magnet, is considered, to show that phase differences in the fluxes actually may occur even with open secondary and to derive the manner in which the primary reacts at the closure of the secondary. Sections III., IV. and V. take up factors of split-phase magnet design.

I.—Resolution of a Flux in Its Components.

The diagram of Fig. 1 represents a magnet core and a coil wound on a portion of the same, excited by an E.M.F. e.† Assuming the coil to be without resistance, the relation between flux, exciting current and E.M.F. is shown in the vector diagram Fig. 2, wherein $OD=e$ is the impressed E.M.F., $OA=\varphi$ the flux lagging 90 deg. behind OD, and $OB=c$ the exciting current leading the flux by the angle a. We can resolve the flux φ in two arbitrary components, φ_1 and φ_2, so that geometrically

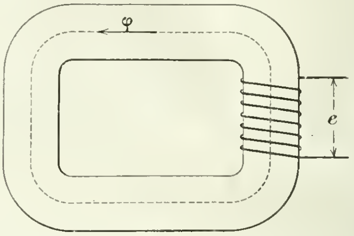


Fig. 1.—Diagram of Magnet Core and Coil.

$$\varphi=\varphi_1+\varphi_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The flux φ_1 will have an exciting current c_1, the flux φ_2 an exciting current c_2, and the problem which we here propose to solve consists in determining the relation which must exist between c_1 and c_2. Since the fluxes φ_1 and φ_2 occur simultaneously, that is, since only the resultant flux φ actually exists, it is clear that the number of lines of force per ampere exciting current must be the same for the resultant flux as well for its component, so that:

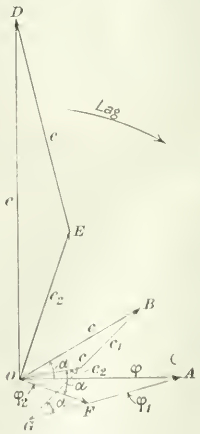


Fig. 2.—Relation between Flux, Exciting Current and Electromotive Force for conditions of Fig. 1.

$$\varphi/c=\varphi_1/c_1=\varphi_2/c_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

---

† The capital letters used in reference to an E.M.F. or current denote instantaneous values, and the small letters indicate effective values. Capital letters in reference to fluxes denote instantaneous values and small letters maximum values.

* Abstracted from the "Electrical World."

From 1 and 2 we derive

$$c=c_1+c_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . (3)$$

which means that the exciting current c, inducing the resultant flux φ, is the resultant of the currents c_1 and c_2, exciting the component fluxes φ_1 and φ_2, as shown in Fig. 2. When thus OAF is the triangle of the fluxes and OBC the triangle of the corresponding exciting currents, we deduce from the proportionality 2 at once :—

1. The triangle of the fluxes OAF and the triangle of the corresponding exciting currents OBC are similar, so that $\angle BOA=\angle COF=\angle BGA=a$, and hence :

2. In the triangles of the exciting currents and of the corresponding fluxes, each exciting current will lead the corresponding flux by the same angle.

In Fig. 2, c leads φ by the given angle a. If we therefore resolve φ in the components φ_2 and φ_1 we obtain the corresponding exciting currents by drawing OC and BG so as to make an angle a with the directions of OF and FA respectively, when CB will be the exciting current of φ_1 and OC of φ_2. Since the fluxes all link with the same spool, it is clear that the impressed E.M.F. e must be the resultant of the E.M.F.s, necessary to balance the E.M.F.s of self-induction due to φ_1 and φ_2. Each of the former E.M.F.s leads the corresponding flux by 90 deg. We draw consequently through D and O lines perpendicularly to the directions of FA and OF, whence ED and OE will be the E.M.F.s which induce the fluxes φ_1 and φ_2.

II.—Coil Linked with Two Cores, of which One is Provided with a Secondary.

As will be set forth in detail in Section III., the phenomena which take place in the split-phase magnet are identical to those occurring in a core structure as in Fig. 3, consisting of two individual cores 1 and 2, simultaneously excited by a single primary spool of n_p turns and provided with a secondary of n_s turns on core 1. Considering first the conditions with open secondary. When the primary is excited a flux φ_1 will be set up in core 1 and a flux φ_2 in core 2. When the two cores have different magnetic properties—each, for instance, having different dimensions, although consisting of the same material—the fluxes φ_1 and φ_2 will neither be in phase nor will their wave form be sinusoidal. These interesting facts can be demonstrated as follows :—

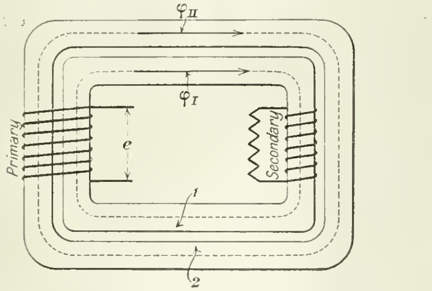


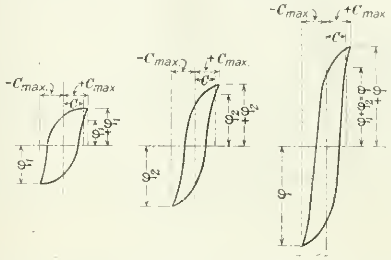
Fig. 3.—Core Structure used to illustrate Action of Split-phase Magnet.

Let Figs. 4A and 4B represent the hysteresis loops for the cores 1 and 2 respectively, where flux values are plotted as ordinates against current as abscissæ, $C_{\max.}$ being the maximum instantaneous value of the exciting current c. At each instant the total flux linking with the primary must be the algebraic sum of the instantaneous flux values induced in core 1 and core 2. We consequently obtain the loop Fig. 4C of the resultant flux by plotting against each instantaneous current value C the sum of the corresponding instantaneous flux values φ_1 in core 1 and φ_2 in core 2, which we obtain immediately from Figs. 4A and 4B. Assuming the primary to have no resistance, all of the impressed E.M.F. must be consumed by the E.M.F. of self-induction due to the linking of the resultant flux with the primary. If, therefore, the impressed E.M.F. is a sine wave, it follows that such must also be the case with the resultant flux.

In Fig. 5A the curve a represents the sine wave form of the resultant flux, instantaneous flux values being plotted against time. The wave form of the exciting current c (Fig. 5B) is derived by ascertaining the value of φ at a given instant from Fig. 5A, whence we obtain from Fig. 4C the corresponding value of the exciting current and plot the latter against the time in Fig. 5B. Knowing at each instant the value of the exciting current, we obtain from Figs. 4A and 4B the corresponding value of the fluxes φ_1 and φ_2, and can plot these values as ordinates in Fig. 5A, where curves b and c will be the wave shapes of the fluxes in core 1 and core 2. The wave forms of these fluxes are no longer simple harmonics ; they attain their maximum simultaneously, but φ_2 the flux with the higher maximum value, leads φ_1 by a considerable amount.

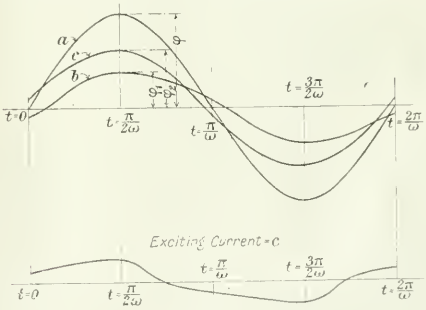
Under the conditions in actual magnets the phase difference between the fluxes φ_1 and φ_2 is generally slight, and no material error is made when treating them as harmonics.

In Fig. 6A the condition with opens secondary are thus represented by OC, the vector of the flux φ_1 in core 1 ; OA, the vector of the flux φ_2 in core 2 ; OH, the vector of the resultant flux φ, which links with the primary, and OG, the vector of the current c, which excites the fluxes φ_1 and φ_2. Upon the closure of the secondary a current c_s will flow through its windings, and the problem consists in determining the manner in which the primary will react. To distinguish the new conditions from the conditions with open secondary, the primary current will be denoted by c_p and the fluxes in cores 1 and 2 with the secondary closed by φ_I and φ_{II}.



Figs. 4A, 4B and 4C.—Hysteresis Loops for Cores 1 and 2 of Fig. 3 and the Resultant Flux.

Since the primary is assumed to have no resistance, the impressed E.M.F. must under all conditions be consumed by the E.M.F. of self-induction, caused by the linking of the resultant flux with the primary spool. Consequently the resultant flux φ linking with the primary remains the same with open as well as with closed secondary, and however the fluxes in cores 1 and 2 may be affected by the closure of the secondary, their new phase and magnitude must be such that their resultant remains the flux φ represented by the vector OH. Vectorially this is expressed as follows :—



Figs. 5A and 5B.—Sine Wave Form of Resultant Flux and Wave Form of Exciting Current.

With open secondary, $\varphi_1+\varphi_2=\varphi$,

with closed secondary, $\varphi_I+\varphi_{II}=\varphi$.

Hence,

$$(\varphi_1-\varphi_I)=-(\varphi_2-\varphi_{II}). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

But in Fig. 6A,

$$\varphi_I=\varphi_1+CD \quad \text{and} \quad \varphi_{II}=\varphi_2+AE.$$

Substituting for φ_I and φ_{II} in 1, we obtain

$$CD=-AE \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

expressing that the vectors CD and AE are equal, parallel to each other but of opposite directions.

When, however, the closing of the secondary causes the flux in core 1 to change from φ_1 to φ_I and in core 2 from φ_2 to φ_{II}, the changes are measured by the vectors CD and AE respectively and we consequently deduce the following from equation 2 above :—

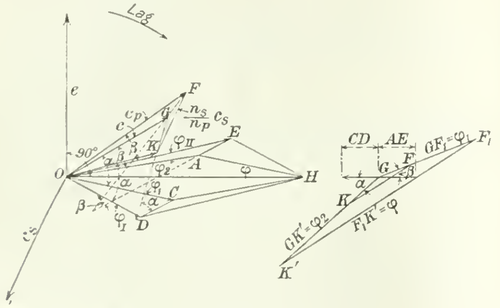
The re-adjustment which takes place upon the closure of the secondary occurs in such a manner that the vectorial increase in flux in one core is equal to the vectorial decrease in flux in the other.

With the above and the results of Section 1, we are now in a position to determine phase and magnitude of the fluxes in cores 1 and 2 and also of the primary current, upon the closure of the secondary, provided, of course, that the open secondary conditions as well as phase and magnitude of the secondary current is given. Supposing for the present phase and magnitude of the primary current c_p with closed secondary known and represented by OF in Fig. 6A. Considering first core 2, an inspection of Fig. 3 will show that the M.M.F. which excites the flux φ_{II} is $n_p \cdot c_p$ so that c_p will be the current exciting φ_{II}. If we now join G and F, evidently OGF will be the triangle of the exciting currents and OAE the triangle of the corresponding fluxes in core 2. According to Section 1, these triangles are similar, and hence

$$\varphi_2/c = AE/GF \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In the triangle of exciting currents OGF and in the triangle of the corresponding fluxes OAE, OG leads OA by the given angle β, so that in further accordance with Section 1., GF leads AE by the same angle, as shown in Figs. 6A and 6B.

Referring now to core 1, an inspection of Fig. 3 will show that the magnetomotive force which excites φ_1 is the vector difference between the magnetomotive force $n_p \times c_p$ due to the primary and the demagnetising magnetomotive force $n_s \times c_s$ due to the secondary. The resultant magnetomotive force is expressed by



FIGS. 6A AND 6B.—VECTOR DIAGRAMS FOR CONDITIONS WITH OPEN SECONDARY AND CLOSED SECONDARY.

$$n_pc_p - n_sc_s = n_p\{c_p - (n_s/n_p)c_s\},$$

and is consequently equivalent to a current $c_p - (n_s/n_p)c_s$ flowing through the n_p turns of the primary. If in Fig. 6A, c_s is the vector of the secondary current, we draw $FK = (n_s/n_p)c_s$ parallel to c_s, whence OK will be the vector difference of the current c_p and a current of magnitude $(n_s/n_p)c_s$ and the phase c_s, and will be the exciting current of the flux φ_1. By joining K and G, OGK will be the triangle of the exciting currents and OCD the triangle of the corresponding fluxes. In these triangles, OG leads OC by the given angle α and consequently GK leads CD by the same angle. The relative relation between the vectors GK and CD is also shown in Fig. 6B, wherein CD is drawn equal but opposite to AE in accordance with equation 2. The above triangles OGK and OCD are similar according to Section 1, so that

$$\varphi_1/c = CD/GK. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Since by equation 2, CD and AE are numerically equal, we deduce from 3 and 4

$$\varphi_1/GF = \varphi_2/GK. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

If, now, in Fig 6B we make $GF_1 = \varphi_1$ and $GK' = \varphi_2$, it is clear that F_1K' is the resultant of φ_1 and φ_2, and must therefore be equal to $OH = \varphi$ of Fig. 6A. On account of the proportionality 5, we further deduce that triangles GFK and GF_1K' of Fig. 6B are similar, so that

$$GF/\varphi_1 = GK/\varphi_2 = FK/\varphi.$$

Triangle GFK of Fig. 6B is merely a reproduction of the same triangle of Fig. 6A, wherein, as stated before $FK = (n_s/n_p)c_s$. Substituting in the above for FK, we obtain

$$GF/\varphi_1 = GK/\varphi_2 = (n_s/n_p)c_s/\varphi. \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

How to construct the diagram for closed secondary when the open secondary conditions are given is now clear, for, with the latter known, triangle GF_1K' of Fig 6B can at once be drawn. If, in addition, the phase and magnitude of the secondary current is given we can draw in Fig. 6B FK parallel to F_1K' and of such length that $FK = (n_s/n_p)c_s$. Transporting there upon triangle GFK of Fig. 6B to Fig. 6A, but so that the side FK is parallel with the direction of c_s, we obtain at once OF, the vector of the primary current, which excites the flux φ_{II} in core 2 as well as OK, the vector of the exciting current of the flux φ_I in core 1. Applying again the theorem of the triangles of exciting currents and corresponding fluxes, we find easily that OF leads φ_{II} by the angle β and OK leads φ_I by the angle α. Making, therefore, $\angle FOE = \beta$ and $\angle KOD = \alpha$, we obtain the phase of φ_{II} and of φ_I, and since $OH = \varphi$ must be their resultant, their magnitudes are readily determined.

In another section of this article to appear in a later issue, practical factors of split-phase magnet design and operation will be discussed.

HIGH-TENSION SUBMARINE CABLE BETWEEN DENMARK AND SWEDEN.*

The cable which has been laid for the purpose of transmitting power from Sweden to Denmark is remarkable, inasmuch as it is the longest submarine cable of its kind, having regard to the pressure at which the transmission takes place. The power is received by the electricity and tramway company at Hellerup, near Copenhagen, and is transmitted by the South Sweden Power Co., at Malmö ; the generating power station is on the Lagan river, about 50 miles north-east of Helsingborg. The original proposal to take power in this form from Sweden met with opposition from the Danish military authorities, as difficulties might quite possibly arise in time of war, but eventually it was considered that the advantages outweighed the disadvantages. A contract was, therefore, made early in 1914 for laying the necessary cable, and the work was completed before the end of 1915. The submarine cable is about 5·4 km. long, and consists of nine factory lengths, each measuring 600 metres. The cable is of the three-conductor type, insulated with impregnated paper. Each conductor has a sectional area of 70 sq. mm. It was tested at the works at 87,500 volts, and carries current at 35,000 volts. A great amount of experience has been had with regard to gutta-percha cables for submarine work, but things are very different with high-pressure cables. The jointing of lead-covered paper-insulated cables at sea is not at all a simple matter, and all sorts of precautions have to be taken both with regard to regulating the movements of the ship and its laying machinery, and also with regard to the exclusion of moisture from the joints. The greatest depth at which a joint is laid is 38 metres. After the cable had been laid it was tested for half an hour at a pressure exceeding the working pressure by 50 per cent. The whole transmission line is made up as follows : The first portion from the Lagan river is overhead, and carries a pressure of 50,000 volts. There is a transformer station at Helsingborg, where a conversion to 25,000 volts takes place. From this point there is an underground cable, about 4·8 km. long, to a switch house, situated near Palsjö, nearly north of Helsingborg. At this point the submarine length begins ; it reaches land in Denmark at Marienlyst, whence an underground cable, 1·5 km. long, conveys the power to a sub-station at Elsinore. About 200 metres to the north of the submarine high-tension cable there is laid a four-cored heavily armoured gutta-percha cable, which is used for telephone purposes ; it also serves to protect the high-tension cable from the anchors of ships that may be driven out of their course by stress of weather. On the south side of the high-tension cable there are three telegraph cables. At the present moment only 370 kw. are being transmitted to Denmark, but this is likely to be much increased in the future. Taking into account the present high price of coal, the contract ought to be very useful to the Danish tramway authorities.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Depreciation and Wasting Assets and their Treatment in Computing Annual Profit and Loss." By P. D. Leake. (London : Sir Isaac Pitman & Sons, Ltd.) Pp. xxiv.+233. 10s. 6d. net.

"Annales des Postes, Télégraphes et Téléphones." (Paris : A. Dumas.) Pp. vii.+200. 12 fr.

"High Speed Internal Combustion Engines." By Arthur W. Judge, A.R.C.Sc. (London : Whittaker & Co.) Pp. ix.+350. 15s. net

"Annuaire Pour l'An 1917." (Paris : Gauthier-Villars et Cie. Pp. viii.+700. 2 fr. net.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 13, 1916.

LEGAL INTELLIGENCE.

Alien Enemy Patent.

Application was recently made by the United Flexible Metallic Tubing Co. for a licence to use a German-owned patent (No. 3,822 of 1909) for a form of metal tubing which can be used for covering electric cables, the characteristic of which is that a metal band is wound in the form of a screw thread and has its edges welded, the joints being welded together by electric or autogenous welding. The welding of the joints of the tube could be done through the winding of the tube on the ordinary tube-winding machine in which case the winding spindle would form one electrode and one of the winding rollers of the winding-head the other electrode. The longitudinal section of the wall of the tube, when constructed, had the configuration of a waved line, and the tube readily bent by reason of the corrugation.

Mr. Imray, chartered patent agent, said applicants already made a flexible tube, which was used for cables of an entirely different construction. That was in the form of rings or in section interlocking strips, each coiled upon itself. Where there was much vibration there was a disadvantage in the continuous sliding of the parts, and the wear and tear involved. That was avoided in the patent, which, however, was less flexible than their own. The form of tubing covered by the German patent was not being manufactured in this country at present.

Mr. Wm. Berryman, works manager, stated that the applicant firm made 4,000,000 ft. (or 760 miles) of tubing last year, in sizes ranging from $\frac{1}{4}$ in. to 15 in. in diameter. They were supplying large quantities to the naval and military authorities. The patented tubing, because of its space, was more suitable for heating and cooling, and avoided the disadvantage of applicants' asbestos packing where there was wet steam or vibration. The flexibility of the tube arose from the spring of the metal.

The Controller said he would recommend that a licence be granted at a royalty of 5 per cent.

Workmen's Compensation.

At Lambeth (London) County Court recently, Judge Parry had again before him the case of Thomas Woolley, electrician, who was being paid compensation, the respondents being Watson, Marsh & Co. The case came before the judge in December, when, acting on the report of the Medical Referee, he directed that 15s. a week should be paid to applicant until the date of the present hearing, and that he should in the meantime make every endeavour to get back to work. It was reported that applicant was engaged in packing china, being paid 5s. a day, or 30s. a week. He stayed four days in January, but his leg became so painful that he had to stop work, and had done none since. He had seen his panel doctor, who said he was unable to do any work at present.

Judge Parry, after ascertaining that applicant was 56 years of age, said the Medical Referee had stated there were still some effects of the injury, and that there was a certain amount of incapacity. Whilst litigation was hanging about he did not think that the man would try to overcome his difficulty, and suggested a settlement. After a short conference the parties came to terms, applicant being paid 15s. a week to date and £26 in full settlement of his claim. Judgment was then entered for applicant for £26 with costs, but the doctor's fee for attendance that day was disallowed.

J. Beatty v. Salford Corporation.

At Manchester Assizes last week plaintiff sought to recover damages from Salford Corporation for injuries sustained through being knocked down by a tramcar. On the night of Aug. 4 last plaintiff was riding on a bicycle in Trafford-road, Salford, when, as he came out from behind a stationary tramcar, he was knocked down by a car coming in the opposite direction, the driver of which, it was alleged, neglected to sound his gong. His leg was fractured, and he had been unable to work since.

The driver of the car and other witnesses for the defence said the gong was sounded, and that plaintiff came so suddenly from behind the car that he ran into it.

The jury found for plaintiff, and assessed the damages at £200. Judgment was entered for this amount, but a stay of execution was granted.

Telephone Charges.

At the City of London Court last week (before Sir John Paget, K.C.) the Postmaster-General sued Messrs. Harry South & Lambe for £3, being balance of telephone charges. Defendants raised a counterclaim for loss suffered through the telephone being cut off, but the Postmaster-General pleaded that no one had any right to claim damages against the Crown except through the old form of a petition of right. Judgment was entered for plaintiff, with costs.

Boy Tramcar Drivers.

At the Carlisle County Court recently two claims were made by cattle dealers for damage for injuries to cattle by a tramcar, and a total sum of £95 was awarded. The accident occurred on a dark night. It was stated that the driver of the car was aged 16, and the manager of the company admitted that the lad had only had one week's training. The maximum speed of 12 miles an hour had not been reduced since the lighting restrictions came into force.

Liability for Lost Tramcar Luggage.

At Newcastle-on-Tyne last week Judge Greenwell gave a reserved judgment in a claim by a passenger (Elsie Hewitson) against Newcastle Corporation for £9, the value of a suit case and its contents.

The facts were given in our issue of Jan 26 (p. 532). In giving his judgment, his Honour pointed out that the statute required free carriage of passengers' luggage up to 28 lb., and if it was less (as in the present case) the Corporation became common carriers when they accepted a penny for its conveyance. They attempted to limit the liability by a ticket which had a clause on it in type so small that it was impossible to read except by good eyes in a strong light. He had seen no notice in the cars disclaiming responsibility. After referring to the Corporation Acts and by-laws, he said no authority had been given for the penny charge. In one judgment it was said the ticket was no more than a receipt. He found that the Corporation were common carriers, who had failed to contract out of their liability, and he gave judgment for plaintiff for £9.

Blundell v. Comins.—Last week the Court of Appeal dismissed the appeal of Mr. C. J. Weld Blundell from a verdict and judgment against him in a libel action brought by Mr. Comins, C.A. £500 damages had been awarded to Mr. Comins in respect of a letter written by appellant, and which had also formed the subject matter of an action by Capt. Lowe, a former manager of the company. The grounds of the appeal were that the damages were excessive, and that there was misdirection on the part of the judge. The appeal was dismissed without calling upon respondent.

EDUCATIONAL.

University of Cambridge.—A Grace has passed the Senate approving of the granting of the new research degrees of "Master of Letters" and "Master of Science."

The intention is to encourage students to remain in residence for one or two years after they have completed their work for the Tripos and engage in research under competent direction. Though the new degrees are mainly intended for Cambridge graduates they will be open to properly graduated students from other universities.

University of Birmingham.—At the recent annual meeting the reports of the Council and of the Principal (Sir Oliver Lodge) were presented.

In 1915-16 there were 370 matriculated and 319 unmatriculated students, a total of 689, compared with 786 in 1914-15, and 1,032 in 1913-14. There was an increase in the number of women students, and in the medical faculty women are 40 per cent. of the total.

Prof. Frankland put forward certain specific reforms in the teaching of science by universities in order to replace the amateur by the professional aspect of science study. With regard to the length of the curriculum, he suggested that no science degree should be conferred unless the candidate has had a minimum of four years' study, reckoned from matriculation, at one or more of the recognised universities or equivalent institutions. This minimum period of four years should be exacted for the lowest degree (B.Sc.), and even this should not be conferred without the performance by the candidate of some relatively simple research work. A higher degree (M.Sc.) should be conferred for a fifth year devoted to original investigation at a university on presentation of a thesis embodying the results of this research, and approved by the examiners. The highest degree (D.Sc.) should be awarded only for published research work approved by the examiners on the same lines as heretofore. Every facility should be provided to enable undergraduates and graduates to pass from one university to another. The funds available for scholarships should be distributed on an eleemosynary basis, and not for conferring distinction on exceptionally brilliant students. The universities must insist on a higher standard of school attainments, more especially in mathematics, English and foreign languages (French and German at least.) The time spent on examinations should be very greatly reduced. It is (according to Prof. Frankland) altogether subversive of the true spirit of university life that undergraduates should be shepherded and driven to their work like schoolboys. Once let it be clearly understood that a high standard of attainment will be rigorously exacted for the degree, and there will soon be an end of the slackness and shirking which these ever-recurring examinations are intended to prevent. Physical training and the civilising influence of military discipline must form an integral part of the university curriculum.

Manchester School of Technology.—At the meeting of the Manchester Education Committee on Monday last the Technological School Committee recommended that the salary of Prof. Miles Walker be increased from £600 a year to £1,200, by three equal instalments of £200 on April 1, 1917, 1918 and 1919.

After a short discussion the recommendation was approved, with two dissentients. It was said that Prof. Walker was one of the most distinguished professors of electrical engineering in the country and that a great engineering firm had offered him a salary of £1,800. Principal Maxwell Garnett, replying to a question as to the number of students at the School of Technology and the cost of administration, said the number was certainly less than it was a year ago, but that was what one would have expected. One must remember, however, that the school's grants from the Government during the last four years had increased by £4,000 a year. As to research work, the amount going on now was very much greater than it was this time last year, and, if allowed, he could give information concerning such work and of the extreme value put upon it by the Government that would astonish the Committee.

University of Sheffield.—Prof. W. Ripper succeeds Dr. H. A. L. Fisher as Vice-Chancellor.

University College of North Wales.—At a meeting of the General Committee for North Wales and the Welsh Communities of London last week it was decided to make the erection of new science buildings at this college the North Wales memorial to men fallen in the war. The nucleus of the fund is a gift of £20,000 from Mr. Thomas, supplemented by another of £5,000 from Col. David Davies. It was urged that by the development of science the whole country and future generations would benefit. Lord Kenyon was appointed chairman, and it was stated that the King and the Prime Minister approved of the proposal. The scheme will cost £150,000.

University College of S. Wales.—Sir Wm. Tatem has given £25,000 for equipping a chemical laboratory at this college.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstracts from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

[illegible].319 Blathy. Process of and apparatus for testing electricity meters.
10,722 Nobbs & Nobbs. Electrical heating apparatus. (21/1 16.)
17,581 Western Electric Co. Automatic telephone call distributing systems. (19 12 14.)

1916 Specifications.

70 Hamilton, J.E. Electric controller, particularly for use in connection with electrically-propelled vehicles. (3 1 16.) 102,981.
471 Marconi's Wireless Telegrpah Co. & Franklin, C.S. Electrical condensers. (11 1 16.) 102,997.

The condenser is formed of a series of overlapping coaxial cones of conducting material each of which has its bottom edge turned out and rounded off into a flange and has its apex rounded and preferably closed or nearly closed.

477 C[illegible]d, M. A. Ignition devices for internal combustion engines. (11 1/16.) 102,998
487 Schmidt, W. Magnet systems for magneto-electric machines for ignition purposes in internal combustion engines. (11/1/16. Convention date not granted.) 100,018.
[illegible]19 Pearson, C. Secondary batteries. (12 1 16.) 102,999.
[illegible]41 Ma[illegible]n, C. T. Ignition dynamos. (25 1 15.) 100,031.
[illegible]79 M[illegible]ld, J. Starting or synchronous dynamo-electric machinery and means therefor. (13 1 16.) 101,809.
[illegible]1 W[illegible]ght, E. B. Electrical apparatus for producing hot and cold currents of air for drying hair and for other purposes. (13 1 16.) 103,153.
[illegible]9 E[illegible]ll, C. F. & Cl[illegible]se, C. J. Radio-receiving circuits. (13 1 16.) 103,004.

The circuit is provided with two electromagnetically-coupled coils interposed [illegible] between the receiver and the antenna and between the receiver and [illegible]. The secondary or earth coil and the coupling between the two eliminator [illegible] may [illegible] be variable for tuning purposes. The aerial may also be connected [illegible] inductance coil to a variable point of which the receiver is con[illegible] [illegible] are trapped both at the inductance coil and at the [illegible]

[illegible] B[illegible] S[illegible] & L[illegible] Co. & Routledge, W. Electro-magnetic shuttle-[illegible] weaving looms. (17 1 16.) 103,157.
[illegible] B.T.-H. [illegible] E[illegible]. (18 1 16.) 103,167.
[illegible] P[illegible] A[illegible] Telephone Co. & Bygrave, L. C. Telephone systems. ([illegible] 1 16.) 1[illegible]3,173.
[illegible] W[illegible] E[illegible] C[illegible] (Western Electric Co.) Cores for Pupin loading [illegible] and the like. (29 1 16.) 103,188.
[illegible] A. W. E[illegible]phragm horn for automobiles and the like. (25 7 16.) [illegible]
[illegible] B[illegible] J. & G[illegible] E. Radio-telegraphy. (11 2 '15, addition to [illegible]) [illegible]

T[illegible] of means whereby the properties of circu[illegible] [illegible] in order to obtain easily an auxiliary volt[illegible] [illegible] the main spark gap.

[illegible] E[illegible] (1[illegible] 2 16.) 103,020.
[illegible] S[illegible] W. R. & Tarrant, R. W. Railway signalling [illegible] 26.
[illegible] W. L. B[illegible] (17 3 1[illegible]) 100,176.
[illegible] & L[illegible] E. E[illegible] drums, reels or the like. ([illegible]4 3 16 [illegible]
[illegible] (28 3 16.) 103,046.

[illegible] a portion of the discharge path [illegible] electrical resistance but which i[illegible] [illegible] electrical resistance by [illegible]

[illegible] (1[illegible] 3 16.) 103,047.

[illegible] oscillation [illegible] consisting of [illegible] substantially non-[illegible] an anode, and [illegible]

[illegible] telephones. (13 4 16.) [illegible]
[illegible] 103,2[illegible]
[illegible] Telegraph [illegible]
[illegible]

10,122 Forest, L. [illegible] Electric vacuum devices with incandescent cathodes. (22/7/15.) 100,959.

Relates to an electric vacuum device for generating electrical oscillations, comprising an evacuated metallic vessel, forming the wing electrode of said device, and an outer vessel surrounding said evacuated vessel, and in electrical connection with same, the grid and filament electrodes being located in said evacuated vessel, and extending out of both of said vessels, and means enclosed by said outer vessel for maintaining said inner vessel airtight.

10,611 Western Electric Co. Automatic telephone call distributing systems. (19/12/14, divided application on 17,581/15.) 101,033.
10,745 Jones. Anodes for electroplating. (29/7/16.) (Addition to 17,328/15). 102,897
11,327 British Westinghouse Electric & Mfg. Co. (Westinghouse Electric & Mfg. Co.) Alternating-current dynamo-electric machines of the compensated commutator type. (10 8 16.) 103,265.

Automatic means are provided in the control circuit of a motor whereby under extremely light loads, the excitation of the cross field winding is greatly reduced, irrespective of the specific connections of the control system at that time, and the cross-field winding may even be entirely eliminated from the circuit when the load current falls below a certain value.

11,691 Soc. de Paris et du Rhone. Magneto ignition systems. (6/12/15.) 102,606.
11,736 King, W. (Chkliar, I., & Theodor, B.) Construction of pocket or portable electric lamp. (18/8/16.) 103,268.
13,631 Sangster. Attachment of magnetos to the power units of motor cycles. (22/3/16.) (Divided application on 4,217/16.) 102,913.
13,727 Pate, G., & Wood, A. R. Electric heating and cooking apparatus. (27/9/16) 103,279.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

January 8, 1917.

329 Cambridge & Macgregor. Controlling speed of internal combustion engines by electric ignition.
331 Cannart d'Hamale. Adjustable resistances and inductances.
362 B.T.-H. Co. (G.E. Co.) Electric heating devices.
363 Devers. Electric arc devices. (26 3 16, U.S.)
368 Armstrong, Whitworth & Co. & Cheetham. Apparatus for electric lighting.

January 9, 1917.

386 Molyneux. Ignition devices for engines.
400 Carland. Automatic or wireless steering control.
414 Trier. Electric starting devices for engines.
426 Garde. Electric switches.
436 Codd. Induction coils or transformers.
438 Bethenod & Girardeau. High-frequency alternators. (10 8 15, France.)
449 Bethenod & Girardeau. Stators of electric generators. (10/8/15, France.)

January 10, 1917.

468 Hurst & Patton & Spiller. Sparking plugs.
481 Jenkins. Electric heated wearing apparel.
452 White. Mechanical circuit-breaker for electric heated water apparatus.
488 Roose & International Electric Co. Telegraph and telephone apparatus.
502 B.T.-H. Co. (G.E. Co.) Electric controllers.
528 Murray & Woodrow. Electric welding machines. (8/3/16, U.S.)

January 11, 1917.

538 Crichton. Electric welding.
558 Kleinschmidt. Telegraphic printers.
560 Engelke. Electric lampholders.
565 Pugh. Controller for electric time signals.
566 B.T.-H. Co. (G.E. Co.) Bearings for instruments.
577 Graham. Electric apparatus for indicating at a distance numerical data.
578 Graham. Electric apparatus for transmitting and indicating orders, &c.
584 Hubbard. Clutch mechanism for electric cranes.

January 12, 1917.

609 Clark & Longford. Ignition plugs.
614 Spencer. Electric warehouse crane.
625 Western Elec. Co. Signalling device.
634 Balzarini. Obtaining non-alternating h.t. currents by means of three-phase or polyphase E.M.F. of l.t. with one single induction coil.
640 Igranic Elec. Co. (Cutler-Hammer Mfg. Co.) Overload circuit-breakers.

January 13, 1917.

686* Berry. Magnetic material.
691 Dover. Telephone receiver casings.
695 Balzarini. Reversal of primary current and periodic communication of secondary circuit to improve working of induction coil.

January 15, 1917.

713 King. Electric lamps for motor vehicles.
720 Carson. Electric illuminated rudder indicator.
732 Ashcroft. Galvanic batteries.
740 Relay Automatic Telephone Co. & Johnson. Automatic telephone systems.
744 B.T.-H. Co. (G.E. Co.) Valve mechanism.
749 British Elec. Transformer Co. & Crosbie-Hill. Phase transformation of electric currents and transformers therefor.
752 Henderson. Electric magnetic signalling apparatus. (13 1 16, U.S.)

January 16, 1917.

767 Hartley. Electric illuminated indicators for personal wear.
773 McLoughlin. Commutators and collecting rings.
788 Humphries. Carbon holders for arc lamps.
802 Bennett. Cord-grips for lamp wires.
807 S[illegible]ley. (Soc. Anon. des Phares et Lanternes Tul[illegible]) Lamps for searchlights, &c.
819 Fletcher & J[illegible]el. Dynamo-electric machines.

January 17, 1917.

830 Lancashire Dynamo & Motor Co. Apparatus for operating feed device of reciprocating tools, &c.
851 Western Electric Co. Semi-automatic telephone systems.
[illegible]0 Henry. Electric batteries.

January 18, 1917.

8[illegible] Greville. Electro-medical apparatus.
894 H[illegible]hfield. Windings of motors and generators.
910 Harris. Electric keyboard transmitting apparatus, &c.
930 Na[illegible]er & Liliendahl-Petersen. Auxiliary apparatus for telephones.
93[illegible] Austin & Taylor. Electric couplings and [illegible] therefor.
934 935 Cowper-Coles. Electro-deposition of copper.
936 Cowper-Coles. Production of copper tubes.
937 Cowper-Coles. Recovery of copper from weak copper sulphate solutions.
943 [illegible]ke. Electric motor control.

January 19, 1917.

[illegible]5 H[illegible]. Electric switches.
974 B.T.-H. Co. (G.E. Co.) System of electric ship propulsion.

January [illegible] 1917.

99[illegible] El[illegible] M[illegible] (Ltd.), Greenhal[illegible] & L[illegible] Dynamo-electric machinery.
1,01[illegible] Ha[illegible] Miners' safety lamps.
1,017 H[illegible] Telegraph Works Co. & P[illegible]. Suspender for electric cables, &c.
1,02[illegible] S[illegible] Telephone, &c., [illegible]

January 22, 1917.

1,046 Tayl[illegible] Accumulator for miners' lamps.
1,0[illegible] Harvey. [illegible] for telegraphy and telephony.
1,0[illegible] [illegible] M[illegible] detector for wireless telegraphy.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The War Loan. The Chancellor of the Exchequer (Mr. A. Bonar Law) announced in the House of Commons on Monday that the new War Loan had been a much greater success than the Government had anticipated, and he estimated that the amount of new money was over £700,000,000.

Among the latest subscribers to the loan were: Harland & Wolff (£1,500,000), Mond Nickel Co. (£250,000), Messrs. C. A. Vandervell & Co. (£64,800), Aerators (Ltd.) (£30,000), Stanton Iron & Coal Co. (£275,000), India Rubber, Gutta Percha & Telegraph Works Co. (£20,000 new), Anglo-Argentine Tramways Co. (£240,000 new), Sterling Telephone & Electric Co. (£25,000), Crittall Mfg. Co. (£20,000), Liverpool Overhead Railway Co. (£10,000), Mersey Power Co. (£5,000), Brown, Boveri & Co. (£4,000), British Westinghouse Co. (£60,000), Monte Video Telephone Co. (£50,000), Joseph Tomey & Son (£2,000), employés of the General Electric Co. and allied companies (£26,500), L. Le Personne & Co. (£18,000), Osram-Robertson Lamp Works employés (£10,000), Western Union Telegraph Co. (£9,000), Peel-Conner Telephone Works employés (£2,000).

* * * *

Trade After the War. An interim report by Lord Balfour's Committee on Commercial and Industrial Policy, which was issued on Tuesday last, makes the following recommendations in favour of Imperial Preference:—

1. In the light of experience gained during the war, we consider that special steps must be taken to stimulate the production of food-stuffs, raw materials and manufactured articles within the Empire wherever the expansion of production is possible and economically desirable for the safety and welfare of the Empire as a whole.

2. We therefore recommend that H.M. Government should now declare their adherence to the principle that preference should be accorded to the products and manufactures of the British Overseas Dominions in respect of any Customs Duties now and hereafter to be imposed on imports into the United Kingdom.

3. Further, it will in our opinion be necessary to take into early consideration, as one of the methods of achieving the above objects, the desirability of establishing a wider range of Customs duties which would be remitted or reduced on the products and manufactures of the Empire and which would form the basis of commercial treaties with Allied and neutral Powers.

In a letter to the Prime Minister the Committee state that they have arrived at the above conclusions chiefly on the ground that, although to some of them any measures which might act in restraint of trade were in the abstract distasteful, they think it necessary that, for the sake of the unity of the Empire, a serious attempt should now be made to meet the declared wishes of the Dominions and Colonies for the development of their economic relations with the United Kingdom, and that any abstract opinions members may hold should not, under the circumstances and with the experiences gained during the war, stand in the way of any measures which are seen to be important, having regard to the general interests of the Empire. In recalling the resolutions of the Colonial Conference of 1902 the Committee say that whatever controversies may have arisen in the past, they think that, "regard being had in particular to the sacrifices made and the services rendered by our fellow subjects overseas for a common purpose during the present war, the time has now arrived at which this request should be granted to the fullest extent which is now or may hereafter become practicable." The Committee desire to emphasise the fact that for the purpose of recovering trade lost during the war, of securing new markets and of consolidating the resources of the British Empire, the development throughout the Empire of a system of mutual tariff preferences was a subject which cannot any longer be neglected. Measures must be devised to safeguard the interests of the consumer and the rightful demand of labour.

The recommendations are made unanimously, but there are separate memoranda by Sir F. H. Smith and by Messrs. R. Hazleton and John O'Neill.

* * * *

Excess Profits Duty Decision. The Board of Referees have increased the statutory percentages in the following cases:

To 7½ per cent. for companies and 8½ per cent. for others operating electric tramways in Cape Province (S. Africa), on the application of the Cape Electric Tramways (Ltd.).

To 8 per cent. and 9 per cent. respectively for companies and others operating motor omnibuses in London, on the application of the London Omnibus Owners' Federation.

Census of Aluminium. The Minister of Munitions has made an order requiring that all persons shall in the first seven days of each month beginning in March send in to the Director of Materials, A.M.2 (H), Hotel Victoria, Northumberland-avenue, London, S.W., monthly returns of:—

(*a*) All aluminium held by them in stock or otherwise under their control on the last day of the preceding month.

(*b*) All aluminium purchased or sold by them for future delivery and not yet delivered on such last day, together with the names of the sellers to or purchasers from them.

(*c*) All aluminium delivered to them during the preceding month.

(*d*) All aluminium scrap or swarf produced by them and or issued from their works during the preceding month.

(*e*) All contracts or orders existing on the last day of or entered into during the preceding month requiring for their execution the use of aluminium, specifying the purposes thereof.

No return, however, is required from any person whose total stock of aluminium in hand and on order for future delivery to him has not at any time during the preceding month exceeded 56 lb.

Failure to comply with the order or false declaration will be an offence against the Defence of the Realm Regulations, and be liable to penalties of fine and imprisonment. Under the order made by the Minister of Munitions on Dec. 2, 1916, all dealing or negotiation for dealing in aluminium without a permit is illegal.

* * * *

Employers and After-war Problems. In the annual report of the Employers' Parliamentary Council it is stated that when the time comes for taking stock of the nation's industrial resources, in view of the universal competition which will rule the markets of the world, it will be found that any return, even on a small scale, to the conditions which governed national production in the period before the war would be disastrous and possibly fatal to British interests both at home and abroad.

The Council note evidence of the growing feeling of distrust in the old methods of labour unionism. The fact of those methods having to be abandoned to meet national necessities has impressed itself strongly even on the minds of those who formerly excused them as promoting the interests of labour.

The demand that after the war labour shall take a larger share of the profits of industry, a demand that has been endorsed by several members of the Government, and with which sympathy has been expressed in many influential quarters, is, in the opinion of the Council, one to which no reasonable exception can be taken. provided that labour, earnestly and whole-heartedly, performs its part in the general scheme of production, and thus establishes a good title to the claim for greater remuneration. A high standard of production can be maintained only if the energies of capital and labour alike are exerted to their utmost capacity.

* * * *

U.S.A. Electrical Manufacturers. It is reported that the value of the total sales of the three leading electrical manufacturers in the U.S.A. (the General Electric, Western Electric and Westinghouse companies) during the past year was over $305,000,000 (an increase of 62.3 per cent.), and that the value of unfilled orders is over $105,000,000 (an increase of over 144 per cent.

The sales of the General Electric Co. were $120,000,000, compared with $85,500,000, and $107,000,000 in 1913. The figures of the Western Electric Co. were $105,000,000, $63,800,000 and $77,500,000 respectively; while the Westinghouse Co.'s sales were $80,000,000, $38,000,000 and $43,700,000. The figures represent only the regular products of the companies, and do not include orders for munitions, but it is estimated that the average increase of prices over the previous year was 15 per cent.

* * * *

American Copper Production in 1916. The United States Geological Survey Department announces that the production of copper in 1916 surpassed all previous records.

It is estimated that, at an average price of about 27 cents a pound, the value of the 1916 output is $520,000,000, compared with $242,900,000 in 1915. According to statistics and estimates, the output of blister and Lake copper from domestic ores was 1,928,000,000 lb. in 1916, against 1,388,000,000 lb. in 1915. The output of refined copper (electrolytic, Lake, casting and pig) from primary sources, domestic and foreign, for 1916 is estimated at 2,311,000,000 lb. against 1,634,000,000 lb. in 1915, and the production of copper from the mines of the United States for 1916 was more than double that of 10 years ago and more than four times that of 20 years ago. The profit resulting from the domestic production was far greater in 1916 than in any previous year, and probably exceeded $300,000,000. The exports of pigs, ingots, bars, plates, sheets, rods, wire, &c., for the first ten months of 1916 amounted to 655,472,000 lb., compared with 529,286,000 lb. for the first ten months of 1915. It is estimated that the supply available for domestic consumption is materially greater than the 1,043,000,000 lb. of 1915, no account being taken of stocks held at the close of the year.

The average price of copper for 1916 showed a marked increase over that of 1915, being slightly above 27 cents a pound, against 17·4 cents in 1915. Much of the copper was sold several weeks or months in advance of delivery, and it is probable that the actual average price differed somewhat from the average of the daily quotations for immediate delivery.

* * * *

Electric Ranges in the U.S.A. It is estimated that the value of the electric range business in the United States of America in 1916 amounted to $2,300,000 at list prices, and it is calculated that during the current year this figure will be increased to $4,750,000. The list prices were advanced on Feb. 1 owing to the high price of raw materials, &c.

* * * *

Development of the Empire's Resources. A movement has been inaugurated for the purpose of promoting the development by the State of the Empire's resources in order to assist in the payment of the war debt.

The Empire Resources Development Committee has been formed in order to push the movement. Among the members are: Earl Grey, Lords Selborne, Desborough, Dunraven, Islington and Plymouth, Sir Starr Jameson (chairman), Sir L. Worthington Evans, Mr. Bigland, Sir Wm. Bull, Mr. Page Croft, Mr. Cust, Mr. Moreton Frewen, Mr. Rudyard Kipling, Mr. Wilson Fox, Mr. Hodge, Mr. Almeric Paget, &c.

* * * *

Metals and Empire. In a recent lecture at the London School of Economics, Mr. O. Beale, chairman of the London Chamber of Commerce, said that if this country had gone on in the path it was pursuing before the war for another decade it would have lost its place in the world.

Mr. Beale said he had continually warned the Australian Administration that the lead which was being allowed to be exported to Germany would be returned to Australia's sons in the shape of bullets, but his warnings were unheeded. The war had taught Australia and, indeed, the British Empire, that Germany must never again be allowed to dominate their markets.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 10, 1917, *to* Feb. 16, 1917.

IMPORTS.

[illegible] A [illegible] Elec. carbons, £10[illegible]; elec. machinery, £5,267; wire [illegible] unenumerated, £1[illegible],533. *Japan*: Unenumerated, £2,481. *France*: E[illegible] £[illegible] unenumerated, £263. *Switzerland*: Unenumerated, £41. *Holland*: [illegible] £44. *Denmark*: Elec. machinery, £115. *Spain*: Elec. carbons, £[illegible].

EXPORTS.

T[illegible] A[illegible] *Auckland*: Unenumerated, £77. *Melbourne*: Elec. machinery, £[illegible] material, £330; unenumerated, £617. *Sydney*: Elec. machinery, £101 unenumerated, £1,319. *Wellington*: Elec. machinery, £77; unenumerated, £1,495. [illegible] Unenumerated, £176. *Christchurch*: Elec. machinery, £135. *Brisbane*: E[illegible] £3,960 [illegible] *Lyttelton*: Elec. machinery, £104. *Fremantle*: Unenumerated £51. *N*[illegible] Elec. machinery, £1,907.

A[illegible] *Town*: Elec. machinery, £18; elec. lamps, 1,100 n.o.; unenumerated [illegible] *Port Elizabeth*: Unenumerated, £79. *East London*: Unenumerated, £61 [illegible] W[illegible] £47[illegible] unenumerated, £1,735. *Beira*: Elec. lamps, 2,360 n.o.; unenumerated, £14. *Mauritius*: Unenumerated, £192. *Napier*: Elec. machinery, £[illegible]; unenumerated, £41.

E[illegible] *Alexandria*: Elec. lamps, 1,500 n.o.; elec. machinery, £513; unenumerated, £[illegible]48.

INDIA, CEYLON, [illegible] AND STRAITS SETTLEMENTS.—*Bombay*: Elec. lamps, [illegible] unenumerated, £3[illegible]. *Calcutta*: Elec. lamps, 5[illegible]0 n.o.; wire and cable, £[illegible] [illegible] £195 [illegible] £1,021. *Madras*: Elec. machinery, £29 [illegible] £[illegible]71 [illegible] Wire and cable, £2[illegible]; telegraph material, £65; elec. lamps [illegible] unenumerated, £14[illegible] *Singapore*: Unenumerated, £246. *Karachi*: Unen[illegible] *Port Swettenham*: Elec. machinery, £439. *Penang*: Unenumerated [illegible] *Wire* [illegible] £1[illegible]; unenumerated, £14.

[illegible] £14[illegible] [illegible] Unenumerated, £61. *O*[illegible] E[illegible]

[illegible] Unenumerated, £4[illegible] [illegible] Elec. machinery, £5[illegible]

[illegible] *Buenos Ayres*: Unenumerated, £217. *Tele*[illegible] [illegible] Unenumerated, £118. *Port Alegre*: Unenumerated [illegible]

[illegible] W[illegible] £1,[illegible]; unenumerated, £42[illegible] [illegible] £55[illegible]; unenumerated, £1,[illegible]8 [illegible] material, £[illegible]3; elec. machinery, [illegible] Elec. machinery, £313; [illegible]

[illegible] £[illegible]4

[illegible]

FOREIGN GOODS (duty paid and free).

[illegible] £14[illegible] *Amsterdam* [illegible] Unenumerated [illegible]

TRANS[illegible] [illegible]

NOTE.—[illegible]

BUSINESS NOTICES.

Messrs. Siemens Bros. Dynamo Works (Ltd.) and Siemens Bros. & Co. (Ltd.) have removed their Caxton House offices to Palace-place Mansions, Kensington Court, London, W. Telephone, "Western 6319"; telegraphic address, "Siemens Kens London."

Messrs. George Ellison have removed their head office and works to Wellhead-lane Works, Perry Barr, Birmingham. Telegrams: "Induction, Birmingham"; telephone: "740 Northern."

Mr. J. P. Kemp has taken permanent business premises for his business in connection with electric vehicles, trucks, &c., at 62, Broad-street, Birmingham. There is a fairly large showroom with three offices, workshop and large basement, and Mr. Kemp proposes to go in strongly for the development of the electric vehicle industry.

The following companies have removed to 3, London Wall-buildings, London, E.C. (telephone number, London Wall, 2902):—

Canadian & General Finance Co., Brazilian Traction, Light & Power Co., Rio de Janeiro Tramway, Light & Power Co., Sao Paulo Electric Co., Barcelona Traction, Light & Power Co., Mexico Tramways Co., Mexico Electric Tramways, Ltd. (Reg. Office), Mexican Light & Power Co., Mexican Electric Light Co., and the Pachuca Light & Power Co.

The partnership between Robert Organ, sen., Robert Organ, jun., and E. E. S. Organ (trading as R. Organ & Sons), electricians, &c., 88, Winchcombe-street, Cheltenham, have dissolved partnership. Debts by Robert Organ, jun., and E. E. S. Organ, who continue under the old style.

Sale of Shares by Tender.—The Public Trustee invites tenders for the purchase of the whole or any part of 3,679 A shares of £10 each (fully paid) and 1,200 B shares of £10 each (fully paid) of the Tudor Accumulator Co. (Ltd.) which are vested in him as custodian by an order of the Board of Trade. Tenders must be delivered to the Public Trustee, Kingsway, London, W.C., on or before Feb. 26.

The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of April 2. *Further particulars are set out in an advertisement.*

Plant for Sale.—Messrs. W. H. Allen, Son & Co. (Ltd.), Queen's Engineering Works, Bedford, have for sale a second-hand 150 kw. 2,500 revs. per min., 250 volt. d. c. direct coupled turbo-generator set, with surface condensing plant.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Railless Electric Traction Co. (Ltd.) is being wound up voluntarily, and Mr. A. Page, 28, King-street, Cheapside, London, E.C., has been appointed liquidator.

The Electric Railway & Tramway Carriage Works (Ltd.), George F. Milnes & Co. (Ltd.), and the British Electric Car Co. (Ltd.) are being wound up voluntarily. Mr. L. E. Pickin has been appointed liquidator. Messrs. Linklater & Co., 2, Bond-court, Walbrook, London, E.C., are solicitors to the companies.

The Grondal Kjellin Co. (Ltd.) having gone into voluntary liquidation for the purpose of reconstruction, a meeting of creditors will be held at 20, Abchurch-lane, London, E.C., on March 1 at 2.30 p.m. Creditors must send particulars of claims by March 29 to Mr. G. H. Hill, liquidator.

A meeting to receive an account of the winding-up of the South Wales Wireless Training College (Ltd.) (in vol. liq.) will be held at 92, Queen-street, Cardiff, on March 22.

Claims against Fredk. Brown, electrician, 8, Stafford-street, Llanelly, are to be sent by March 7 to Mr. H. W. Thomas, 4, Queen-street, Carmarthen, preparatory to the payment of a dividend.

The adjudication in the case of John Taylor Peddie, mechanical engineer, Exhibition-buildings, Aldwych Site, London, W.C., has been annulled, and a scheme has been approved under which the debtor is to pay preferential claims forthwith, and to pay a composition of 5s. in the £ to unsecured creditors.

ELECTRICITY SUPPLY.

EXTENSIONS.

Colchester. The Electricity Committee has been empowered to purchase a motor alternator and to lay a main from the station to the shipyard of Messrs. Rennie, Forrestt & Co., for supplying the firm with electric current for power and lighting.

The Committee is also to prepare a scheme for the erection of a new generating station at Hythe and to adopt such other measures as they may be advised to be needful for meeting the increased demands for current in the near future.

Keighley.—Application has been made to the L. G. Board for sanction to borrow £2,000 for an e.h.t. cable.

Leeds.—The Electricity Committee has applied to the L. G. Board for authority to borrow £17,128 for additional generating plant.

Norwich.—On Tuesday the Council resolved to apply to the L.G. Board for sanction to borrow £3,500 for the equipment of a new substation.

St. Helens.—The Corporation have applied to the L.G. Board for sanction to a loan of £12,000 for additional generating plant, cables, &c.

Southend-on-Sea.—The Electric Lighting and Light Railways Committee has considered a report by the electrical engineer (Mr. R. Birkett) upon the necessity for providing additional generating plant in order to cope with the increasing demand for current.

The Committee is of opinion that in view of the shortage of current which would otherwise ensue steps should be taken without delay in order that immediately upon the termination of the war, or sooner if possible, the manufacture of the plant may be proceeded with. It has, therefore, been decided (subject to the usual sanction) to apply to the L. G. Board for leave to borrow £45,520 for the provision of additional generating plant at the electricity works.

An application from the Manager of the local Gas Company for a supply of current for power purposes at the Gas Works has been referred to the Electrical Engineer.

Swindon.—The Electricity and Tramways Committee has been authorised to expend £6,000 in providing new plant, cables, &c., in order to give a supply of electrical energy to newworks in the district.

GENERAL.

Bandon (Co. Cork).—The Town Commissioners have an electric supply scheme under consideration.

Barnes.—The Council has appointed the chairman of the Council, the chairman of the Electricity Committee and the Electrical Engineer to meet Ealing Council representatives to discuss the question of bulk supply.

Batley.—The Electricity Committee is making an effort to improve the methods of steam raising at the destructor works, and £100 per year is to be paid for the steam passed on to the electricity works.

The foreman at the destructor works is to act as foreman over the boilers at the electricity works (receiving 5s. per week extra for his services) and the Electrical Engineer is to superintend the foreman's work in the matter of steam raising.

Belfast.—Ald. Tyrrell has been elected chairman, and Councillor White vice-chairman of the Tramway and Electricity Committee for the ensuing year.

Birmingham.—The Electric Supply Committee has allocated £25,000 from the profits of its undertaking in relief of rates.

A similar sum was handed over last year, but the Tramways Committee, which contributed £50,000 last year, will be unable to make a contribution this year.

Exeter.—In his last report the borough electrical engineer (Mr. H. D. Munro) draws attention to the fact that the maximum load, which occurred on Dec. 18, 1916, amounted to 1,318·5 kw., or 227·4 kw. greater than the maximum demand for 1915, and 89 greater than the last normal maximum demand which occurred in 1914.

The report points out that a maximum of 1,318·5 kw. called for serious attention, as it had occurred at a period when the public lighting was practically non-existent, the lighting of shop fronts suppressed and a general reduction of interior and private lighting in operation for economical reasons. If, in the event of conditions becoming more or less normal by the end of the year, the Electric Supply Committee would be in a position of difficulty through shortage of generating plant.

Mr. Munro has been instructed to report fully to the Committee on the situation.

Hackney Preferential Charging Case.—West Hartlepool and Redditch Councils have decided to make contributions towards the costs of Hackney Borough Council in defending the action brought by the Gas, Light & Coke Co. to restrain an alleged preferential method of charging for current.

Harrogate.—At the last meeting of the Corporation the Lighting Committee's minutes stated that the borough electrical Engineer (Mr. Geo. Wilkinson) had reported that he had designed a steam plant which embodied in one complete and self-contained unit of reasonable size and capital cost the valuable features of smokeless combustion with the recovery of tar and ammoniacal liquors as by-products.

Designs of the new plant had been submitted on behalf of the Corporation to Government experts, with the result that he had been granted by the Ministry of Munitions a certificate for the construction of the plant. Mr. Wilkinson stated that the scheme had now arrived at a stage when the specifications for the plant could be prepared, and asked for authority to prepare such specifications and advertise for tenders.

The necessary authority to prepare specifications and advertise for tenders was given.

Hospital Lighting.—At the recent annual meeting of the subscribers to the Carlisle Fever Hospotal it was decided to expend £400 on an electric light installation for the buildings, and in providing electric power for the laundry.

Redditch.—The chairman of the Electric Supply Committee (Mr. F. C. Dolphin), in moving the adoption of the committee's report last week, welcomed the electrical engineer (Mr. Mayne) on his return to duty after his recent illness.

Mr. Dolphin said he had recently paid several visits to the electric supply station, and he had been delighted with the appearance of things. The new plant was in good working order. Much praise was due to Messrs. Handcock & Dykes and to their own engineer for the way in which they had carried out the extension scheme. They now had one of the most up-to-date stations in England, and could face the financial problem with confidence.

Rotherham.—Wortley Rural Council has consented to the Corporation supplying four firms in their district with electrical energy. The Electrical Distribution of Yorkshire has also consented to their supplying three of the four firms for the period of the war, as the company is not able to supply at present.

Sheffield.—At last week's meeting of the Council there was a long discussion on the proposal to place £300,000 in the War Loan, and a motion to increase this figure was defeated.

Ald. Hobson said it should be borne in mind that municipal finance was not an easy problem at any time, but it was particularly complex at present. Their income was being used to finance capital, and they had no capital at all in hand from which they could loan money to the Government. The city was more heavily pledged than any other city in the country, and it was most important that they should maintain their financial position if they were to maintain the city in a state of efficiency as the country's great arsenal and to maintain their electric supply. He did not mean private lighting, because he had deprecated the laying of mains for that purpose, though at another time he swould like to see electricity in every house in Sheffield. At present they were going through a transition period whereby electricity was being used more and more for the works. Steel was most urgently needed by the Government, and the provision of electric power for turning the lathes and machinery, and heating the steel furnaces of the city, was the greatest service Sheffield could render to the prosecution of the war. If they put money into the Loan that they afterwards found it difficult to put into that necessary equipment of the city, they would be rendering a service to the eye, but not the most essential service that they could. There seemed to be some idea that electric power was a profit-earning kind of luxury, or an advantage to the great firms of the East End, which they could very well afford to wait for until the money had been put into the war, and that if the Council did not extend electricity, but did put some money into the war, they would have answered the highest call. He submitted that that was not the case. Sheffield had more controlled firms for its area than any other place in the kingdom. The idea that profits would accrue to the East End firms through the provision of electricity was a fallacy. What would accrue was the capacity to go on making munitions, which were the most essential thing, in addition to the men, to win the war. They had recently had a report that the writings off for the electricity sinking fund were not adequate for the life of the machinery. The new station was to cost ultimately a million and a half. Of that amount, it was proposed to spend £600,000 in the first year, and the manager estimated that £306,449 would be required up to June 30. It might be that that period would be extended by a month or two. But he urged members to realise that they would have to raise that money for electricity, as a war service, later, whatever they did that day, and that heavy commitment had been the factor which had mainly governed his mind on the matter.

Ald. Blanchard moved an amendment in favour of putting £500,000 into the Loan. He did not think that the expenditure on the electricity undertaking would be as rapid as Ald. Hobson had suggested. He was satisfied that when the time came Sheffield could finance that and all its other undertakings.

Sir Wm. Clegg, chairman of the Tramways Committee, and others favoured the investment of the larger sum, but the amendment was ultimately defeated.

Walsall.—During the six weeks ended Jan. 21, 700,015 units were generated, compared with 624,041 in the corresponding period of the previous year.

However, it took 9·12 lb. coal for each unit generated, against 7·7 lb. in 1916. This higher consumption of coal is due to the general deterioration of the plant, and more particularly the boiler house plant by reason of the continuous operation of the station on a load considerably above its proper maximum operating capacity. On Dec. 13 last the maximum load recorded was 2,006 kw., but the effective capacity of the plant is only 1,870 kw. Recently the supply from the old station has been maintained with difficulty, and there had been interruptions of supply to factories and to the tramways.

In order to effect urgent repairs at the generating station, the tramway service was shut down on three days between 9 a.m. and 8 p.m. The increased price to be paid for current will involve an additional expenditure to the tramways department of about £1,000 per annum.

Arrangements had been made for lighting the streets in the centre of the town under a single control system.

Worcester Park.—The Parish Council agree with the decision of the Rural Council to support the application of the South Metropolitan Electric Tramways & Lighting Co. for a provisional order, provided that satisfactory guarantees are given in the order that the price to consumers shall not exceed 6d. per unit.

Yorkshire Electric Lighting Orders.—The town clerk of Bradford (Mr. F. Stevens) has reported to the Parliamentary Sub-committee of the Corporation that only two matters appear to require attention in regard to the bills and plans deposited in Parliament for the current session.

These relate to the Clayton and Queensbury and the Rawdon and Yeadon Electric Lighting Orders. In the former case the Order will affect the Corporation as regards tramways, gas and water, as well as possible extension of boundaries. In the latter case the order affects Bradford only in regard to possible extension of boundaries. Formal objections are to be filed in order to give the Corporation an opportunity to take such future action as may be thought desirable.

TRACTION NOTES.

Doncaster.—The Council has applied to the Board of Trade for authority to double the tramway route in St. Sepulchre Gate.

Dover.—The Tramways Committee has abolished workmen's tickets for the period of the war.

Dundee.—Women conductors made their debut on the tramcars on Monday last.

Grimsby.—The Public Light Committee will construct a shelter for vehicles coming to the electricity works to have their batteries recharged.

London Brighton Electric Railway.—At the recent meeting of the Brighton, Hove and Worthing Season Ticket-Holders' Association the Mayor announced that after the war the L.B. & S.C. Railway Co. had decided to have four sets of rails from Brighton to London, two sets being used for express service. It was also intended to electrify the line. That would practically make Brighton a suburb of London.

London County Council.—On Tuesday the Highways Committee presented a lengthy report on the reorganisation of the tramway system. The report is abstracted on another page.

In the course of the discussion Mr. H. H. Gordon said the success of the scheme would depend upon their getting the right type of men not only for the five senior positions, but also for some of the minor positions. Doubt was expressed in some quarters whether the scale of salaries attached to the posts was sufficiently generous to attract men of the type the Council had in mind. He thought the scheme was very well thought out, but they must allow a reasonable amount of time to elapse before full results were seen.

Mr. G. A. Hardy also criticised the salaries proposed, and Mr. Cotton, while supporting the report, said it was no use having a publicity office to popularise the tramways so long as they had the present truncated system.

Mr. J. D. Gilbert said they could only make their tramways a financial success if they ran them on proper business lines. The undertaking was a huge business concern and he regretted that the committee had tied themselves down to particular salaries for particular posts.

The report was adopted, and it was agreed to authorise the committee to fill the principal positions.

The chairman of the Highways Committee (Mr. G. H. Hume) stated, in reply to a question, that, acting on the request of the Ministry of Munitions, they had sold 10 tramcars to Sheffield. The price paid was £[illegible] each, and as London could afford to spare them, they were only too glad to let them go to Sheffield, where they were badly wanted for the conveyance of munition workers to and from their employment.

[illegible] Borough Council have asked the L.C.C. to construct the [illegible] to connect the tramways in Battersea Park-road with those in Battersea Bridge-road as early as possible.

Notts and Derbyshire Tramways Bill.—In a recent report on this Bill the Parliamentary Committee of the Notts County Council states that the Bill seeks to authorise the transfer to the Notts and Derbyshire Tramways Co. the tramways of Ilkeston Corporation.

To this the [illegible] could make no objection, but the Bill contains a clause enabling the company (with the consent of the Board of Trade) to enter into and carry into effect agreements for or with respect to the purchase by the company of the undertaking of any tramways owned by any local authority, &c., which can be worked in connection with the undertaking of the company. The clause is of very wide effect and the [illegible] council has asked the promoters to withdraw the clause. If they do not comply with this request the Bill will be opposed by the Council.

Salford.—The general manager of the tramways department (Mr. [illegible]) has been requested to prepare a scheme for the running of more tramcars, in order to obviate complaints of crowded cars, irregular services, &c.

EMPIRE NOTES.

Australasia.—The Victorian Parliament recently discussed the position of the Morwell (Victoria) brown coal deposit.

In the course of the discussion, the Minister of Mines (Mr. Livingston) said there was an open perpendicular face of 77 ft. and the deposit extended 500 ft. underground. There were 200 sq. miles of brown coal in the State, varying in thickness up to 600 ft. Scientists had stated that the Morwell coal would produce power at less cost than it cost to produce at the Niagara Falls. In experiments at North Fitzroy it was found that the charcoal residue after the coal was burnt was sufficient to drive suction gas plant. Universities in Great Britain had undertaken to treat samples of the by-products from the coal. It is stated that members of the Victorian Institute of Industry have expressed the opinion that the brown coal could be mined and loaded at 1s. 6d. a ton and delivered at Melbourne in train loads at 3s. 6d. to 4s. a ton.

Customs Regulations.—The Commonwealth Government has announced that officially certified copies of the British Customs Specification (Form 30), or Shipping Bill (Form 64), whichever is applicable, will be required in Australia in connection with all goods of foreign origin re-exported to the Commonwealth from the United Kingdom on March 1, 1917. This requirement is already in force as regards goods from Norway, Sweden, Denmark, Holland and Switzerland, but from the date indicated above it will apply also to goods from any foreign country. The proper Officers of Customs in the United Kingdom are authorised by the Board of Customs and Excise to sign and stamp complete copies of the "Specification" or "Shipping Bill," or extracts therefrom, free of charge, provided the copy or extract is presented at the same time as the original.

Openings for British Goods.—An Australian business man at present in England desires to take up agencies for United Kingdom manufacturers of electrical supplies (especially metal filament lamps), hardware, advertising devices, &c. Communications to the Official Secretary, Office of the High Commissioner, Australia House, Strand, London, W.C., quoting reference No. 2,205/11.

Canada.—The "Electrical News" reports that the Southern Canada Power Co. is becoming a very important factor in the lighting and power situation in the Eastern Townships of Quebec.

Last year's expansion is likely to be more pronounced in the future when the six water powers, with a total head of 300 ft., and an ultimate capacity of about 150,000 H.P., are developed. The demand for power for industrial purposes is growing at a rapid rate, stimulated by muniton orders, and there is reason to believe that after the cessation of hostilities, there will be the same need, as industries are continually increasing in that part of the province. The new transmission line at Sherbrooke has recently been put into operation, and the Sherbrooke Railway & Power Co. has been absorbed. Contracts have been made with the Shawinigan Water & Power Co. for the sale to it of two blocks of power out of the first and second developments. The electric plants at St. Johns, St. Hyacinthe and Drummondville have been modernised, and the services have been considerably extended. High tension transmission lines have been constructed from Chambly to St. Hilaire and Beloeil and thence to St. Hyacinthe. The franchises have been supplemented by contracts with St. Hyacinthe, Beloeil, St. Hilaire, St. Mathias and St. Hugues. The municipal plants at Drummondville and Iberville, with the contracts for municipal street lighting and pumping, have also been acquired.

The Britannia Mining & Smelting Co. has prepared plans for the extension of their hydro-electric works at Britannia Beach, Howe Sound. It is proposed to put in two Pelton-Doble impulse waterwheels (each of 1,850 H.P.), driving a 2,500 k.v.a. Canadian Westinghouse three-phase generator 60 cycles 6,600 volts 720 revs. per min. rated at 2,000 kw., at 80 per cent. power factor. The waterwheel runners will be mounted one on each end of the generator shaft, which is extended for that purpose. Each waterwheel runner is supplied with water by two needle nozzles, one Pelton oil pressure governor controlling the four streams. Additional features include main gate valves operated by hydraulic motors, and the control of the governor by an electric motor mounted upon the governor mechanism and operated from the generator switchboard

Electricity Supply in New South Wales.—Hitherto the Government has not issued any Orders in Council authorising the supply of electricity for lighting and power or for the construction of electric tramways. During the past year, however, certain amendments of the Local Government Act were proposed which would have enabled the Government to finance and construct electric supply undertakings under certain conditions. The amendment failed to pass, and at the present time there is no special legislation on electricity supply in the State.

Electric Supply in Tasmania.—No licences have hitherto been issued by the Government for the supply of electrical energy, but recently authority was issued to enable the hydro-electric department of the Government to develop 8,000 additional horse-power under the existing scheme controlled by the department. This will make the total turbine capacity at the power station 18,000 H.P. The chief engineer and manager of the hydro electric works is Mr. J. H. Butters, of Hobart.

Indian Exports Restriction.—The exportation of iron and steel (in nearly all forms) from India to all destinations is now prohibited.

New Brunswick.—Chatham (New Brunswick) municipality has recently added a 200 H.P. semi-Diesel engine to its electrical plant.

An electrically-operated grain elevator, with a capacity of 500,000 bushels, is to be erected on the harbour front at St. John. The foundation is now being laid.

FOREIGN NOTES.

China.—The following are extracts from reports by British consular officers in China:—

A report from Canton says most British firms there are doing greatly increased business, though nor entirely in British goods. Their hold on the market, however, should be of benefit to British manufacturers later on. Amongst goods in demand are machinery, motor pumps, metals, oils, paints, alkalis, &c.

The bulk of British goods consumed in the Ningpo district is obtianed from Shanghai, of which the district is practicaly a suburb. Prior to the war Germany and Austria supplied lamps, g.i. wire chemical products, &c., to Ningpo.

Imports into Tientsin from the United Kingdom are decreasing owing to decreased production. financial difficulties in China and a tendency to await plower prices. Goods imported include metals and sundries. British goods are at a disadvantage compared to Japanese and American due to high freight rates. There are 15 British firms in Tientsin which are actively taking up agencies.

France.—*Bauxite Deposits.*—It is reported that in different districts of the Riviera hinterland there exist rich deposits of bauxite.

Prior to 1914 these were mostly exploited by Germans and the greater part was transported by rail to Switzerland, where, it is understood, a German-owned plant had been erected for the extraction of aluminium by electrolysis. At the outbreak of war the enemy mines were sequestrated. In close proximity to the mines sites are available for the erection of electrolytic plant for refining the ore, and there is an abundant water supply. Inquiries may be addressed to the secretary, British Chamber of Commerce for the French Riviera, 4, Avenue Masséna, Nice

Russia.—A Consular report from Odessa states that the "Russian Combine for Trade and Industry" has been formed.

The objects of the combine are the development of Russian trade and commerce; the systematic organisation of inland trade and exchange of goods; the familiarising of Russian merchants and manufacturers with foreign markets, particularly those of friendly Powers; the study of conditions of sale of Russian goods in foreign markets and of the import of foreign goods into Russia; the organisation of the export of Russian goods, and of imports into Russia: the opening of information bureaux to give advice on all questions affecting trade and industry, &c. Foreigners (excepting enemy subjects) can be members of the combine.

Siberia.—The Municipal Council of Irkutsk has been authorised to raise a loan of 228,878 roubles for extensions of the electric supply undertaking.

It is also proposed to expend 105,000 roubles on the electric lighting plant at Vladivostock.

Spain.—A concession has been granted to Don Miguel Otamendi for the construction and working for 90 years of an underground electric railway system in Madrid, to be known as the Metropolitano de Madrid Alfonso XIII. There will be four double-track lines. The capital necessary is 30,000,000 pesetas (£1,200,000). The first line to be constructed will cross the city from north to south and will be nearly 3 miles long. The estimated cost is 8,000,000 pesetas (£320,000).

Reports from Barcelona state that it is almost impossible to obtain switches and other wall elecirical goods.

It is also reported that the cessation of imports from Germany has created a shortage of ironmongery, hardware, &c., in the Alicante district.

MISCELLANEOUS NOTES.

Anglo-American Chamber of Commerce.—An American Chamber of Commerce in London has been formed in order to develop Anglo-American commercial relations. The secretary is Mr. J. Tuck Sherman, and the temporary offices are at 3, Lombard-street, E.C.

Enemy Firms Wound Up.—The Board of Trade have ordered the winding up of 410 businesses controlled by alien enemies.

The latest list includes Werths & Co., 41, Aldersgate-street, London. E.C., manufacturers' agents (controller: A. Taylor, Thames House, Queen-street-place, E.C.); Arndt & Cohn, 6, Broad-street-place, London, E.C., hardware and general merchants (controller: W. Boniface, 2, Clement's-inn, W.C.); General Import and Export Co., 24, Budge-row, Cannon-street, London, E.C., dealers in aluminium ware, &c. (controller: R. B. Tyler, 1, Queen Victoria-street, E.C.).

The Controller of the New York-Hamburg India Rubber Co., 89 and 90, Milton-street, London, E.C., has applied for a release. Objections to the Board of Trade by Feb. 24.

Municipal Industrial Development.—The Special Committee recently appointed by Sheffield City Council recommends that steps be taken for the formation and control of an industrial development department of the Council.

It is proposed that it shall act with an Advisory Committee, composed of representatives of the Cutlers' Company, the Chamber of Commerce, the University, the Engineering Trades Employers' Association, the Cutlery Manufacturers' Association, the Master Silversmiths' Association, the two Trade Councils, and the Society of Architects and Surveyors. The committee will watch over and promote the trade, industry, development and general prosperity of the city; promote the establishment of manufactories, trades, works and railway extensions; make inquiries as to land available for such establishments, the selling or leasing terms, and to assist persons to obtain such land on the best terms. Other duties include dealing with all matters relating to the advertising of the city, housing, travelling facilities, &c. In the early stages the cost of the department will be defrayed out of the profits of the tramways undertaking.

Trading with the Enemy.—The "London Gazette" of Feb. 16. contains further additions to the statutory list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include: *Netherlands.*—Allgemeine Radiogen A.G. (Amsterdam), A. M. Van der Griendt (Wilhelm Siemens) (Rotterdam), Siemens & Halske (The Hague), Siemens Schuckert Automobilien Werke (The Hague), Wilhelm Siemens (manager, A. M. Van der Griendt) (Rotterdam).

War Savings Association.—The employees of Messrs. C. A. Vandervell & Co. have formed a War Savings Association and the subscribers already number over 1,300 after about a fortnight's work. Mr. Mowbray Atkinson is secretary, Mr. Barker (the cashier), is treasurer and there is also a representative committee.

TENDERS INVITED.

Synchronous Condensers.

The TORONTO ELECTRIC COMMISSIONERS invite tenders for Synchronous Condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28. *See also an advertisement.*

Turbine, Dynamo, Battery, &c.

KILMALLOCK (CO. LIMERICK) ELECTRIC LIGHT & POWER CO. (LTD.) require tenders by 10 a.m. March 5 for the supply of Hydraulic Turbine and Accessories, Dynamo and Motor Booster, Storage Battery and Switchboard. Specifications from the Secretary.

Railway Stores.

The GREAT CENTRAL RAILWAY CO. invite tenders for the supply during the six months ending Oct. 31, 1917, or during the 12 months ending April 30, 1918, of various stores and Materials, including Asbestos Packing Sheets and Boiler Covering, India Rubber, Hardware, Oils, Wire, &c. Samples and patterns may be seen from Feb. 26 to March 5 inclusive in the Public Hall of the Conservative Club, Gorton-lane, Gorton, Manchester, and specifications and forms of tender may be obtained from the stores superintendent, Mr. Walter Williams, Great Central Railway, Gorton. Tenders to the secretary, Mr. Oliver S. Holt, Marylebone Station, London, N.W., by March 6.

Coal Conveying and Ash-handling Plant, &c.

MANCHESTER Corporation want tenders by 10 a.m. March 7 for the supply and erection at Stuart street station of Coal-conveying and Suction Ash Plant. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical and Tramway Stores.

The Electricity Committee of BOLTON Corporation invite tenders for Materials and Stores for year ending March 31, 1918, including Lubricating Oils, Joint and Service Fuse Boxes, Jointing Materials, Wire, &c., Meters, Motors, Motor Starting Switches, Transformers, Ironmongery, Stoneware, Cable Troughs, Covers, &c. Specification and form of tender from the borough electrical engineer (Mr. W. J. H. Wood), and tenders to the Chairman of the Electricity Committee, Town Hall, Bolton, by noon March 7. *See also an advertisement.*

The Tramways and Electricity Committee of BELFAST Corporation invite tenders for the supply of stores and materials, including mill furnishings, packings and asbestos goods, lubricating oils and petrol, rubber goods, tools, ironmongery, steam, gas and water tubing, trolley wire, overhead line material and galvanised wires, v. b. insulated cable, v. i. r. cables and wires, electrical accessories, lamps, arc lamp carbons and carbon brushes; bitumen, bitite strip, prepared tape and rubber tape, joint box compound, fuse wires, wood and stoneware troughing, c. i. street box frames and covers, c. and w. i. pipes, lighting feeder and section pillars, glazed stoneware or glass cable bridges, copper cable connectors, meters, maximum demand indicators, time switches and house service cut-outs, &c. Forms of tender and particulars from Mr. T. W. Bloxam, city electrical engineer, East Bridge-street, Belfast. Tenders to the town clerk, Mr. R. Meyer, by 10 a.m. Wednesday, March 14. *See an advertisement.*

HAMMERSMITH (LONDON) Borough Council invite tenders for the supply of stores for the year ending March 31, 1918, including small Engineers' Tools, Metal Steam Tubes and Fittings, Hand Files, Steam Packing and Jointing, Oilmens' Goods, Electric Light Sundries, Insulated Wires, Cable Joint and Fuse Boxes, Insulating Compound, &c. Forms of tender from Mr. G. G. Bell, 85, Fulham Palace-road, and tenders to the Town Clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W., by 4 p.m. of Feb. 28.

Tenders are required by first post March 14 for supply of Electrical goods for one year to the Cheshire County Asylum, MACCLESFIELD. Forms of tender, &c., from the Clerk.

POWELL-DUFFRYN STEAM COAL Co. require tenders by 10 a.m. March 7 for supply of Electrical Goods, Asbestos, &c. Forms of tender from Stores Manager, Aberaman Offices, near Aberdare.

The BEDWAS NAVIGATION COLLIERY Co. (LTD.) requires tenders by 10 a.m. March 8 for 12 months' supply of Electrical Goods, &c. Forms of tender from the Secretary, Bedwas, Mon.

BARROW-IN-FURNESS Corporation require tenders by noon March 5 for one year's supply of Electrical and Engine-room Stores, &c. Forms of tender from Borough Electrical Engineer.

LONDONDERRY Corporation want tenders by noon March 17 for supply of Carbons, Meters, Cables, Fuse Boxes, Engine-room Stores, &c., for their electricity department. Specifications from the Borough Electrical Engineer.

Steam and Electric Wagons.

BRIGHTON Corporation require tenders by 10 a.m. March 9 for supply of 5-ton Steam Wagon and 3½-ton Electric Wagon, each with front watering tank.

Electric Lamps, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. March 21 for supply of 200 Half-watt Lamps, 100 Lanterns and 100 Contact Couplings. Specification, &c., from the Commissioners' offices, Spencer street, Melbourne.

The METROPOLITAN WATER BOARD require tenders by 11 a.m. March 8 for three, six, nine, or 12 months' supply of Electric Lamps. Forms of tender from the Chief Engineer, [illegible], Strand, London, W.C.

Telephone Materials, &c.

Tenders are invited up to March 28 for the supply and delivery to the Postmaster-General's Department, State of SOUTH AUSTRALIA, of Telephones, Telephone Parts, Cords, Line Material, Creed Tape, &c., and up to noon Feb. 28 for the supply of telephone apparatus, ear-pieces, heat-coils, protectors, &c., to the Postmaster-General's Dept., State of QUEENSLAND. Specifications, tender forms, &c., can be obtained at the Commonwealth Offices, London. *See also an advertisement.*

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Specification and conditions of contract from the offices of the High Commissioner, 32, Victoria-street, London, S.W., where tenders must be lodged by noon March 8.

Turbo-Alternator and Condensing Plant.

Tenders are invited for the supply and delivery, f.o.b., and complete erection of One Steam Turbo-alternator (of 7,500 k.v.a.) and Condensing Plant, at the City of MELBOURNE electricity works. Tender forms from Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), agents for the City Council, Billiter-square-buildings, London, E.C. Tenders to Chairman, Electric Supply Committee, Town Hall, Melbourne, by noon March 5.

Boiler, Coal Bunker, Conveyor, &c.

The Electricity Committee of HARROGATE Corporation invite tenders for the supply and erection of a by-product Steam Boiler, Overhead Coal Bunker, Coal Conveyor and Structural Steel Work. Specifications from borough electrical engineer, Mr. Geo. Wilkinson, M.I.E.E., to whom tenders are to be sent by March 5.

Carbons.

BUENOS AYRES Municipality invite tenders for the supply of Electric Carbons during 1917. Conditions of tender may be consulted at the Oficina de Licitaciones, Avenida de Mayo 525, Buenos Ayres, when tenders will be received until March 30.

Electric Light and Power Concession (Extension of Time).

The time for the receipt of tenders for a concession offered by the Government of Grenada for Generating and Supplying Electricity for Lighting and Power in the town of St. George's and the residential suburbs has been further extended, and tenders will now be received at the Office of the Colonial Secretary, Grenada, up to March 31. The Government will grant the exclusive right to furnish light and power for 30 years, renewable in periods of 20 years thereafter, the Government to have the sole right to purchase at a price to be fixed by arbitration. The contracting firm will be allowed to import free of duty all materials required for electric lighting. Plan of town, with particulars, may be obtained from the office of the Colonial Secretary, Grenada, British West Indies.

TENDERS RECEIVED AND ACCEPTED

BRADFORD.—The following tenders have been recommended for acceptance by the Council:—

British Thomson-Houston Co., turbo-generator and condensing plant, £8,674; Siemens Bros. & Co., supply of cables, £3,273, and laying and jointing cables, £2,631; British Electric Transformer Co., six transformers, £1,136; Sterling Boiler Co., two boilers, with mechanical stokers, £6,610.

GLASGOW.—The Corporation has accepted the tender of Smith & Stevenson for wiring two shops in Gallowgate.

The Tramways Committee has accepted the tender of the Liverpool Electric Cable Co. for the supply of cable.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—The net earnings during 1916, after payment of debenture interest and loan charges, were £18,2[illegible] 11s. 1d. and with £1,2[illegible] 12s. 2d. brought forward, the total is [illegible] 6d. Deducting interim dividend for 6 months ended June 30 at rate of 4 per cent per annum (£3,100), the balance is £19,605. 0s. 6d. The directors recommend payment of final dividend of 4½ per cent (making [illegible] per cent for year) on the share capital, absorbing £6,750, placing to general reserve £1,000 and to depreciation reserve £5,000, writing down value of investments by £3,005. 7s., leaving £3,719. 19s. 6d. to carry forward, subject to excess profits duty.

CENTRAL LONDON RAILWAY CO.—For the year 1916 the aggregate gross traffic receipts of the five companies parties to the "Common Fund" agreement (the City & South London, Central London, London Electric and Metropolitan District Railway Companies and the London General Omnibus Co.) were £5,278,812. 7s. 10d., and the aggregate gross receipts of the five companies from all sources were £6,038,520. 5s. 11d. The aggregate amount retained by the five companies for "revenue liabilities" was £5,531,561. 12s. 10d. The balance of £506,967. 12s. 1d. was credited to the "Common Fund." and under the terms of the agreement the Company is entitled to 20 per cent. of this fund. This sum (£101,393. 10s. 5d.), plus £15,685. 17s. 6d. brought forward, makes a total of £117,079. 7s. 11d., which is availabe for dividends on the ordinary, preferred ordinary and deferred ordinary stocks. The total number of passengers carried and the average fare per passenger cannot be given, owing to the Metropolitan District Co. still being under Government control, and the figures of that company consequently not being available. The gross receipts of the Central London Co. were £316,810, and the expenditure was £169,191. With miscellaneous receipts (£36,873), the total net income was £184,492. The interim dividends of 1¾ per cent. on the ordinary and of 2 per cent. on the preferred ordinary stock for the half-year ended June 30 absorbed £42,711, leaving £74,368, which will admit of the payment of a dividend of 1¾ per cent. on the ordinary stock, of 2 per cent. on the preferred ordinary stock for the half-year ended Dec. 31, 1916, and of 3 per cent. on the deferred ordinary stock for the whole year, making 3½ per cent. on the ordinary and 4 per cent. on the preferred ordinary stock for the year, leaving £12,079 to be carried forward. The dividends paid in 1915 were 3 per cent. on the ordinary, 4 per cent. on the preferred ordinary, and 2 per cent. on the deferred ordinary stock, with £15,686 carried forward. On account of the uncertain outlook, the high price of materials and labour, and the impossibility of securing all the materials required for the complete maintenance of the property, the appropriation to reserve has been increased by £10,000 compared with 1915. The capital expenditure during the year amounted to £12,295, and the construction of the extension between Wood-lane and Ealing Broadway is making slow progress owing to the war. An agreement has been entered into whereby the members of the administrative staff will have the opportunity of participating in a superannuation fund which has been established jointly with the other companies parties to the "Common Fund." The managing director (Sir Albert H. Stanley) has, in consequence of his recent appointment as President of the Board of Trade, resigned his position with the Company, and the directors desire to place on record their great appreciation of the many valuable services rendered to the Company by Sir Albert Stanley. Mr. William C. Burton has been appointed a director to fill the resulting vacancy on the board, and arrangements have been made whereby Mr. Burton has consented to perform the duties of the managing director.

CITY & SOUTH LONDON RAILWAY CO.—The gross receipts of the City & South London Railway Co. for 1916 were £231,675 and the expenditure was £121,321. With miscellaneous receipts from rents, &c. (£14,134), the total net income was £124,488. Adding £9,027 from 1915 and deducting interest, rentals and other fixed charges (£31,570), the appropriation to reserve (£20,000), and the dividends on preference stocks £42,500) the balance available for dividend on the consolidated ordinary stock is £39,445. The interim dividend of ¾ per cent. for the half-year ended June 30 absorbed £11,100, and the balance (£28,345) admitted of the payment of a dividend for the half-year ended Dec. 31 on the consolidated ordinary stock of ¾ per cent., making 1½ per cent. for the year, leaving £17,245 to be carried forward. For 1915 the full dividend of 5 per cent. was paid on all the preference stocks, but nothing was paid on the consolidated ordinary stock. The Company's portion of the "Common Fund" was £30,418. On account of the uncertain outlook, the high price of materials and labour, &c., the appropriation to reserve has been increased by £10,000, compared with 1915. The capital expenditure during the year was £24,850. An agreement has been entered into whereby the members of the administrative staff of the Company will have the opportunity of participating in a superannuation fund which has been established jointly with the other companies parties to the "Common Fund." The managing director (Sir Albert H. Stanley) has, in consequence of his recent appointment as President of the Board of Trade, resigned his position with the Company. Mr. Wm. C. Burton has been appointed a director of the Company to fill the vacancy, and arrangements bave also been made whereby Mr. Burton has consented to perform the duties of managing director.

The report and accounts were adopted at the meeting on Tuesday.

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.).—The net profit for 1916 was £3,494. 18s. 9d., against £3,638 in 1915 and £2,963. 15s. 6d. in 1914. With balance from 1915 (£905. 7s. 8d.) the disposable balance is £4,400. 5s. 8d. The directors recommend payment of a dividend (tax free) at rate of 6 per cent. per annum on the ordinary shares (£2,531. 12s. 2d.), adding £1,000 to reserve, and carrying forward (subject to directors' remuneration) £868. 13s. 6d. Having regard to lighting restrictions, increased expenditure and other difficulties caused by the war, the directors consider the results are satisfactory.

FIFE TRAMWAYS, LIGHT & POWER CO. (LTD.)—The annual accounts show that £1,263 has been placed to debenture stock redemption fund and £3,000 to reserve, and a dividend of 4½ per cent. (less tax) for the year is recommended, with £8,165 carried forward. A year ago the dividend was 3½ per cent., a similar sum was placed to reserve and £3,737 carried forward.

GIANT'S CAUSEWAY & PORTRUSH ELECTRIC TRAMWAYS CO. (LTD.)—The annual meeting was held on Saturday. The report stated that owing to the war the passengers carried had fallen from 155,000 in 1913 to 73,000 last year. The receipts decreased by practically one-half. An electric mileage of over 27,000 was run at 2¾d. per mile.

LANCASHIRE UNITED TRAMWAYS (LTD.)—The net profit for 1916 is £33,105. The receipts increased £12,979, but the increase in expenditure was £8,775, due to additional output of electrical energy and to increased charges for materials and labour. The interest and dividend received from the operating companies, together with sundry receipts, amounted to £16,782. After deducting interest on the prior lien debenture stock and expenses, there remains £3,024. Out of this interest will be paid on the second mortgage debenture stock for 1916 at rate of 1 per cent., which will absorb £2,965, and £59 is carried to depreciation account. There is also a balance on the year's working of the operating companies after payment of interest and dividends of £17,580. The depreciation and renewal accounts and amounts carried forward in the combined companies now amount to £57,330.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—The directors' report for 1916 states that the net capital expenditure amounted to £38,832, the major part of it being incurred upon the electrical equipment of the suburban railways and the provision of additional rolling stock. The Board recommends dividends of £3. 17s. 6d. per cent. on the undivided ordinary stock (making 5 per cent. for the year), £3. 15s. per cent. on the preferred ordinary stock (making 6 per cent. for the year), £4 per cent. for the year on the deferred ordinary stock, leaving £30,128 to be carried forward.

LONDON ELECTRIC RAILWAY CO.—The gross receipts for 1916 were £1,007,902 and the expenditure was £513,989. With miscellaneous receipts (£96,277) the total net income was £590,190. Adding balance from last year (£12,303) and deducting interest, and other fixed charges (£276,153), appropriation to reserve (£35,000) and dividend on preference stock (£126,947) the balance available is £164,393. The interim dividend for the half-year ended June 30 on the ordinary shares was ¾ per cent. and absorbed £69,960, leaving £94,433, which admits of the payment of a dividend for the half-year ended Dec. 31 of ¾ per cent., making 1½ per cent. for the year, leaving £24,474 to be carried forward The dividend on the ordinary shares for 1915 was 1¼ per cent. with £20,000 placed to reserve and £12,303 carried forward. On account of the uncertain outlook the appropriation to reserve has been increased by £15,000, compared with 1915. The capital expenditure during the year amounted to £39,257. The manufacture of the joint rolling stock for the through running of trains from the "Bakerloo" section of the Railway to Watford having been delayed owing to the war, arrangements have been concluded with the L. & N. W. Co. whereby the London Electric Railway will, for the present, provide the necessary rolling stock, and operate the train service. It is hoped to commence through running at an early date. An agreement has been entered into whereby the members of the administrative staff will have the opportunity of participating in a superannuation fund. The managing director (Sir Albert H. Stanley) has resigned and Mr. Wm. C. Burton has been appointed a director to fill the resulting vacancy. Arrangements have also been made whereby Mr. Burton will perform the duties of the managing director.

LONDON ELECTRIC SUPPLY CORPN. (LTD.).—The report of the directors for the year ended Dec. 31 states that the profit on the working for the year is £55,213 14s. 0d., against £77,687 18s. 9d. for 1915. With amount brought forward (£9,049 12s. 6d.) and interest on Treasury Bills (£847 2s. 9d.) the total is £65,110 9s. 3d. Deducting interest on debenture stock (£23,494 4s.) and sinking fund for redemption of debenture stock in 1931 (£16,580), the balance is £25,036 5s. 3d. The board propose to pay a dividend of 4 per cent. on the preference shares (of which an interim dividend of 3 per cent. was paid in September last), viz., £17,968, and to carry forward £7,068 5s. 3d. The supply has been efficiently maintained during the year. The number of units sold amounted to 49,810,105, against 50,757,584; the total costs per unit sold being 0·80d., against 0·64d. last year, caused by the continued great increase in the price of coal and wages owing to the war. The average receipt per unit sold (lighting and power) was 1·02d., compared with 0·96d. last year. The expenses of generation have increased 73 per cent. compared with 1914, owing to the war (from £67,693 to £127,897), while the units sold have increased 7 per cent. (46,343,065 to 49,810,105). An accident to the generating station during the year caused considerable damage and a temporary stoppage of the supply.

METROPOLITAN DISTRICT RAILWAY CO.—The gross receipts for 1916 were £1,026,411 and the expenditure was £603,263. With miscellaneous receipts (£142,617) the total net income was £565,765. Adding £13,952 from 1915 and deducting interest, rentals and other fixed charges (344,999) appropriation to reserve (£35,000) and dividends on guaranteed and first preference stock (£124,930), the balance available for dividend on second preference stock and further reserve is £74,788. The interim dividend of 1½ per cent. on the second preference stock for the half-year ended June 30, absorbed £22,050, leaving £52,738, which will admit of the payment of a dividend of 1½ per cent. for the half-year ended 31 Dec., making 3 per cent. for the year. It is proposed to appropriate a further £10,000 to reserve, making £45,000 for the year (compared with £35,000 for 1915) and to carry forward £20,688. The dividend on the second preference stock for 1915 was 3 per cent. for the year, with £13,952 carried forward. The company's share of the "Common Fund" was £60,836. The capital expenditure during the year was £2,475. The managing director (Sir Albert H. Stanley), who recently accepted the appointment of President of the Board of Trade, has resigned and Mr. Wm. C. Burton will now perform the duties of managing director.

ST. JAMES' & PALL MALL ELECTRIC LIGHTING CO. (LTD.)—The report of the directors for the year ended Dec. 31 states that the connections, which at the end of 1915 were 16,305 kw., have been increased during the year to 16,631 kw., and 11,272,368 units were supplied to consumers. The net profits for the year applicable to dividends on shares amount to £22,842. 9s. 1d., and with £2,752. 4s. 9d. from 1915 the total is £25,594. 13s. 10d. The interim dividend paid in August last for half-year ending June 30, at rate of 7 per cent. on preference shares (£3,500) and 5 per cent. on ordinary shares (£5,000) absorbed £8,500, leaving £17,094. 13s. 10d. The directors propose to pay a dividend at rate of 7 per cent. on the preference shares for the second half-year (£3,500), and a dividend on the ordinary shares for the second half-year of 5s. 6d. per share, making with the interim dividend, a total distribution of 8 per cent. for the year (£11,000), leaving £2,594. 13s. 10d. to be carried forward.

SMITHFIELD MARKET ELECTRIC SUPPLY CO. (LTD.)—The gross profit for 1916 was £3,797. 7s. 9d. (against £4,249. 18s. 6d. in 1915) and the net profit £2,466 14s. 11d. (against £2,815 19s. 2d.). A sum of £490 has again been placed to debenture stock redemption fund and £1,250 to depreciation account. With £1,296 4s. 6d. brought in the balance is £2,112 19s. 5d. In consequence of a serious fire which occurred in the generating station in October the profits have been adversely affected. The service to the Markets was interrupted for some days pending arrangements for a temporary supply and it was then decided, in order to provide against any similar interruption in future, to retain that supply as a permanent standby, and to alter the pressure of the company's system to conform thereto. The cost of the change will be gradually liquidated out of revenue spread over three years. The damage caused by the fire was covered by insurance. The directors propose to pay a dividend at rate of 1 per cent. per annum on the ordinary shares (£600), to write off cost of change of pressure (£500) and to carry forward £1,012 19s. 5d. For the first nine months of the year the sale of current showed a satisfactory increase. The higher costs of production, due to the prevailing conditions, were met to some extent by increasing the price of the current; but there is reason to expect a further rise in the price of the principal commodities so long as these conditions last. The new Diesel oil generating set, which was installed in the spring, has proved entirely satisfactory.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The revenue account for 1916 shows a credit balance of £50,509. 12s. 4d., which, with £6,604. 18s. 7d. brought forward and £1,601. 14s. being dividend of 10 per cent. on the company's holding of shares in the West Kent Electric Co., makes a total of £58,116. 4s. 11d. After deducting £12,588. 13s. 4d. for interest on debenture stock and £7,863. 17s. 2d. for interim dividends paid on the preference shares, the balance is £37,663. 14s. 5d. The directors recommend payment of final dividends upon the 7 per cent. cumulative first preference shares (£5,003. 17s. 7d.) and the 6 per cent. cumulative second preference shares (£2,890. 19s. 7d.), the appropriation of £17,600 to credit of depreciation fund, and the payment of a dividend of 4 per cent. per annum (less tax) on the ordinary shares for the year (£4,920), leaving a balance of £7,248. 17s. 3d. to be carried forward. There are 6,985 consumers (against 6,781 in 1915), with 21,411 H.P. (against 19,389 H.P.) connected. The gross revenue shows a further substantial improvement, but owing to the high price of coal throughout the year nearly the whole of the increase has been absorbed in extra expenditure. The new 5,000 kw. turbo-generator has been put to work, and, in order to deal with the growth of the business, an additional 5,000 kw. set has been placed on order. With the sanction of the Treasury, £29,140 4½ per cent. first debenture stock and 5,440 6 per cent. cumulative second preference shares were issued during the year. Substantial progress has been made in the business of the West Kent Electric Co., the gross receipts having more than doubled, while the net revenue increased from £3,051. 3s. 3d. to £5,432. 7s. 3d.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The report for the year 1916 states that the total power of the lamps, motors and apparatus connected to the company's mains, which on Dec. 31, 1915, was the equivalent of about 42,255 kw., had increased by Dec. 31, 1916, to the equivalent of about 43,969 kw. The directors have elected Lieut.-Col. J. F. Remnant, M.P., to fill the vacancy caused by the retirement of the Rt. Hon. W. Hayes Fisher, M.P. An interim dividend at rate of 5 per cent. per annum on the ordinary shares and the dividend on the 4½ per cent. preference shares for the half-year ending June 30, 1916, has been distributed. After allowing for depreciation, sinking fund and other charges the balance is £40,077. 3s. 2d., from which must be deducted the second half-year's dividend on the preference shares (£12,375), leaving £27,702. 3s. 2d. Out of this the board recommend payment of a dividend at the rate of 9 per cent. per annum (less tax) for the past half-year, making 7 per cent. for the year, carrying forward £2,952. 3s. 2d.

NEW COMPANIES, &c.

ASSOCIATED BRITISH MACHINE TOOL MAKERS (LTD.) (145,999).—[illegible] reg. [illegible] 14, capital £100,000 in £1 shares, to carry on the [illegible] tool manufacturers, mechanical [illegible] makers of sand blast machinery, air [illegible] plant, &c. First directors are W. [illegible] H. March, A. H. Baldwin, W. B. Lang, [illegible] W. D. Ford Smith, E. Williams and H. [illegible], S.W.

BORRA MAGNETO REPAIRING CO. (LTD.) (146,020).—Private Company, reg. [illegible] capital £1,000 in £1 shares [illegible] pref.), to take over the [illegible] carried on by D. Borra, and to carry on the business of [illegible] motor accessories, &c. [illegible] D. Borra, W. H. M. [illegible] and H. J. Prockter [illegible] office: 72, Dean [illegible] W.

DRIVER, DENMAN & COOPER (LTD.) (145,955.)—Private company, reg. Feb. 9, capital £50,000 in £1 shares, to take over the business of cable manufacturers, wire drawers and electrical engineers and metallurgists carried on by J. Drennan and J. K. Cooper as Drennan & Cooper and the North Western Cable Co., and also certain assets in England belonging to the Driver-Harris Wire Co. (of Newark, U.S.A.), and to enter into an agreement with W. B. Driver and J. Drennan and J. K. Cooper. First directors (to number not less than three nor more than five) are F. L. Driver (chairman), W. B. Driver, A. Bensel, J. Drennan (managing director) and J. K. Cooper. The two last mentioned may retain office for six years. Secretary, J. Drennan.

N. GUNN & CO. (LTD.) (145,992).—Private Company, reg. Feb. 13, capital £1,000 in £1 shares (900 cumulative preference), to carry on the business of manufacturers and dealers in name-plates, labels, discs, badges, &c., metal, celluloid, bone, ivory and other materials, manufacturers of electric lamps and fancy goods, &c. N. Gunn is permanent governing director. Reg. office: 46, Queen Victoria-street, E.C.

NEW SWITCHGEAR CONSTRUCTION CO. (LTD.) (145,964.)—Private company. Reg. Feb. 9, capital £10,000 in £10 shares, to carry on the business of electrical engineers, manufacturers of and dealers in switchgear, transformers, heating and lighting apparatus, &c. The Board of Trade has authorised the company to acquire part of the undertaking of the Switchgear Construction Co. (Ltd.), the books and documents of which are liable to inspection under the Trading with the Enemy Act. The usual provisions to ensure the British character of the new company are inserted in the memorandum of association. The subscribers are J. Hall, electrical engineer, and C. E. Cleeves.

CITY NOTES.

MEMORANDA (Feb. 20).—Consols, 52. Consols Pay Day March 1. Stocks and Shares Ticket Day, March 13. Pay Days, Feb. 23 and March 14. Price of Silver, 38d.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—A final dividend has been declared on the ordinary shares at the rate of 7 per cent. per annum (less tax) for the half-year ended Dec. 31, making 6 per cent. for the year.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—Mr Andrew Wilson Tait, C.A., has joined the boards of Callender's Cable & Construction Co. (Ltd.) and of the Anchor Cable Co. (Ltd.).

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—The total profit for 1916 was £7,096, and £2,753 was brought forward. Debenture and other interest require £1,783, £1,000 is placed to depreciation account, and a dividend of 5 per cent. per annum for the year is recommended, £2,607 being carried forward.

DIRECT WEST INDIA CABLE CO. (LTD.)—An interim dividend of 6 per cent. per annum (tax free) has been declared on the ordinary shares

GUERNSEY RAILWAY CO.—Including £471 brought forward, the net profit for 1916 (after writing off £840 for depreciation and placing £500 to general reserve) is £1,711, against £1,729. An ordinary dividend of 5 per cent. has been declared, the same as in 1915.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—An interim dividend of 6 per cent. per annum (tax free) has been declared on the ordinary shares.

LIVERPOOL OVERHEAD RAILWAY CO.—The directors recommend payment of a final dividend for the half-year ended Dec. 31 at the rate of 5 per cent. per annum on the preference shares and of 4 per cent. per annum on the ordinary shares (less tax in both cases), making 5 per cent. on the preference and 3¼ per cent. on the ordinary shares for the year.

MATHER & PLATT (LTD.)—The directors recommend a final dividend of 12½ per cent. on the ordinary shares, making 17½ per cent. for the past year compared with 12½ per cent. for each of the two preceding years and 15 per cent. for 1913. The net profits, after charging depreciation, directors' remuneration and making provision for doubtful debts and war taxation, were £171,053, to which must be added £75,461 brought forward, making £246,514. After paying the above dividends and transferring £30,000 to reserve (making £300,000) a sum of £91,514 has been carried forward.

MERSEY RAILWAY CO.—The directors announce interest payments as follows:—4 per cent. on 1866 debentures, 3 per cent. on 1871 debentures, 3 per cent. on the 1882-3-5 debenture stocks, and 1 per cent. on the "13" debenture stock.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.).—A final dividend of 4½ per cent. has been declared on the ordinary shares, making with the interim dividend of 2½ per cent. already paid, 7 per cent. for the year.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared, subject to final audit, a dividend on the ordinary shares at the rate of 5 per cent. per annum for the year 1916, placing £7,550 to depreciation fund and carrying forward £3,053.

TYNESIDE TRAMWAYS & TRAMROADS CO.—On the past half year's working there is a disposable surplus of £6,923. It is proposed to pay 1¼ per cent. (making 3 per cent. for the year), to carry £1,800 to reserve and £661 forward.

WESTINGHOUSE ELECTRIC & MFG. CO.—The stockholders have voted in favour of increasing the capital from $50,000,000 to $75,000,000.

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NOTES.

Insulating Properties of Oil.

ELSEWHERE we give a short account of an experimental research on the electric insulating properties of transformer oil. The tests were carried out in the Electro-Technical Laboratory at Tokyo, and the investigation, which was started with the object of standardising commercial methods of testing, brought to light a number of interesting phenomena. By far the most important of these is the effect of what the authors term dust on the insulating properties of the oil. The dust referred to is the cotton fibre which adheres to the electrodes and to the walls of the containing vessel after these have been cleaned and polished with well-dried cotton cloths. The curves showing the breakdown voltage of an oil containing various percentages of moisture are very instructive, and the authors state positively that the water in the oil does not materially affect its insulating properties unless the oil contains some hygroscopic medium, such as cotton fibre, which can easily absorb the moisture. It would appear that such fibres make bridges between the electrodes, and that the fibres by absorbing moisture put the gap into a condition corresponding to the bridging of the gap with water strings. The rules laid down for the cleaning of the vessel and electrodes before making a test are explicit. So important are the conclusions that we should like to see them verified at an early date, and it would be helpful if Messrs. HIROBE, OGAWA and KUBO, the authors of the present work, would endeavour to make the electrodes and containing vessel chemically clean before introducing the sample of oil to be tested.

The L.C.C. Tramways.

DURING the last few years, and especially since the outbreak of war, the tramways of the London County Council have been a source of anxiety to the Committee responsible for their management. Once again the whole position has been reviewed by the Highways Committee, and conclusions have now been reached which will be found summarised on another page. These conclusions at length show an awakening to the real needs of the case. It is, no doubt, only natural when an undertaking is not showing satisfactory financial results that economy should be practised as far as possible, but this is not necessarily the best course to follow. In 1910, when Mr. J. H. RIDER resigned his position as electrical engineer, this post was abolished and the work was given to his assistant at half the salary. A similar economy was practised in the Traffic Department. The result of this sort of thing was that Mr. A. L. C. FELL, the Chief Officer, was overburdened with details and recently broke down in health. That this policy does not pay now seems to be realised. It is quite impossible for those chiefly responsible for a large undertaking to give adequate attention to matters of prime importance if at the same time they are required to attend to those details which should be left to their subordinates.

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IT has now been decided to appoint, in addition to the Chief Officer, a Traffic Manager and an Electrical Engineer, a Rolling Stock Engineer and a Permanent Way Engineer, apart from other minor officials, and it is the intention to give a certain freedom of action to those in responsible positions. This is obviously desirable. As a rule such freedom leads to a greater sense of responsibility and to better work. Of course, this scheme will involve a certain additional expenditure, namely, £5,600 per annum, and we have noticed an outcry in the daily press against this supposed waste of money. Such a sum, however, is small in comparison with the yearly revenue and expenditure of the undertaking, running into millions. Thus, in normal times the number of employees in the Traffic Branch is 7,000, the wages being £11,000 per week; in the Electrical Branch the annual expenditure is £300,000; in the Rolling Stock branch the number of employees is normally about 3,000, and salaries and wages run to £4,000 a week; whilst in the Permanent Way branch the number of employees is normally 1,400 and the salaries and wages amount to £2,000 a week. Undertakings of this magnitude cannot be properly run unless officials are obtained who are adequately paid, and we are glad to see that the Highways Committee, and the County Council also, now realise this side of the question and are acting accordingly.

Contrast in Lighting Problems.

IN his Paper before the Illuminating Engineering Society on Feb. 20, Dr. KERR discussed the effect of "glare" from a somewhat novel standpoint. Suggestions have often been made that the absolute brightness of shades should be limited to a stated figure. What is less generally understood is that the prejudicial effect of a bright light is largely a matter of contrast. The eye can withstand enormous variations in brightness if the transition is gradual, but it objects to abrupt changes. A striking instance of this is the alternation of bright patches of light and dense obscurity in London streets at night. We are glad to note that the changes now being introduced in some of the streets give promise of greater uniformity and better diffusion of light. We should not be surprised if experience of the milder luminosity of the lanterns now coated with translucent whitewash did not lead to the more general use of diffusing glass after the war. Another instance of extreme contrast is furnished by the cimena theatre. The flicker of a poor film and the effect of sudden extinction or switching-on of lights, both of which are admittedly trying to the eyes, illustrates "successive contrast," while the transition from the brightly lighted screen to the dark surroundings of the theatre exemplifies "simultaneous contrast." In the interests of children, by whom such entertainments are largely visited, the lighting conditions in such theatres deserve careful study. We observe that the Cinema Commission has now invited the Illuminating Engineering Society to form a small committee to go into the matter.

The Use of Stranded Wire.

In our present issue our readers will notice an advertisement by the Cable Makers' Association asking that solid wires be used instead of stranded wires for the smaller sizes of cable. This request is due to the fact that Government requirements in small stranded wires at the present time are very great, and if stranded wires are ordered for other purposes delay will necessarily occur in completing Government orders. The objections to the use of solid wires are well known, but under the circumstances we feel that the needs of the country must come first, and we trust that those who are responsible for the type of wire that is to be used in installations will accept the position and will comply with the request of the Cable Makers' Association.

The Electrical Training of Disabled Soldiers and Sailors. H.M. the Queen visited the Northampton Polytechnic Institute (London) on Feb. 21 in order to inspect the classes that have been arranged for training disabled soldiers and sailors as electrical sub-station attendants. On the same occasion Her Majesty inspected the shops of the newly established lens-grinding section of the department of technical optics at the Institute.

Interconnection of Lancashire and Cheshire Electricity Supply Systems.—A Conference of Delegates representing the Municipal and Company Electricity Supply Authorities will be held in the Manchester Town Hall to-day (Friday) at 11 a.m., to consider the proposals set forth in the Report of the Committee for the Interconnection of Lancashire and Cheshire Electricity Supply Systems. The Conference will be presided over by Mr. G. H. Roberts, M.P., the Parliamentary Secretary to the Board of Trade, and the electricity supply authorities will be represented by about 120 delegates.

Audible Reception of Cable Messages. It is announced that as the result of experiments carried out under the direction of Lieut.-Col. G. O. Squier cable communication may be received by ear instead of by eye as at present. The improvement consists essentially in the adaptation of the "ticker" and audion type of instrument used for receiving the signals in radio-telegraphy. The cable used in the tests was 1,086 miles in length and had a K R approximately equivalent to one of the Atlantic cables. The actual receiver was an ordinary telephone. The feeble current received was broken up by means of a slipping-contact "ticker" and rendered audible, and in order to secure greater sensibility a tuned audion amplifier was used in connection with the ticker. The sensitiveness of the apparatus is said to be so great that less than one-hundredth of the voltage necessary for operating the siphon recorder is sufficient to give readable signals.

National Service.—The second reading of the National Service Bill took place in the House of Commons on the 22nd ult., when the Home Secretary explained the objects of the measure.

Sir Geo. Cave assured the House that the scheme outlined was of a voluntary character, and that it contained no new element of compulsion. There was, therefore, no need to harbour the slightest fear of industrial conscription.

In this connection, Mr. Neville Chamberlain has issued a list of essential trades, and these include public utility services (electricity supply stations, tramways, &c.); mining and quarrying; metals, mines, implements and conveyances (including electrical engineering, manufacture and repair of mining and electrical machinery, &c.), and the chemical and oil trades, &c.

Speaking at Sheffield on Tuesday, Mr. Chamberlain stated that a revised list was in preparation and would be issued in a few days.

State Control of Coal Mines and Canals.—The Government have decided to take possession of the Coal Mines and Canals in the United Kingdom.

Coal.—The Board of Trade have issued an order taking possession as from March 1 of all coal mines in the United Kingdom, other than those in South Wales and Monmouthshire, of which possession was taken on Dec. 1 last. A new department has been created, with Mr. Guy Calthrop (general manager of the L. & N.W. Railway Co.) at its head, for controlling the mines and exercising all the powers of the Board regarding coal. Mr. Calthrop will be assisted by Sir R. Redmayne, H.M. Chief Inspector of Mines. The objects of the scheme are: (1) To control the coal mines of Great Britain during the war; (2) to organise an executive similar to the executive in the case of the railways; (3) to install machinery for economical handling and distribution; and (4) to pay colliery proprietors their pre-war dividends.

Canals.—The Board of Trade have also issued an order taking possession of a number of canals as from March 1. They have appointed a committee to control the canals taken over. Sir Maurice Fitzmaurice is chairman of the committee, and the other members (in addition to representatives of the Government departments concerned) are Mr. H. J. Ash, Mr. A. Peploe, Mr. A. J. Saner, and Mr. J. T. Williams.

Improvement in Public Lighting in London.—A welcome improvement has recently been made in the lighting conditions of London, lanterns of public lamps being blackened only over a short length of the upper portion, the lower and larger part being covered with special translucent whitewash.

The method has already been introduced into many of the chief thoroughfares. It has the merits of eliminating the bright patches under the lamps, making the general illumination both brighter and more uniform, and diminishing the severe contrasts which were a disagreeable feature of the methods of screening previously employed. In the present darkened condition of the streets the shielding of the lamp filament or mantle by the diffusing coating of whitewash is also a good feature, with a view to reducing glare.

Sir G. Cave, in reply to a question in the House on Monday, stated that the avoidance of the bright patches under lamps was considered an improvement. It was also stated that the number of fatal street accidents in the Metropolitan area during the hours of darkness from Aug. 1, 1914, to Jan. 31 last year was 954 and the number of persons killed by Zeppelins during the same period was only 137.

Chemists in War. In the current part of the "Proceedings" of the Institute of Chemistry there appears an interesting short article by the Registrar, giving certain details of the important part played by chemists in the war.

In previous wars the authorities have considered officers of the R.A.M.C. sufficiently trained for all necessary military duties involving chemical knowledge, but in the present conflict it has been impossible for the medical staff to take on the necessary chemical work. Many chemists have, therefore, been appointed to commissions engaged in scientific work not only with the R.A.M.C., but also with the A.S.C., the A.O.D., and other units. In consequence of the methods employed by the Germans there also arose a demand for men with training in chemistry for service in the field, and it was, therefore, deemed expedient to enlist men with scientific knowledge, and thus a new force was brought into existence. The men who went voluntarily and were sent abroad at a very short notice, and after a short training went into action. According to despatches they did their work exceedingly well, dealing with the offensive and defensive in gas attacks. Generally speaking, it was found that the best qualified chemists proved to be the best soldiers. In due course, when the force was more completely organised, a considerable number of men were withdrawn and transferred to the Ministry of Munitions, in order that their services might be available for work of a more scientific character. At the conclusion of the article attention is drawn to the many lines of activity in which chemists are essential, both in this country and at the front.

OBITUARY.

J. H. TUCKER.—We regret to announce the death, which took place on the 18th ult., of Mr. J. H. Tucker, of Messrs. J. H. Tucker & Co., electric light and power accessory manufacturers. Mr. Tucker, who was in his 5[illegible] year, had not been really well since the summer.

but was taken seriously ill in December, and has been unable to attend to business since then. We are informed that Mr. Tucker's death will involve no change in the business or policy of the firm.

Wm. Church.—The death occurred on Sunday of Mr. William Church, the electrical engineer at Buckingham Palace during the reign of King Edward VII., and later at Marlborough House, where he continued to discharge his duties till a fortnight ago. Mr. Church was in his 73rd year.

J. R. Preece.—The death of Mr. John Richard Preece, C.M.G., M.I.E.E. (formerly H.M. Consul-General at Ispahan, Persia), occurred in London on Sunday last. He was a brother of the late Sir William Preece.

Mr. Preece was 73 years of age. He went to Persia in 1867 as assistant engineer of Persian telegraphs. He resigned in 1891, when he became a Consul, and he retired from the consular service about 15 years ago.

W. H. Hunter.—The death of Mr. Wm. Hy. Hunter, M.Inst.C.E., aged 68, consulting engineer to the Manchester Ship Canal Co., occurred on Tuesday.

E. C. Churchward.—We regret to record the death of Mr. E. C. Churchward, general manager and engineer of the Scottish Central Electric Power Co.

Deaths on Active Service.—The following deaths on active service are reported :—

We regret to announce the death of Capt. Eric Sutherland Phillips (8th Batt. Border Regt.), eldest son of Mr. and Mrs. J. A. Phillips, "St. Aubyn," Rugby. At the declaration of war Capt. Phillips was a pupil in the works of the British Thomson-Houston Co., Rugby. He volunteered for service and enlisted as a private in the 6th Oxon. & Bucks Light Infantry in September 1914. He was given a commission in the 8th Batt. Border Regt. in December, 1914, was promoted to Lieutenant in November, 1915, and to Captain in December, 1916. He died of wounds received in action on Feb. 21, aged 22 years. His Colonel writes :—"He was a most excellent young officer, always willing and cheerful. During the time when he was in charge of the Machine Gun Detachment of the Battalion he did very good work. He was very plucky under fire, and a very good leader. We shall all miss a cheery, plucky comrade, and a great favourite in the Battalion."

Second-Lieut. Geo. W. Bowater (R.G.A.), who has died on Feb. 20 after an operation necessitated by an illness contracted while on active service, was an electrical engineer by profession. He served at the front for 11 months as a sergeant in the S. Midland Brigade, R.F.A., before obtaining his commission last autumn.

Mr. W. E. Evans, chief clerical assistant at the London showrooms of the Edison-Swan Electric Co., died early in February, after only three weeks' service with the R.F.C.

PERSONAL.

Hull Corporation, on the recommendation of the Electricity Committee, have increased the salary of Mr. J. F. Magoris, acting city electrical engineer (in the absence of the city electrical engineer, Mr. H. Bell, who is on military service), by £75 per annum. Mr. Magoris has had entire charge of the department since the outbreak of war, and the committee have expressed high appreciation of the services rendered by him.

In the absence of Mr. Spencer, general manager of the Bradford tramways, on Government work, the Corporation have appointed Mr. Stirk, traffic superintendent, to take charge of the traffic side of the department, and Mr. J. W. Dawson, engineering assistant, will look after the engineering side.

His many friends in the electrical industry, who have heard with regret of his recent illness, will be glad to know that Mr. W. Crawford, of Belliss & Morcom, is making satisfactory progress.

APPOINTMENTS VACANT AND FILLED.

A draughtsman is wanted, preferably with some knowledge of magnetos. *See advertisement.*

Messrs. Johnson & Phillips (Ltd.), Charlton, London, S.E., advertise for switchgear draughtsmen. The firm also advertise for an assistant transformer designer.

Junior engineers-in-charge are required for a large power station in Scotland (d.c. and e.h.t. three phase with rotaries) : also junior engineer for mains department. *See advertisement.*

A switchboard attendant is required for a.c. and d.c. municipal electricity works in the Midlands.

A shift engineer is required for a small municipal station.

Mr. F. H. Rudd, station superintendent at Rochdale, has been promoted to the position of acting borough electrical engineer for three months and Mr. W. J. H. Wood, of Bolton, has been appointed consulting engineer for the same period, in order to prepare a report on the present position of the electricity undertaking.

INSTITUTIONS AND SOCIETIES.

Royal Society.—At the meeting held yesterday Papers were read, among others, on "Osmotic Pressures Derived from Vapour Pressure Measurements," by the Earl of Berkeley, F.R.S., E. G. J. Hartley and C. V. Burton ; and on "The Complete Photo-Electric Emission from the Alloy of Sodium and Potassium," by W. Wilson.

Institute of Metals.—*Metal Melting.*—A special feature of the forthcoming spring meeting of the Institute of Metals, to be held on March 21 and 22, will be a general discussion on metal melting, a subject which hitherto has received very little attention from the scientific societies. It has now assumed great national importance, since vast quantities of fuel—solid, liquid and gaseous—are used in metal melting, particularly for munitions making. Economies in the use of these fuels in the metal industries are generally realised to be possible, but the lack of comparative data has often hindered the adoption of the most efficient means of metal melting. The Institute of Metals is very fortunate in having as its president, who will preside over the discussion, Sir George Beilby, LL.D., F.R.S., the head of the new Government Board of Fuel Research. At the forthcoming meeing a series of six communications will be made bearing on all phases of the question of the melting of the non-ferrous metals, whether by high-pressure or low-pressure gas, coke, oil fuel or electricity. In regard to the last-named we notice that a Paper is to be read by Drs. H. C. Greenwood and R. S. Hutton on "An Electric Resistance Furnace for Melting in Crucibles." In addition to the metal melting discussion, several important communications bearing on other phases of metallurgical work will be presented. On account of Caxton House having been commandeered by the War Office, the address of the Institute of Metals will in future be 36, Victoria-street, London, S.W.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, March 6th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "Internal Combustion Engines," by Prof. W. E. Dalby, M.A. (Lecture II.)

Engineers' Club.

7.30 p.m. At Albert-square, Manchester. Paper on "Engineering and Imperial Production," by Mr. T. C. Elder.

Faraday Society.

8 p.m. At the Rooms of the Chemical Society, Burlington House, W. Discussion on "The Training and Work of the Chemical Engineer," opened by Sir George Beilby, F.R.S. Papers on "The Training of the Chemical Student for Work in the Factory," by Prof. F. G. Donnan, F.R.S. ; "The Training of the Works Chemist in Physics," by Mr. C. R. Darling ; and "A Plea for the Forgotten Factor in Chemical Training," by Mr. W. R. Cooper, M.A.

THURSDAY, March 8th.

The Institution of Electrical Engineers.

8 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Voltage Regulation of Rotary Converters," by Mr. G. A. Juhlin.

FRIDAY, March 9th.

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington, S.W. Agenda : "To Measure the Pressure in a High Vacuum by Means of Logarithmic Decrement," by Dr. P. E. Shaw, B.A. ; "A Diffraction Colour Box," by Mr. A. W. Clayden, M.A. : Demonstration of Interference Effects with a Thorpe Grating," by Mr. A. W. Clayden, M.A.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Colonel C. B. Clay, V.D., Commanding.

Orders for the Week ·

Officer for the Week.—Platoon Commander W. J. A. Watkins.

Next for Duty.—Platoon Commander E. Greenop.

Monday, March 5.—Technical for Platoon No. 9, at Regency-street : Squad and Platoon Drill, Platoon No. 10 ; Signalling Class ; Recruits' Drill, 8.30 to 8.

Wednesday, March 7.—Instructional Class, 6.15 ; Platoon Drill, Platoon No. 1.

Thursday, March 8.—Platoon Drill, Platoon No. 7 : Ambulance Class by M.O., 6.30 ; Signalling Class.

Friday, March 9th.—Technical for Platoon No. 10, Regency-street : Squad and Platoon Drill, No. 9 ; Recruits' Drill, 6.25 to 8.25.

Saturday, March 10.—N.C.O.'s Class, 2.30, Company Commander Castell, knots and lashings.

Sunday, March 11.—Special work at Bombing School Parade Clapham Junction Station (City & S.L. Tube Railway), 9.45 a.m Uniform, haversacks, water-bottles. Midday rations to be carried.

Easter Training.—Will be at Esher. See Special Order.

Musketry.—For all Companies. See Notice at Headquarters.

Note.—Unless otherwise ordered, all Drills, &c., will take place at Headquarters.

ELECTRICAL SYSTEM OF THE RAND POWER COMPANIES, WITH SPECIAL REFERENCE TO METHODS OF OPERATION AND EXPERIENCE.*

BY BERNARD PRICE.

(*Continued from page* 629.)

Summary.—The object of this Paper is to describe the lay-out and operating characteristics of the electrical portion of one of the largest power schemes of to-day, and to place at the disposal of electrical engineers certain experience gained on that scheme during the last seven years. The Paper is confined to a consideration of the electrical system when viewed as a complete entity.

CONTROL OF SYSTEM OPERATION.

The control and regulation of supply is partly automatic and partly non-automatic (*i.e.*, executive), and concerns three factors: economy, suitability and reliability of supply.

The first essential is that the executive control shall be centralised at one point from which all instructions affecting the safe and efficient operation of the system shall emanate.

The control room is at Simmer Pan. From this room radiate special telephone circuits direct to all important centres on the system. By connecting through at these centres, communication can be established with any sub-station or with employees located along the routes of any of the overhead lines. The control engineer sits at a table in the centre of the room and on the wall facing him a large diagram of the entire system is placed. This diagram is very similar to that shown in Fig. 1 and is arranged so that all switching operations, as they take place, may be recorded thereon by means of coloured discs suspended from pins.

In order that the switchboard attendants may expeditiously carry out instructions received from the control engineer, telephonic communication is provided between the station control switchboard and [illegible] passages in the switch houses. A special signalling system is also provided for communicating messages to and from [illegible]. When a switchboard attendant desires to send an instruction he presses one of a number of buttons on the control panel [illegible], which [illegible] several large electric [illegible] of the engine room, and simultaneously [illegible] the section and the instruction concerned [illegible] of every driver in the turbine room. [illegible] the bell, look at the signal board, and the [illegible] of the [illegible] notes the instruction given. [illegible] presses one of a number of [illegible] to notify the switchboard attendant that he has received the message, or that certain instructions have been carried out, this operation [illegible] the ringing of a bell at the control switchboard and the [illegible] of a small signal on the switchboard control panel.

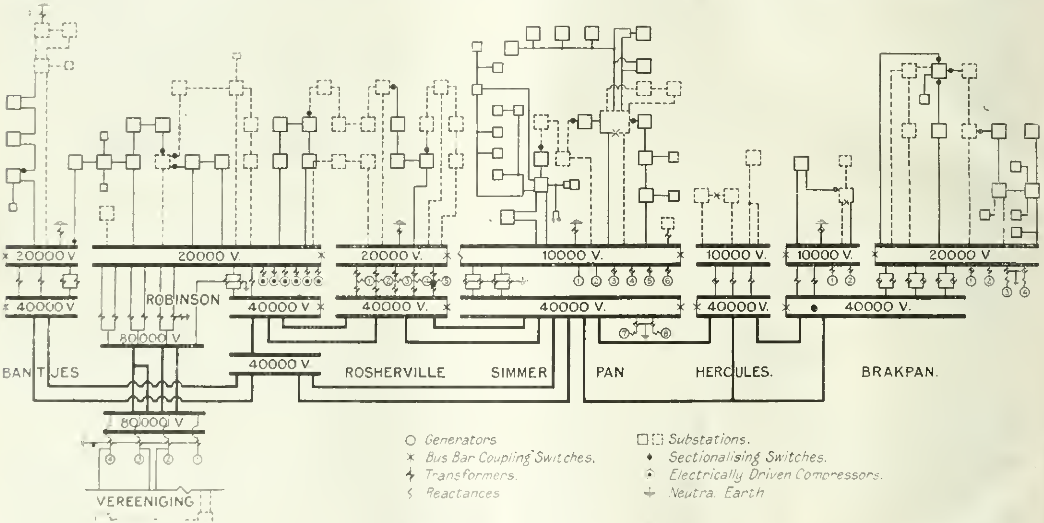

FIG. 1.—DIAGRAM OF POWER COMPANIES' SYSTEM.

An illuminated sign is also placed in each boiler house indicating two signals: "Load rising" and "Load falling." By this means the switchboard attendant is enabled to assist the boiler-house staff in the regulation of steam generation.

In order that the control engineer may immediately be made aware of the automatic operation of sub-station switches, an alarm system has been installed which operates a bell and indicators at the local generating station or step-down station and also operates a bell and master indicators in the control room. The installation of this alarm system has proved very valuable in expediting resumption of supply under emergency conditions, and it has not involved any large expenditure because existing telephone wires have been utilised.

Economy of Supply.—The economical operation of the system involves intelligent regulation of the loading of the several generating stations to secure minimum generating costs. This involves not only the careful regulation of the loading of each of the four stations every hour of the year, but also the organisation of maintenance work to obtain minimum loss of output from those stations which generate at lowest cost.

The cost of coal is by far the most important item of generating cost, and especially so in the case under consideration where the monthly system load factor is 70 per cent. The calorific value and railage of the coal varies widely at different stations, the cost per unit sent out being less at the Vereeniging and Brakpan stations than at the other two, and a little higher at Rosherville than at Simmer Pan.

The most economical method of loading is as follows:—

During the period of heavy load in the morning and early afternoon, Vereeniging, Brakpan and Simmer Pan stations are run at the maximum possible output, leaving Rosherville to generate a minimum quota. The Rosherville station is run as a peak station. When the load falls and after Rosherville has been shut down, the Brakpan station continues to run at maximum possible output whilst Simmer Pan and Vereeniging share the remainder of the load in such a manner as to keep to a minimum the balance of power exchanged between the two systems over the week. In practice this means that the load factor of the Vereeniging output is but little less than the maximum possible.

As regards maintenance work, it is clearly economical that the time during which machines are out of commission should be a minimum at all stations excepting Rosherville. For this reason it pays to work overtime on repairs and overhauls at Vereeniging, Brakpan and Simmer Pan stations.

The above considerations determine the kilowatt loading at the various stations, and to that extent define the transmission loss, but as this loss is dependent upon the distribution of current, there is still room for economy by intelligent regulation of power factor.

Transmission loss may be minimised in two ways, viz.:

1. By raising to a maximum the power factor of the system as a whole.

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* Abstract of a Paper read before the S. African Inst. of E.E.

2. By reducing to a minimum the distance of transmission of the lagging current on the system.

The bulk supply of air already referred to is compressed partly by turbine-driven rotary compressors at Rosherville and partly by electrically-driven rotary compressors at Robinson. There are six compressors at the latter station, each arranged on a pair of shafts making 12 motors in all. These motors are of the synchronous type rated for 2,000 k.v.a. each, and designed to operate at a leading power factor of about 90 per cent.

Excluding supply to these compressor motors, the power factor of the total output to all consumers averages about 72 per cent. during the day time and 70 per cent. during the night on week-days. When five out of the six Robinson compressors are run, the system power factor during peak hours is raised to close upon 79 per cent. and the combined k.v.a. load is nearly 10,000 k.v.a. less than it would have been if the compressor motors had operated at a lagging power factor of 90 per cent.

The pair of motors for any compressor at Robinson, which is not required for compressing air or for standing by as a spare set, are disconnected from the compressor and run up as rotary condensers for power factor correction. Each pair of motors absorbs about 200 kw. when taking full leading current as a rotary condenser and raises the power factor of the day load on the system by about 1 per cent.

The conditions under which it pays to improve the system power factor by operating an idle generator as a rotary condenser have been carefully investigated, and it has been found that whilst it does not pay to do this merely for the purpose of reducing transmission losses, it does pay to run a generator if by so doing a turbine can be shut down. The steam consumption of the turbo-generators obeys Willan's law fairly closely. If by running a generator as a rotary condenser it becomes possible to shut down one turbine unit, the no-load consumption of the latter is saved as against the loss of the power absorbed by the rotary condenser. When brought to a common denominator, the comparison between these quantities for the Rosherville sets and for the small machines at Simmer Pan is approximately as follows:—

	No load. kw.		Rotary condenser. kw.
Rosherville machines..................	1,200	......	660
Simmer Pan small machines	500	......	165

As regards the distribution of lagging current over the system, it is obvious that the Vereeniging station must operate at the highest possible power factor so that minimum current may be transmitted over maximum distance. Generating plant in a station like Vereeniging should preferably be specified for a relatively high power factor because additional k.v.a. capacity at that point is of less value than at other stations which are nearer the load. The two 18,000-k.v.a. Vereeniging machines might with advantage be interchanged with two of the 12,000-k.v.a. Rosherville machines, but unfortunately their transformers are not wound for the same pressures.

All loaded machines on the Rand, therefore, are normally operated at maximum safe k.v.a. capacity, leaving the sets at Vereeniging to generate at maximum power factor. To this end the machines are loaded to maintain full generator temperature from hour to hour.

It has been found by careful tests that for a given rotor current and temperature the pressure across the separate slip-ring brushes is the same whether the rotor be at rest or operating under load, and the simultaneous measurement of this pressure and current enables the average temperature of the windings to be calculated. In this way the loading of each set can be regulated to maintain approximately constant full temperature on those sets which are required to generate maximum k.v.a.

The effectiveness of the ventilation of the generators varies considerably from season to season. Water spray cooling and washing plant has now been installed on all the large sets, and experience gained with a trial equipment which was in service during the whole of last summer has shown that such plant, in addition to lowering the average temperature, largely reduces the range of temperature variation. The cooling effect is dependent upon the humidity of the atmospheric air, and the coincidence of high temperature and high humidity is exceptional. The cooling is therefore most effective when it is most required, namely, when the temperature is greatest.

The power factor of the load carried by the 40,000-volt transmission lines along the Reef is mainly determined by the number of generating units in service at the various stations and, as already explained, this in turn is governed by considerations of economy of generation. The matter is also affected to some extent by limitations in regard to the pressure of distribution over the system. It would not pay to install 40,000-volt pressure regulating boosters for controlling the power factor independently of the pressure of distribution, because such regulators would be expensive and would add considerably to the complication of the system. It is possible, however, to exercise some control over the quantity of current transmitted over the 40,000-volt system at certain times of day, and also to regulate the distribution of current over the 20,000-volt cable network between Rosherville and Robinson, which is fed at both ends.

Experience when switching-out large transformers has shown that an extremely high pressure rise may occasionally occur due no doubt to the dissipation of stored energy in the magnetic circuit of the transformer. To obviate this risk it has been necessary to adopt special methods of operation. Wherever possible large transformers are shut down gradually with a rotating machine, and in other instances arrangements have been made whereby an artificial load may be connected through the spare 'busbars to the transformer before it is demagnetised.

As regards transformation loss, there is little latitude for saving on a scheme of this type, because the load factor is high and all substations, being static, are without attendants.

Lack of symmetry between the currents on the three phases of the system may influence transmission loss. The output from substations is virtually a balanced load, but as a result of inequality in the magnetising current of individual phases of the transformers the output from generating stations is not symmetrical, the currents flowing in the three phases differing from one another by 5 per cent. to 10 per cent. on the various sections of the system. This lack of symmetry reduces the effective k.v.a. capacity of the system, and also complicates all those measurements which are made by single-phase instruments.

It should be possible very largely to reduce this out-of-balance by reconnecting a number of transformers so that the particular phase-winding which takes the heaviest magnetising current is fed from different phases in different instances. The matter is being investigated from this point of view, and if it is found impossible entirely to correct the balance, it will be advisable where possible to arrange for consumers to take any single phase load they may require from phases which are relatively lightly loaded.

Suitability of Supply.— In order that the supply may be in a form suitable to the consumer, pressure and frequency require regulation.

The generating pressure at Vereeniging, Brakpan and Simmer Pan Stations is automatically controlled by Tirrill regulators installed on two large machines at each station, and at Vereeniging any pair of machines may be chosen for this purpose. Similarly the steam governors on the turbines automatically reduce the range of fluctuation in frequency, and they are remote controlled from the switchboard so that the attendants may adjust the speed when necessary, and especially under emergency conditions.

The four large machines recently installed at Brakpan and Simmer Pan are nozzle governed. The older sets are governed by throttling at the main stop valve. These nozzle governors are much more sensitive than the throttle governors and in order to prevent wide fluctuations of loading at Brakpan, where maximum output is so desirable, the governors there have been rendered sluggish in action. It is more economical to govern on one nozzle at a time than to throttle the steam taken by all nozzles, and for this reason governing is confined to the minimum number of machines required to ensure satisfactory frequency in the event of a portion of the system becoming separated or a large machine being automatically disconnected from the system.

Reliability of Supply.—It is probable that there is no system in the world which has afforded better opportunity for testing the reliability of supply than that under consideration. In addition to the severity of climatic conditions the plant and apparatus installed have exhibited many weaknesses and defects, and although the failure of a protected item of equipment should not in itself affect supply, the case is totally different when the switch called upon to isolate that item fails to do so and explodes in the attempt.

Interruption of supply may be due to either of the following causes:—

1. The failure of some item of equipment produced by an internal defect or by damage from external cause.

2. Operating mistakes and accidents occurring whilst work is proceeding in proximity to live conductors.

Faults, from whatever cause, may be isolated by automatic means, but mistakes and accidents involve risk to life and limb (a much more serious question than security of supply) and can only be prevented by efficient executive control.

Executive Control. By centring control of all switching operations in a separate department the risk of mistake through an error of judgment is reduced to a minimum, but for the correct performance of the switching operations themselves reliance must be placed upon a number of less responsible employees. To safeguard against mistakes and accidents most stringent regulations have been enforced and these are briefly summarised in the original Paper.

Stringent rules governing the exact procedure to be adopted when making dead or making alive, the issue, possession, and use of keys, and the keeping of records are also enforced. In order to reduce the risk of making accidental contact with a live conductor, and to render a working place evident to the eye, scarlet barrier boards are fixed in front of every high tension cubicle. The removal of any particular board (after the apparatus it guards has been made dead and earthed), creates a gap in an otherwise continuous line of boards along the length of the switch-house gallery.

Automatic Control. Electrical transmission offers great scope for automatic control because the power is in a form which can produce inductive effects and thus enable relay systems to be employed. The differential method of protection in use is assisted in its action by the fact that the neutral of the system is earthed. The system naturally divides itself into a number of sections which are insulated from one another, and the neutral point of each such section has been earthed through a non-inductive resistance at one or more points.

Whenever possible the neutral point of the star winding of a large three-phase step-down transformer or generator transformer has been selected for this purpose, but this cannot be done unless the other windings of the transformer are delta-connected. Where such large transformers are not available a three-phase transformer of 1,500 k.v.a. or 1,000 k.v.a. capacity has been installed specially for the purpose, its secondary windings being delta-connected.

In several instances one section of the system is earthed at two points. This is advisable for two reasons—firstly, because the section in question is extended in length, and, secondly, because it may become separated into two portions at times of emergency. The object of the neutral resistance is to limit the fault current as much as possible, but this current must not be reduced below the minimum value required to operate the cut-outs controlling the sub-station transformers and distribution lines, otherwise the faulty item might not be isolated. If the section of the system is long its impedance from the point of earthing to the furthest boundary may be sufficient to reduce considerably the power on short circuit, and in such case the neutral resistance cannot be made large enough to diminish materially the power which will flow to a fault in the vicinity of the earthed connection. Moreover, the greater the impedance becomes the less rigidly is the potential of the extremities of the network held with regard to earth. By earthing at two separate points these difficulties are overcome, and in the event of the section becoming separated between the two earthing points, each separated portion remains earthed through a resistance of suitable value.

The earthing of the 80,000-volt lines requires special mention. Until recently this section was earthed at Vereeniging only, but for reasons explained later it has been deemed advisable to earth at Robinson also. The transformers at this point were not suitable for 80,000-volt earthing, but a 1,500 k.v.a. three-phase 40,000-volt transformer was connected to the middle points of the delta windings of one of the 80,000-volt step-down transformers, the secondary of the 40,000-volt transformer being delta-connected.

At all points of earthing a current transformer for operating a recording ammeter is inserted in the neutral connection. This instrument is unable to give a reliable quantitative measurement, but it provides useful evidence as to whether an observed fault has been to earth or between phases only. As might be expected, almost every fault is to earth, though sometimes between phase also. The current normally flowing through the neutral is very small. For example, on the 10,000 volt system with the neutral earthed through 28 ohms at Simmer Pan only, the root mean-square value of the current was found to be about 1 ampere and the 10,000-volt network when earthed through 7 ohms gave a neutral current of only 0·2 ampere. When the 10,000-volt system is earthed at two points the neutral current is less than 1 ampere.

Oscillograms of the neutral current have shown the presence of harmonics up to the 13th and 23rd, and when the 40,000-volt system is earthed at two points even harmonics are prominent, especially the 6th, which amounts to 20 per cent. of the fundamental and is in phase with it.

(*To be concluded.*)

ELECTRICAL INSULATING PROPERTIES OF TRANSFORMER OIL.*

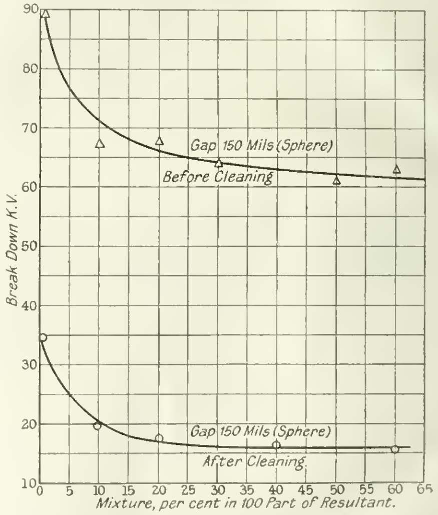
BY T. HIROBE, W. OGAWA AND S. KUBO.

The chief result of the investigation, which was carried out at the electrotechnical laboratory of the Imperial Department of Communication at Tokyo, is the predominant importance which any dust in the oil exerts on the insulating properties. The reason is that when a voltage is applied to the electrodes the dust particles will arrange themselves between the electrode ends so as to form a bridge. The importance of this became evident early in the investigation, when it was found that the method of polishing the electrodes has a great effect on the breakdown voltage, because by polishing with a cotton cloth one is liable to introduce cotton fibres into the oil.

All the tests showed that the dielectric strength of oil free from dust or impurities is exceedingly high, the puncturing voltage being from 87 kv. to 97 kv. per 150 mils between two sphere electrodes of 0·5 in. diameter, provided that the oil under question is of high quality. It is the injurious fibres bridging between the electrodes that impair seriously the insulating power of oil. These fibres can be seen without any difficulty when looking through the gap.

The oil tester used consisted of a glass cylinder with a capacity of 25 cubic in., the two electrodes being adjustable so as to vary the gap and permit the removal of the electrodes for polishing and cleaning.

In order to clean the vessel and the electrodes without introducing dust into the oil, the authors have developed the following method: Immerse the polished electrodes into the oil in the tester and adjust the gap as required. Apply a P. D. between the electrodes as high as possible for several minutes. The high-tension charge thus given on the electrodes is very effective in accumulating all the dust to the gap. Then wash the electrodes with the oil, take it out of the containing vessel, and after that wash the vessel by stirring up the oil in it. This cleaning should be made with great care not to touch both the electrodes and the inner surface of the vessel. Now renew the oil in the vessel, put the electrodes in it as before, and then repeat the same operation several times.



BREAKDOWN KILOVOLTS OF OIL USING SPHERE ELECTRODES.

The relation between the breakdown voltage and the length of the gap for different forms of electrodes was investigated. The lowest breakdown voltage was obtained with the needle and disc; but, contrary to expectations, the breakdown voltage between two discs was found to be much lower than between two spheres.

The effect of the temperature of the oil on the dielectric strength was next investigated. The authors conclude that while the dielectric strength of oil is frequently said to increase with temperature, this increase is only apparent. It is not a true increase of the dielectric strength of oil proper, but is probably due to the fact that the hygroscopic substances, such as cotton fibres, &c., contained in the oil are dried up by heating.

The authors then discuss the effect of moisture in oil. The amount of moisture in the oil was determined by means of metallic sodium. The results show that the water dissolved in the oil or the water particles suspended in the oil as emulsions have little effect on the disruptive voltage as long as the oil is free from dust; but whenever any substances such as cotton fibres, which can easily absorb moisture, are present, they will easily be wetted by the water in the oil and the gap will soon be bridged. This is clearly shown in the above curves, the abscissæ indicating the amount of moisture in the oil. The upper curve relates to dust-free oil, and shows that the effect of moisture on the breakdown voltage is relatively small. After this test was made the upper electrode was taken out and rubbed with a well-dried cotton cloth. This was sufficient to introduce enough dust into the oil to change the test results completely, as is shown in the lower curve.

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* From "Abstract of Report No. 25, of the Third Section Electrotechnical Laboratory, Tokyo."

The authors conclude that, while very small water particles have little effect in themselves on the breakdown strength of oil, particles of appreciable size, when resting on the high-tension coil of a transformer, have a very injurious effect in impairing the insulation. The filter press is of practical value to filter the dust as well as the moisture, and the machine should be fully cleaned before it is put in service.

Whenever foreign substances exist in oil they will be attracted to and accumulate on the high-tension coil, where the flux density is high. This, therefore, damages the insulation of the transformer seriously. It may then be positively stated that only a single fibre of poor insulating value will be sufficient to break down the insulation of the transformer, however high the quality of oil may be as a whole, because the puncture occurs locally at the weakest point. In any case, all possible care should be taken not to admit any dust, especially moist fibres, into the transformer, and it is advisable that in a large transformer house the oil should be circulated continuously through a filter press to remove the dust as soon as it gets into oil.

THE PARALLEL OPERATION OF ELECTRIC POWER STATIONS.

We give below an account of the discussion which was held by the Western Local Section of the Institution of Electrical Engineers on Mr. Peck's Paper. An abstract of the Paper appeared in our issue of November 24th :—

Mr. W. A. Chamen (South Wales Electrical Power & Distribution Co.), in opening the discussion, said that perhaps some considerations regarding the question of changing over the periodicity of one system to suit that of another might be useful. It was obvious that such a course was always desirable in the interest of simplicity and of the highest efficiency, and in many cases no doubt it was quite a possible and proper course to adopt, but in the case of a supply concern having a considerable number of large consumers, many of which were collieries, the problem was exceedingly difficult, if not impossible, and the cost prohibitive. New plant in the power station would require to be put down before the original plant could be thrown out of action. So far as the plant was concerned, it might be possible to change it over piecemeal, and it might even be possible to follow the same course with regard to the main switchboard which was usually duplicated as regards the 'bus-bars, so that the new plant could deliver to one set of 'bus-bars while the old plant could deliver separately to the other. But the real difficulty would arise in dealing with feeders upon which, perhaps, several large consumers might be grouped together. The periodicity of supply to all these consumers must obviously be changed at one and the same time, which meant that the consumers must be dealt with simultaneously. Coming now to the consumers' installations, the worst difficulty of all arose. Motors of the new periodicity would require to be provided in readiness for the change, and in many cases it would be impossible to get these motors delivered below ground and transmitted to their various destinations at the same time that the old motors were being taken out, except by arranging for periods of "shut down" of such duration as no colliery would be likely to be able to bear. It would involve practically the construction of duplicate engine houses or pump houses underground, so that the new plant could be erected when the periodicity was changed. The time taken to carry out such operations and the cost of them would clearly be prohibitive. It must be remembered that the transmission of motors and other heavy machinery along the underground roads must all be arranged and carried out in such a way as not to interfere with the ordinary working of the mine, and this in itself would be the cause of very serious delay. It might be taken therefore that the question of changing over the periodicity of an extensive system of supply was, practically speaking, quite impossible. It followed then, that in cases of the linking-up of power stations running at different periodicities, we should be often driven to the use of frequency changers; and all questions relating to them, therefore, became of great interest and importance. He knew of one instance of linking-up of power stations of different frequencies, where energy was sometimes transmitted in one direction and sometimes in the other, in which it had been thought necessary or desirable to construct the frequency changers with motor ends of the induction type, and with generator ends of the synchronous type, coupling one in the one direction and the other in the opposite direction, so that the induction end should always be the motor in one or other of the sets, according to the direction in which the load was being transmitted. He gathered from Mr. Peck's reply to a previous discussion that this was not really necessary, and that frequency changers with synchronous machines at both ends could be used with safety. The fear expressed in regard to this arrangement was apparently that one station might tend through overload to drop its speed slightly, and that the synchronous machines, allowing of no slip, would be liable to destruction by being called upon to suddenly transmit loads altogether beyond their capacity. This, however, seemed simply to point to the necessity for having the frequency changers of ample capacity to deal with any situation which might be likely to arise in practice, and for the use of reactances, automatic overload circuit-breakers, or other protective devices to prevent injury to the machines in case of abnormal conditions arising. Surely, after all, this question could not be really different from that of linking up two power stations of the same frequency, because the same question of the carrying capacity of the inter-connecting cable and of the necessity for protecting it against excessive and abnormal loads must obviously arise there. The fact of having to interpose running machinery no doubt tended to accentuate the point, but it existed just the same in either case.

Mr. C. G. Morley New (Cardiff Tramways) agreed that stations could be operated in parallel without difficulty, and for that reason he could not understand the emphasis laid by the author on speed regulation. He thought this could be safely left to engineers who had been running plant of all types and ages in parallel successfully. The power factor question might be troublesome, and he thought that at any rate as far as the station was concerned, this should be improved. Inter-connector voltage would have to be carefully considered as it was probable in many instances that the linking-up system of to-day would be the transmission system of the future, and extensions to generating stations only carried out in the most suitable places. He saw no reason why reliable automatic devices could not be installed for the purpose of earthing a system, in the event of the inter-connector opening. The alternative to a rotating machine, mentioned in paragraph 2, where out-of balance was not serious, was, he supposed, transforming by the Scott system, although it would be somewhat difficult to balance up single-phase plant on the two-phase side. He was interested in this system of transformation in dealing with single-phase load from a three-phase supply, and he was not at all satisfied as to the effect on, say, phase "A" during a severe overload, such as a fault on phase "B," seeing that the neutral point on the three-phase side was not fixed. The induction machine was the most stable, as the synchronous plant as often as not shut down when faults occurred outside. Difficulty might be obtained in getting suitable speeds for some frequency changes, as, for instance, in changing from 50 to 40 there is only one speed available.

Mr. A. T. Kinsey (Bristol Post Office Telephones) referred to the effect of earth current on telegraphic apparatus. Telephone engineers, as well as telegraph engineers, would view with great concern any transference of load from one power station to another if it meant that large alternating currents of high frequency would pass through the earth.

Mr. T. J. Nelson (Port Talbot), in a communication, remarked that the parallel working of two power stations having different frequencies had been successfully carried out in South Wales at the "New Markham pits" of the Tredegar Iron & Coal Co. These new pits had a supply from two existing stations which belonged to the company, and were situated at Tredegar and Oakdale, but which had different frequencies, Tredegar being 40 ∽ and Oakdale 50 ∽, and in order to be able to use either supply it was decided to instal frequency changers. These were used at the same time so as to interlink the two stations, enabling them to assist each other. Two motor-generators were installed, one with an induction machine on the 40 ∽ side and the other with an induction machine on the 50 ∽ side, thus enabling the two sets to float on both systems without loading either supply with wattless current. The synchronous machine could be excited to such a degree as to give wattless current equal to or exceeding that taken by the induction machine connected to the same 'bus-bars. The first set consisted of a 750 B.H.P. 600 revs. per min. three-phase 50 ∽ 6,600-volt induction slip-ring motor, rigidly coupled to one 500 kw. 0·8 power factor three-phase 40 ∽ 6,600-volt synchronous-type generator. The second set was similar, except that the slip-ring induction motor is designed for 40 ∽ and the synchronous generator for 50 ∽. Two liquid starters were provided for starting the induction motors, and two sets of resistance grids were permanently connected in series with the rotors of the induction motors to give approximately 1½ per cent. additional slip at full load. The provisions of slip-ring motors with adjustable permanent slip resistance provided, as it were, a flexible coupling between the two stations so connected. It was not necessary that the two stations should run in exact synchronism. The frequency of one station might vary approximately 2½ per cent. in either direction without overloading the frequency changer set. Suppose that the Tredegar station kept exactly a frequency of 40 cycles, if the machines at Oakdale were overloaded the speed of the prime movers would have a tendency to drop, but in the measure that its frequency dropped below 50 ∽, one of the frequency changers would transmit power from Tredegar. If the drop were approximately 2½ per cent., then 500 kw. would be transmitted in that direction, with one frequency changer running, and 1,000 kw. if both were in service. On the other hand, if the prime movers in Oakdale had a light load their speed would rise over the normal frequency, and power would be transmitted from Oakdale to Tredegar. The condition for the smooth working of the plant was, of course, that the governors of the prime movers in both the Tredegar and Oakdale stations should cause a few per cent. speed drop from no load to full load. The outside adjustable slip-ring resistance allowed the slip of the frequency changer to be brought into line with the regulation of the governors in both stations. This would not be possible with squirrel-cage motors.

Prof. David Robertson thought the figures given by Mr. Peck as to the size of frequency changer necessary for connecting two systems made one wonder whether it would not be better to change over the smaller system in every case in which it was at all possible to do so. Since the changer set involved both a motor and generator, if it had to be rated as high as 20 per cent. of the capacity of the smaller system, it would cost somewhere about 40 per cent. of the electrical equipment of the station, and would thus go quite a long way towards paying the station part of the cost of changing over to the standard frequency. It should not be forgotten that so long as it maintained its own frequency the smaller system would be handicapped whenever extensions were proposed by the fact that the frequency-changer capacity must be increased as well as the generating plant. In connection with the regulation of the engines, the governors would usually be adjusted from time to time while running, so as to give the desired load transference from one system to the other independently of the inherent regulation of the machines themselves. Mr. Peck's calculations on this subject would consequently apply, not to the total exchange of power, but to its deviation from the value to which it has been set.

Mr. PECK, in replying, said that where a station was isolated from other stations in the same district, due to a different frequency, it was worth considering when laying down new generating plant to couple two generators to one turbine, one generator to be wound for the frequency of the station and the other for the frequency of the district. There were probably a number of generating sets the steam end of which was badly out of date, while the generating end was in good condition. These old generators could be used in connection with new turbine plant for obtaining the desired frequency. The advantage of a set with two generators was that it could be driven by the turbine and supply current at either or both frequencies, or used as a frequency changer to take energy from either system and supply it to the other. Where two or more very large stations were connected together by short lengths of cable, it would be desirable to install reactance coils in the interconnecting lines, otherwise a short-circuit on any part of the system might produce serious disturbances and perhaps shut down all the generating station. He did not think devices which involved earthing the neutral point of a generating station through a spark-gap or automatic device were very reliable. It was better to earth the neutral point through a resistance. The Scott system of connection for changing from three phase to single phase would not give a balanced load on the three-phase circuit unless the two single-phase circuits were equally balanced. This then became in effect a two-phase system. As regards the effect of earth currents on telegraph and telephone circuits, it would be interesting if someone could give some definite information as to what value of currents and frequencies could be safely transmitted through the earth without interference.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(Continued from page 633.)

STATIC BALANCERS.

XXV. General Note on Static Balancers.

Having now dealt very fully with the theory and some of the applications of the rotary balancer, it remains to consider, much more briefly, and in conclusion, the static balancer. Reference has already been made to the special switchgear and additional amount of full-sized cable required when three-wire dynamos are run in parallel, as well as to the fact that, in cases where a static balancer is used on a long feeder, it may become necessary to install a middle wire booster in order to get level compounding at the distant end by making $B = 100R_m$, $V = 0$. This is a further item to the debit of the static balancer, as compared with the rotary balancer, which, by being designed to make the system overcompounded at its point of connection, will adjust the relative potentials of the three wires without additional apparatus.

A static balancer consists essentially of a choking coil of two or more phases connected to two or more equidistant points on an armature winding by means of slip-rings. In Fig. 30, A and B represent the two points connected by tappings to slip-rings, which are, by means of brushes, connected to the choking coil shown diagrammatically across a diameter of the armature. The terminals of the choking coil, which in the figure is equivalent to a two phase coil, with the two halves 180 deg. apart, have impressed on them an alternating difference of potential of an amount related to the continuous voltage of the dynamo by the usual rotary converter ratio, namely, assuming a sinusoidal flux curve, $1/\sqrt{2}$, or 0·707, for two-phase, $\sqrt{3}/2\sqrt{2}$, or 0·612, for three phase, $1/\sqrt{2}$, or 0·707, between diametrically opposite points, for four phase, and so on. This sets up a magnetising current in the windings of the choking coil, and if its inductance is great and its resistance small, this current will be practically wattless, and so will represent a very small loss. The diagram shows that the two ends A and B of the coil are always symmetrically placed relatively to the potential of the two commutator brushes of the dynamo, and, therefore, the middle point of the choking coil will always be at a potential midway between the potentials of the positive and negative poles of the dynamo. It, therefore, represents a point suitable for the attachment of the middle wire of the three-wire system, and the out of balance current, C_3, will divide amongst the phases of the choking coil, and get back into the armature windings by this path. The theory of the static balancer has been very fully treated at least twice; once in the "Elektrotechnische Zeitschrift," May 17 and 24, 1900, by Prof. A. Sengel, and again by Mr. C. C. Hawkins, in the "Journal" of the Institution of Electrical Engineers, Vol. XLV., pp. 704-721, 1910. Reference should be made for details of the theory to these two complete statements; their results only are quoted here.

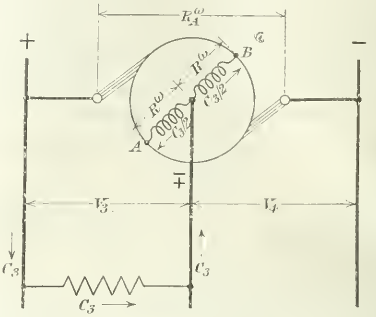

FIG. 30. – DIAGRAM OF THREE-WIRE SYSTEM WITH A STATIC BALANCER.

The static balancer is analogous to the case discussed earlier, where the two halves of the balancer have equal E.M.F.s in them and are of equal resistance. The current C_3 divides equally between the two halves, and the voltage V_3 on the more heavily loaded side drops by an amount dependent on the resistance of the balancer and the resistance of the armature winding. The fact that the inductance of the balancer is high and its resistance is low makes it comply with the condition for good balancing that both C, the light load current of the balancer, and R, its resistance, should be small, and this result is obtained, exactly as before, by introducing an E.M.F. into the balancer itself, which, acting along with the voltage of the dynamo, though now in a different way, keeps C small, while R may be as small as desired. This leads to good efficiency, and, as the unbalancing of the system can be made very small by keeping R small, the overload capacity of the arrangement is capable of being made very great without abnormally low values of V_3 resulting. This is an example of what has already been proved, that a dead resistance takes a large light load current, and leads to extreme undercompounding of the system if used as a balancer, whereas, if an E.M.F. comparable with the P.D. across the balancer terminals be introduced into the balancer itself, the efficiency will go right up and the compounding will very greatly improve. The actual value of the efficiency of the system is difficult to separate out from that of the main generator itself, as the static balancer is practically a resistance in series with the armature. It causes therefore merely a small decrease in the overall efficiency of the machine

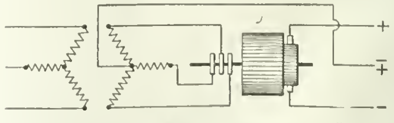

FIG. 31. DIAGRAM OF TRANSFORMER FOR ROTARY CONVERTER USED AS A STATIC BALANCER.

and the figures of each case are best considered from that point of view.

The number of phases in the choking coil need not be two only, but may be any usual number, such as 3, 4, or 6, or, generally, n. In these cases the current C_3 divides into n equal parts, each part traversing one phase, and superposing itself upon the alternating magnetising current already there. The larger the number of phases, the more evenly distributed are the parts into which C_3/n breaks up in the armature windings after entering at the tapping points, and so the less is the irregularity in heating. With a sufficient number of rings it is quite unnecessary to increase the size of a dynamo at all to enable it to give in practice its ordinary output, even when it is working as a three-wire dynamo with a static balancer carrying large out of balance currents, say up to 25 per cent., or even 33 per cent., of the full output in amperes of the dynamo as a maximum. When a rotary converter is used for feeding a three-wire network on its continuous-current side, the star point of the side of transformer connected to the alternating-current side of the rotary converter may be used as the connection point for the middle wire, and the transformer will act exactly like a static balancer ; a diagram of this is shown in Fig. 31. Fig. 32 shows a four-phase arrangement with a static balancer of the ordinary sort. In the two-phase arrangement it is possible to utilise the opposing directions of the two halves of the current in the balancer to cause their unidirectional magnetic effects, superposed on the alternating-current magnetisation, to neutralise each other by a suitable disposition of the coils, or portions of them, relatively to each other. This is also possible in the four-phase case, but in the three-phase case the three unidirectional magnetisations cannot neutralise each other if three simple coils are used on a three-legged core of the ordinary sort. Two modifications of the simple arrangement have been suggested to overcome this ; one is to wind each limb with a second winding, having a number of turns equal to one-third only of those of the choking coil winding, and to connect these three additional windings in series to the middle wire at one end and to the star point at the other end, so that they carry C_3 amperes, while the choking-coil windings carry $\frac{1}{3}C_3$ amperes only. If the additional windings are so connected that their ampere-turns oppose those set up by the direct current in the choking coil windings, then, as the two sets of ampere-turns are exactly equal, the net unidirectional magnetisation is zero. The second suggestion is to have the three phases in halves, coupled up as in Fig. 33, which shows that the continuous-current magnetisation would thereby be neutralised in each limb. Owing to the extra weight of copper involved by the first suggestion, and the loss of output, in the ratio $\sqrt{3}/2$, in the second case, due to the halves of phases connected in series with each other not being in phase with each other and so giving a total voltage per phase less, in the ratio $\sqrt{3}/2$, than twice the voltage of each portion, the three-phase balancer comes out relatively expensive, and it is preferable therefore to use four phases instead of three. Generally speaking, small dynamos are fitted with two phase balancers with two slip-rings, and the number of phases increases to 4, and eventually to 6, as the size of the generator increases. Beyond 6, the balancing does not greatly improve, and it is not economical to spend more money on extra rings and subdivision of windings on the balancer, as the advantage is so small.

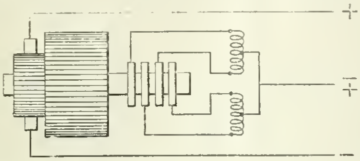

FIG. 32.—DIAGRAM OF THREE-WIRE DYNAMO WITH A FOUR-PHASE STATIC BALANCER.

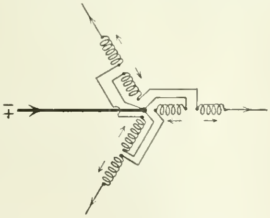

FIG. 33.—DIAGRAM OF ARRANGEMENT FOR NEUTRALISING CONTINUOUS-CURRENT MAGNETISATION IN A THREE-PHASE STATIC BALANCER.

XXVI. VOLTAGE VARIATION ON UNBALANCED LOADS WITH STATIC BALANCERS.

The expressions deduced by Sengel and Hawkins for the amount of undercompounding are not quite the same. They are both deduced from a consideration of the way in which the currents split up in the armature windings, but Sengel uses for the term containing the armature resistance the average value of that resistance as it concerns the various currents, integrated over the whole of the possible varieties of the position of the choking coil as shown in Fig. 30, while Hawkins points out that this is not a complete solution, because as a matter of fact the simple statement already made about the division of currents equally between the limbs of the balancer is found, when everything is taken into account, not to be exactly true, and the distribution of currents in the armature is an extremely complicated one. Hawkins, therefore, suggests a value more nearly in accordance with the actual distribution of current, taking also into consideration the fact that C_3 is not strictly a continuous current, but a slightly pulsating one, and arrives at a somewhat simpler expression than Sengel's. The two expressions denote in each case the amount by which the potential of the middle wire is different from the true mean between the outers, giving thus a clue to the character of the compounding of the system. They are as follows :—

Sengel gives $(C_3/n)\{R+(n/12+1/3n)R_A\}$ volts ;
Hawkins gives $(C_3/n)\{R+\frac{1}{2}R_A\}$ volts,

where C_3 is the total out of balance current, n is the number of phases in the balancer, R is the resistance per phase of the balancer, and R_A is the resistance of the armature winding, measured from one set of brushes to the other on the commutator.

The more heavily loaded side has the lower voltage, hence V_3 is less than V by the above amount. But $V_3=V(1+q/100)$, hence $V+qV/100=V$ minus the above amount, and

$$qV/100=-(C_3/n)\{R+(n/12+1/3n)R_A\} \qquad \text{(Sengel),}$$

or

$$qV/100=-(C_3/n)\{R+\tfrac{1}{2}R_A\} \qquad \text{(Hawkins).}$$

$$\text{Hence } B=q/C_3=-(100/V)\left\{\frac{1}{n}R+\left(\frac{1}{12}+\frac{1}{3n^2}\right)R_A\right\} \quad \text{(Sengel),}$$

$$\text{or} \qquad B=q/C_3=-(100/V)\left\{\frac{1}{n}R+\frac{1}{2n}R_A\right\} \qquad \text{(Hawkins).}$$

This means that a static balancer necessarily gives straight line undercompounding of the system, which, if desired, may be completely compensated by a middle wire booster. As the term R/n will remain more or less independent of n, as n increases, for any given case, if the copper on the balancer is worked at a more or less constant density, making the volts lost per limb approximately constant, the change in B, as the value of n increases, is mainly due to the change in the R_A term, and this means that increasing the phases makes the compounding more nearly level by causing a better distribution of current in the armature windings, this being equivalent to a reduction of armature resistance as far as the total of C_3 is concerned. The expression given by Hawkins gives higher values at first, but the two forms cross at $n=3+\sqrt{5}=5{\cdot}23$. A very brief examination shows that the curves of the two functions are very flat after $n=4$ or 6, and hence this is the maximum number of phases it is worth while to use.

To take an actual case, say $2V=400$, $R_A=0·0125^\omega$, including everything, $R=0·030^\omega$, $n=4$.

$$\begin{aligned}\text{Then } B=q\,C_3 &= -(100/200)\{0·0075+(5/48)0·0125\},\\ &= -0·5\,\{0·0075+0·0013\} = -0·5\,\{0·0088\},\\ &= -0·00440 \text{ (Sengel)},\end{aligned}$$

$$\begin{aligned}\text{or}\quad B=q\,C_3 &= -(100/200)\{0·0075+0·0125/8\}\\ &= -0·5\{0·0075+0·00156\}\\ &= -0·5\,\{0·00906\} = -0·00453 \quad \text{(Hawkins)}.\end{aligned}$$

This shows that the results derived from the two expressions are very similar. The figures apply to a 250 kw. generator, with a static balancer to deal with 33 per cent. of the total current in the middle wire, so that C_3 maximum$=(250{,}000/400)\times 0·33=208$ amperes. For this value, $q=-0·95$ or just under 1 per cent., so that at the maximum deviation from 200 volts, $V_3=198$ and $V_4=202$, and this was confirmed by an actual test. It shows that very good results may be obtained from a static balancer in practice, and makes it clear that unless a long feeder is in question, a middle wire booster is not necessary to compensate for B being negative, except possibly in a case where the resistances are relatively high for the output of the machine, say in a very slow speed dynamo with a large inherent drop. Even then the balancer could be made larger than usual so as to have R small, which would reduce the total resistance causing the drop, and therefore improve the compounding sufficiently to require only a small compensating boost in the middle wire to produce level compounding of the system as a whole.

The design of static balancers is no part of the present discussion, but it may be mentioned in passing that they must be calculated so as to keep down the magnetising current to as small a value as possible, and hence must be worked at a relatively low saturation in the iron; care must be taken that, if the continuous-current magnetisation is not completely neutralised, any additional losses introduced as a consequence of this do not overheat the balancer; and the copper section must be duly proportioned to give a value of R suitable for working with the value of R_A in the case in question. The periodicity for which the alternating current part of the calculation must be made is, naturally, that of the main dynamo, namely, $pN/60$, where p is the number of pole pairs, and N is the number of revolutions per minute. This is of the order of 15 to 25 periods per second in most of the cases which ordinarily occur.

XXVII. General Note on Tapping Armature Windings for Connections to Static Balancers.

The static balancer is connected to certain definite points on the armature winding, the position of which depends on the nature of the winding. The general principles of armature windings are well known; however varied they may be, they all consist of coils arranged so as to have a pairs of circuits between positive and negative brushes, and so as to be suitable for running in a field having p pairs of poles. Each circuit carries $1/2a$ of the total armature current; each pair of circuits carries $1/a$ of the total; and if a be greater than unity, the various pairs of circuits are in parallel with each other, each taking an equal share of the total current. Each pair of circuits may, therefore, be considered as a more or less independent winding, and each must be similarly tapped for connection to the slip-rings, so that each slip-ring has a tappings [illegible] and in this way takes current equally from each of the circuits. Unless equipotential points on the a circuits can be [illegible], equalising currents will flow in the connections to the slip-rings, causing losses, if not actual damage, in the [illegible], and reducing its normal output on account of overheating. All this has been very fully treated by Arnold in "Die Gleichstrommaschine," but in practice, as has been clearly shown by Dr. S. P. Smith in his Paper on "The Shape of the Pressure Wave in Electrical Machinery," published in the "Journal" of the Institution of Electrical Engineers, Vol. LIII, pp. 205–238, 1915, the proper course for safety is [illegible] windings which are truly symmetrical, that is, those in which the a pairs of circuits are all exactly the same as each other in regard to their potential. The simple rule for this is that when the number of slots, s, and the number of pole pairs, p, are both divisible by a without remainder, there will be a identical pairs of circuits in a closed double layer winding, such as is ordinarily used on a continuous-current armature. This is primarily true for windings with two coil sides per slot, where s is equal to K, the number of commutator bars, but Dr. Smith also points out that when there are more than two coil sides per slot, and no idle coils, the winding is still symmetrical if s/a is an integer, the relation between s and K now being that K/s is half the number of coil sides in each slot, or, in other words, is equal to the number of coil sides per layer in each slot.

As is also well known, an armature winding may be made up of more than one independently closed parts, for example, a sextuple winding may be singly re-entrant, doubly re-entrant, triply re-entrant or sextuply re-entrant. Dr. Smith, in the Paper above referred to, also gives the rule for the number of closings in any winding; if the commutator pitch, Y_k, and the number of commutator bars, K, have h as their highest common factor, the whole winding has h closings, giving h independent windings on the armature, each with K/h coils. These h windings are identical, in the sense already used, if the conditions of symmetry are satisfied; these conditions are independent of the number of closings.

For an n-phase static balancer, there are n tappings to each of the a pairs of circuits, and the tappings on each pair of circuits must divide the coils in it into n equal groups of coils connected consecutively to each other. Regarding each pair of circuits as, according to the usual convention, subtending a total "electrical" angle 2π, each of the n phases will, when selected in this way, subtend an "electrical" angle $2\pi/n$, and, as there are a tappings connected to each slip-ring, there will be a such groups of coils in parallel between successive rings. In order to ensure equal voltages between rings, as well as equal loading of the various circuits, it is necessary that the groups of coils be all alike in number and symmetrically situated in the field. The former condition is complied with when K/na is a whole number, as there are n groups of coils in each of the a pairs of circuits, and therefore K/na is the number of coils per phase. Slight divergences from this are frequently necessary, and, if kept within small limits, do not seriously affect the working of the balancer in practice. Vidmar, in "Elektrotechnik und Maschinenbau," Dec. 3, 1911, investigates the effect of inequality, which causes the potential of the star point of the balancer to be no longer the same as that of the middle point of the potential diagram of the aramture, so that actually there is a small rotating E.M.F. introduced into the middle wire, and this may cause enough flickering in lights fed from the balancer to be, at low periodicities, actually noticeable. For a three-phase case with unequal division, in which, as the remainder on dividing any number by three is either 1 or 2, two of the groups of coils are always equal while the third is one less or greater than each of the other two, the value of V, the main voltage between outer and middle wire, fluctuates between $V+r$ and $V-r$, where r is the radius of the circle on which the star point rotates round the true neutral, so that the variation, expressed as a percentage of V, is $200r/V$. Calling this variation δ, it is shown that

$$\delta=200(\varepsilon^2-1) \text{ or } 200(1-\varepsilon^2), \text{ according as } \varepsilon \text{ is } > \text{ or } < 1,$$

where ε is

$$\frac{\operatorname{Sin}\left(\dfrac{180^\circ\times\text{number of coils in the single unequal group}}{\text{total number of coils.}}\right)}{\operatorname{Sin}\left(\dfrac{180^\circ\times\text{number of coils in each of the two equal groups}}{\text{total number of coils.}}\right)}.$$

For example, in a dynamo with 206 coils, the groups would be 69, 69, and 68, so that

$$\varepsilon=\frac{\sin(180^\circ\times 68/206)}{\sin(180^\circ\times 69/206)}=\frac{\sin 59·4^\circ}{\sin 60·3^\circ},$$

and

$$\delta=200[1-(\sin 59·4^\circ/\sin 60·3^\circ)^2]=200[1-0·9822]=3·56 \text{ p.c.}$$

This amount would, at a sufficiently low periodicity, cause objectionable flickering, and, to get over this, Vidmar suggests altering the number of turns on one limb of the balancer so as to make the star point coincide with the true neutral, and gives a method of ascertaining by how much the winding should be altered. While cases of exaggerated trouble do not often appear in practice, it is well to choose armature windings, wherever possible, which lend themselves to equal division. In small machines, where each coil may consist of more than one turn, it is possible to have fractional parts of coils by connecting to a suitable point on the copper of the coil itself, and, even with one-turn coils, a half coil may always be got by coupling the tapping to the back or front end of the winding as may be required. The general rule, then, is to connect each ring to each pair of circuits in such a way as to have K/na coils between tappings, and, if exact and symmetrical division cannot be obtained, to depart by the smallest possible amount from ideal grouping.

(*To be concluded.*)

L.C.C. TRAMWAY ADMINISTRATION.

(*Concluded from page* 635.)

In regard to the Electrical Branch the Highways Committee reported as follows:—

The employés in the branch are over 600, and in normal times over 700; and the salaries and wages paid in the branch amount to about £1,500 a week. The value of plant and machinery under his charge may be estimated roughly at £750,000, the annual expenditure on revenue account under his direction being approximately £300,000. Since April, 1914, the Council has paid a retaining fee of £500 a year to consulting electrical engineers, such fee covering all references, reports and consultations in connection with the electrical engineering of the tramways undertaking. In the case of new constructive work a commission is paid to the consulting engineers on the certified cost of plant. Up to 1910 the head of the electrical section was designated electrical engineer, his salary being £1,200 a year; but upon his resignation an electrical assistant (£800 a year) was placed in charge of the electrical work. We are strongly of opinion that the position of electrical engineer should be reverted to, and that the salary to be assigned thereto should be from £1,200 to £1,500 a year. A lower scale of salary is in our judgment inadequate for an officer competent to have charge of the whole of the electrical work of the undertaking, including responsibility for the safe and efficient working of the extensive, costly and delicate plant and machinery at the power station and sub-stations, and to advise on the many important matters arising in connection with the electrical work. Our Special Sub-committee which inquired into staff matters affecting the electrical section communicated to us on April 22, 1915, their opinion (arrived at in February, 1914) that an electrical engineer should be appointed, on a vacancy occurring (as it has since done) in the position of electrical assistant, and that the salary of the electrical engineer should be from £1,200 to £1,500 a year. The electrical engineer should assist in the work of drawing up specifications for the supply of electrical material for the rolling stock section.

Assistant to Electrical Engineer.—The question of the appointment of an assistant to the electrical engineer, to take charge of the branch in his absence, should be deferred until the electrical engineer takes up his duties. The work of the electrical branch should be organised broadly on the basis of the organisation of the present electrical section. The branch should be divided into three sections, viz. (1) the power station section, (2) the distribution (southern) section and (3) the distribution (northern) section. The designation of the superintendent of the Greenwich generating station should be altered to power station engineer. He would be the principal officer in this section, and we consider that the salary to be assigned to the position should be from £500 to £700 a year. The designation of the resident electrical superintendents (northern and southern sections), the principal officers in the sections, should be altered to distribution engineers and the salary should be from £400 to £600 a year. On a vacancy occurring in either of the positions of distribution engineer, consideration should be given to the desirableness of placing distribution work under one officer. The Sub-Committee have expressed their appreciation, which we fully share, of the valuable assistance given to them in their consideration of questions arising in connection with the electrical work of the department, by Mr. J. H. Rider, formerly electrical engineer in the department, whose advice in many important matters greatly facilitated their work.

Rolling Stock Branch.

Rolling Stock Engineer.—The officer in charge of the rolling stock branch, which will remain practically unchanged as regards the scope of its activities, supervises the maintenance, washing, repair and renewal of all cars and other vehicles operated by the department and the upkeep of the central car repair depot and other depots. He reports on matters connected with rolling stock and staff, prepares estimates, &c., for new plant and machinery, new rolling stock, stores and replace parts for rolling stock, &c. The number of employees in the branch is approximately 2,200, and in normal times nearly 3,000, the salaries and wages paid in the branch amounting to over £4,000 a week. The expenditure on revenue account in respect of the work of the branch is about £325,000 a year. The general considerations already urged as to the inadequacy of the salaries assigned to some of the positions at the head of sections applies to the position of head of this branch, and we consider that the salary to be assigned to the position should be from £1,000 to £1,200 a year. The work of the rolling stock branch should be divided under two main sections, viz., (1) rolling stock section, and (2) repair depot section. The officer in charge of the former section should be designated rolling stock superintendent and should be directly responsible to the rolling stock engineer. The salary to be assigned to the position of rolling stock superintendent should be from £400 to £600 a year. Two technical assistants engaged in the supervision of car depots should be attached to the rolling stock superintendent as personal staff. There are about 70 foremen and intermediate foremen of car depots, with rates of pay ranging from 50s. to 80s. a week. We think the number of classes should be reduced and the minimum pay of a higher class should not be less than the maximum pay of a lower class. The officer in charge of the repair depot section should be designated superintendent of the central car repair depot and should be directly responsible to the rolling stock engineer. The salary to be assigned to the position should be from £400 to £600 a year. An officer of superior standing at the central car repair depot should reside at or near the depot.

Permanent-Way Branch.

Permanent-Way Engineer.—The permanent-way engineer supervises the repair and renewal of all the track on the 147 street miles of tramway operated by the Council; the installation, maintenance and renewal of the tracks in the depot. The number of employees is 800, compared with 1,400 at normal times, the salaries and wages paid in the branch when working under normal conditions exceeding £2,000 a week. In a normal year the expenditure on revenue account in respect of work undertaken to the permanent-way amounts to about £240,000. We propose, having regard to the qualifications and experience which should be regarded as necessary, that the salary to be assigned to the position of permanent-way engineer should be from £800 to £1,000 a year. We think, however, that whilst making provision in the ultimate organisation for such a position, it should not be filled at present. The main organisation of the present permanent-way section should be preserved in the permanent-way branch. To this branch should be transferred the work of the present building section and also work connected with the conduits at present undertaken in the electrical section. The branch should accordingly be divided into three sections, viz. (1) permanent-way (southern) section, (2) permanent-way (northern) section and (3) building section. Each of the permanent-way sections (southern and northern) should remain, as heretofore, under the direction of an assistant permanent-way engineer, each under the immediate supervision of the permanent-way engineer. The scale of salary for the position of assistant permanent-way engineer should be from £300 to £400 a year. The number of employees of the building section in normal times exceeds 100, the value of the work carried out being about £13,000 a year. We are satisfied that under present conditions the system now in operation should be adhered to. The building section can most conveniently be placed in the permanent-way branch, and the building superintendent should be under the supervision of the permanent-way engineer.

General Branch.

The departmental work not allocated to the four main branches already discussed can be organised conveniently in a general branch. The head of this branch, for whom we suggest the designation of chief clerk, would undertake the duties hitherto falling to the general assistant and would also in present circumstances, supervise sections dealing with accounts, stores, ticket checking, claims and printing. We propose that the clerical staff working in all branches of the department shall, for purposes of discipline and promotion, be dealt with as part of the general branch. We also propose that the drawing office staff shall be distributed amongst the various technical and professional branches; and that a technical assistant in the first class, who has acted as a personal assistant to the chief officer, be excluded from branch classification and attached as personal assistant to the chief officer. The arrangement under which Messrs. W. H. Smith and Son act as sole agents of the Council for obtaining advertisements on the Council's cars renders unnecessary the present advertising section of the department. We accordingly recommend the abolition of the position of advertising assistant.

Pending the ultimate transfer to the department of the comptroller of the Council of the accountancy work now undertaken in the tramways department, the accountant's work should be carried out in an accounts section of the general branch by the tramways accountant, and subject to the general direction of the comptroller of the Council. Subject to any change which may result from this inquiry the present stores branch of the accountant's section should be a separate section in the general branch. The tramways accountant has supervision of certain work, connected with cash counting and distributing, which it is not at present proposed to remove from the tramways department upon the transfer of accountancy work to the department of the comptroller of the Council. We propose the allocation to the general branch of the work of ticket checking at present undertaken in a separate section. The organisation of this branch must be regarded as provisional.

Financial Effect of Re-organisation.

The ultimate additional expenditure on re-organisation, in respect of the appointments and promotions provided for under our scheme, will be £5,600 a year. Beyond this figure there may be some additional expenditure resulting from the settlement of the salary of the chief clerk. Further, when the development section of the traffic branch is formed, in addition to the new positions provided for in the scheme additional staff will be required, and will probably be furnished in the first instance by transfers within the department. The work of the section will involve fresh charges on revenue account, for example, expenditure on advertising the tramways. No expenditure, however, on such an object can be incurred without the express sanction of the Council. Having regard to present conditions it has been our object to determine the re-organisation on a basis involving the smallest increase of expenditure compatible with efficiency. We have, indeed, no doubt that the proposed additional expenditure will be highly remunerative

Summary of Recommendations.

(*a*) That the tramways department be re-organised on the basis of the allocation of the work of the department amongst five branches, viz.—(1) traffic branch, (2) electrical branch, (3) rolling stock branch, (4) permanent-way branch, (5) general branch, and the devolution by the chief officer of tramways of duties and responsibilities to the higher subordinate officers upon general lines.

(*b*) That a traffic manager be appointed in the tramways department at a salary of £1,200, rising by annual increments of £50 to £1,500 a year.

(*c*) That on a vacancy occurring in the position of deputy chief officer of tramways, the position be abolished.

(*d*) That the position, now vacant, of electrical assistant be abolished.

(*e*) That an electrical engineer be appointed in the tramways department at a salary of £1,200, rising by annual increments of £50 to £1,500 a year.

(*f*) That a rolling stock engineer be appointed in the tramways department, at a salary of £1,000, rising by annual increments of £50 to £1,200 a year, and that the position be not filled at present.

(*g*) That on the appointment of a rolling stock engineer the present position of rolling stock superintendent be abolished.

(*h*) That in the ultimate organisation the salary assigned to the position of permanent-way engineer in the tramways department be from £800 by annual increments of £50 to £1,000 a year.

(*i*) That a chief clerk be appointed in the tramways department.

(*j*) That positions as follows be established in the traffic branch at the yearly salaries specified :—development superintendent (from £500 by four annual increments of £25 and four of £50 to £800 a year) ; publicity assistant (from £300 by annual increments of £25 to £400 a year) ; an officer in charge of matters relating to fares and independent traffic check (designation to be determined) (from £300 by annual increments of £25 to £400 a year) ; time-tables assistant (from £250 by annual increments of £12 10s. to £300 a year).

(*k*) That an operation superintendent (from £500 by four annual increments of £25 and two of £50 to £700 a year) be appointed in the traffic branch ; and that the position of traffic assistant be abolished.

(*l*) That the designation of the two district traffic superintendents be altered to divisional superintendents ; and that the salary assigned to each position in the ultimate organisation be from £300 by annual increments of £25 to £400 a year.

(*m*) That the designation of certain positions in the electrical branch be altered, and salaries for the positions in the ultimate organisation assigned, as follows :—superintendent of Greenwich generating station, to be altered to power station engineer at £500 by four annual increments of £25 and two of £50 to £700 a year ; resident electrical superintendents (southern and northern sections) to be distribution engineers at £400 rising by annual increments of £25 to £600 a year.

(*n*) That on a vacancy occurring in either of the positions of distribution engineer the Highways Committee do consider as to the desirableness of placing distribution work under one officer.

(*o*) That upon an appointment being made to the position of rolling stock engineer the position of assistant rolling stock superintendent be abolished, a position of rolling stock superintendent (from £400 by annual increments of £25 to £600 a year) established, and a salary of £400 by annual increments of £25 to £600 a year assigned to the position of superintendent of the central car repair depot.

(*p*) That in the ultimate organisation the salary assigned to each of the two positions of assistant permanent-way engineer be from £300 by annual increments of £25 to £400 a year.

(*q*) That the position of advertising assistant be abolished.

(*r*) That an assistant in the first-class be attached as a personal assistant to the chief officer of tramways.

(*s*) That any officer or employee in the tramways department affected by the decision of an officer in that department, other than the chief officer of tramways, in a matter of discipline do have the right of appeal to the chief officer personally.

(*t*) That the heads of branches in the tramways department and certain officers acting under them be responsible for the carrying out of such duties in connection with executive work, the engagement of staff and disciplinary matters, as may be assigned to them by the chief officer of tramways and in accordance with rules of the Highways Committee.

(*u*) That where in a matter which is the subject of report to the Highways Committee, there is a conflict of opinion on a technical or professional question between the chief officer of tramways and an officer occupying the position as determined under the re-organisation scheme of head of a technical or professional branch of the tramways department the report to the Committee shall disclose the opinion of the head of the branch.

(*v*) That the heads of branches in the tramways department be permitted to carry on in their own names correspondence of a routine character not requiring the personal attention of the chief officer of tramways, provided that such correspondence shall be subject to the direction of the chief officer.

(*w*) That officers having the supervision of sections of the work of the tramways department do submit each year to the heads of their respective branches brief reports on the work of their sections ; that the heads of branches do submit each year to the chief officer of tramways reports on the work of their respective branches ; and that the chief officer do advert to such reports when submitting to the Committee his annual report at the time of the submission of the annual accounts.

(*x*) That the heads of branches in the tramways department do keep the records of service of the employees in their respective branches, except the records of service of officers appointed by resolution of the Council.

(*y*) That at the earliest convenient time that part of the accountancy work which is now done in the tramways department be transferred to the department of the comptroller of the Council, and that pending such transfer the work do continue to be done in the tramways department, subject to the general direction of the comptroller of the Council.

(*z*) That the weekly rates of pay of day foremen, night foremen and intermediate foremen of car depots in the tramways department be as follows :—

Approx. weekly car service	Day foremen.							Night foremen.							Intermediate foremen.					
	£	s.	d.		£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.		£	s.
Above 900	3	12	6	to	4	0	0	3	7	6	to	3	12	6	3	0	0	to	3	5
450 to 900	3	5	0	,,	3	10	0	3	2	6	,,	3	5	0	2	17	6	,,	3	0
Up to 450	3	0	0	,,	3	2	6	2	17	6	,,	3	0	0	2	12	6	,,	2	15

and that where a house is provided the value thereof be calculated at 5s. a week and reckoned on that basis as part wages.

(*aa*) That the rate of pay of district superintendents in the traffic branch of the tramways department be from 60s. to 90s. a week.

THE ENGINEERS' CLUB: WHAT IT IS, AND WHAT IT MIGHT BE.*

BY EDMUND L. HILL.

An old puzzle among the schoolmen used to be: "If an irresistible force meets an immovable body, what will happen ?" The answer, correct I believe up to last December, was "Wait and see." But when the irrestible craving for an engineers' club came up against the almost immovable inertia of the engineers of Manchester the answer was Daniel Adamson, backed up by our good friends Walker and Brady, of the "Manchester Guardian." Then things happened, and happened quickly. It reminds me of the story of the bricklayer whose foreman swore at him because the wall he was building was leaning over to one side. "It's not plumb," said the foreman. The bricklayer looked at his work. "Not plumb ?" said he. "It's plumb and a bit over." Even so, the combined forces of Daniel Adamson, Walker and Brady were super-forces, and it is due to their tireless energy and restless enthusiasm that we have our Club to-day.

The proposal to start a club for engineers in by far the greatest engineering centre of the whole world was for some years a pious hope: No one would bell the cat. The possibility of an engineers' club has been discussed over and over again at a certain lunch table at the Midland Hotel. At last when the irresistible forces had made the immovable masses so jolly uncomfortable they had to shift. The club opened on November 7, 1913, with 650 members, and was an immediate success. In less than nine months war broke out, and we had to settle down to new conditions. Some members resigned, some possible members did not join. Other members refrained from using the club because they thought that they were ruined. The majority, I am glad to say, kept a stiff upper lip and carried on. We went through one horrible year with a deficit each month, and with only hope and faith left to illumine the dark path that we were treading.

Many of our members paid their yearly three guineas, as they felt that they ought to continue to support the club, as if any club could be kept going on its subscriptions, which are always too small, without the help of its takings, which are never large enough to satisfy its insatiable requirements.

While taking an affectionate farewell of the minute book, I could not help smiling at the seven suggested names for our club: "The Engineers' Club," "The Joule Club," "The Industry Club," "Carlton," "Technical Societies' Club," "Technical Club," "The Club." What a perfect example of the "alpha and omega"—the beginning and the end. We took the first name, "The Engineers' Club." We shall soon have the last, "The Club," just as one talks of the House of Commons as the House.

Since the war started the Club has been run under very exceptional and difficult conditions. Salaries and wages have had to be increased, while the cost of everything we buy—food, drink, stores, washing and sundries—have advanced in some cases more than 100 per cent. The restrictions in the hours of drinking has hit us, as it has done all clubs. In order to economise, the hours of the opening of the Club have been shortened, and the serving of hot meals in the dining rooms has been somewhat reduced in the evenings, and this has caused a certain amount of grumbling among some of our members.

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* Opening of discussion at the Engineers' Club, Manchester, Feb. 20, 1917. Abstract. Mr. G. D. Seaton in the chair.

In spite of all these difficulties and the increase in costs, the Club has turned a 1915 deficit of £309 into a 1916 profit of £269, a change for the better of over £578, without taking into account one penny of the £461 liberally subscribed by members towards the deficit fund.

One would naturally ask how this marked improvement in our finances has come about. These are three good reasons: Our manager and our staff have worked most loyally and well; our members, in the old rôle of the satisfied consumer, have used the club more and more; and our membership, which at the end of 1915 was 683, to-day is 764. There are some additional temporary members whom we are proud to welcome. By a resolution of the General Committee, some 30 gentlemen, engineer officers in the Navy or Army, or holding responsible positions in the Ministry of Munitions, have been elected temporary members, and by doing this, as I know you will agree, the Club has honoured itself. The Club has also done itself honour in electing as its first honorary member the Right Hon. the Lord Mayor of Manchester, Alderman T. Smethurst, who has shown the greatest interest in and has been of the greatest use to the engineering profession.

In reckoning our membership week by week and month by month I never lost sight of our losses; the figures I have just given are net. Club losses in war time are greater than in peace. Certain members resign for great and sufficient reasons—leaving the district, and so on; others have resignation thrust upon them as undesirable alien enemies. I wish I could complete the old simile and say that others are born great members of the Club.

Although our membership is to-day 764, I can never forget that in this great district, within 40 or 50 miles of Manchester, the engineering hub of the world, there must be at least 3,000 engineers who are eligible for membership, and should be made to join the club. Engineers—as our Club has proved—are the most "clubbable" of men. For generations almost they have been institutionalists, but not clubbists.

Our Club has also done most useful work in breaking down competitive barriers. Four years ago when we saw a competitor in the street we were Pharisees, and passed by on the other side. He was usually a rogue and always a liar, while we were invariably it, spelt capital I, capital T. After our Club started we found that we were not IT spelt with capitals, and that our competitor was not the other kind of being.

When, as once happened to me, a competitor, in one day, takes a £30,000 order that was yours, stands you a drink on the strength of it—at a meal, of course—gives you 60 in a 100 and beats you at billiards, and then, quite as an after-thought, shows you how all your ideas of correct leads at auction bridge were exploded years ago—well, if you can't love him at once, you must respect him. With respect comes confidence, and then, if we are not fools, we meet and talk frankly together. How can we help each other instead of cutting each other's throats? Conditions to-day make mutual help and co-operation imperative, and our Club makes them possible. It is up to us to see that we bring this happy state of affairs about.

We—the members of the Club—can do much to further this, but to do it effectively we must be strong in numbers as we are strong in faith. There cannot be a single member of our Club who does not know at least one engineer in the district who is not but who ought to be a member.

With a membership of 3,000 to 4,000 what could not the Club do? It could build, or have built for it, a suitable dwelling house. Just before the war our friend W. T. Anderson was hard at work on the proposed housing scheme for the learned societies of Manchester. It was hoped that a large part of the premises immediately behind us here might be taken. A fine lecture hall, a library and committee rooms for the different societies and institutions would have been provided, and connection would have been made with the Club through what is now the card room. Dr. Hopkinson, with great generosity, came to our help financially, Anderson and others worked very hard, but the war came and the whole matter had to be shelved. Let us see to it that it is not postponed indefinitely.

We must help our Club in every way; we must use it more ourselves, we must get other engineers to join and see that they use it. We must strengthen our finances in every possible way. Of all the great truths that the war has taught and is teaching us, the greatest to my mind is this: It is "engineering"—mainly "British engineering," home and overseas—that is saving and will save the world. We are justly proud of the large share that we are taking in this noble work. Peace is coming—surely, if slowly—and for us and our brave Allies it will be peace with honour and great and worthy results.

We, the engineers of Manchester, will have done our full share in men and blood and brains and work and money in bringing that desired peace about.

Let us now prepare for that peace, and let us determine that one of the things that we must do as soon as possible after it comes is to provide in Manchester a fit and abiding habitation for the best and noblest profession in the world.

DISCUSSION.

Alderman W. Walker, in opening the discussion, called attention to the wider work of the club in the engineering world. It was already the home of the local section of the Institution of Electrical Engineers in Manchester, the meetings of which were held in comparative comfort and were well attended on that account. He endorsed Mr. Hill's references to the value of the club as a means of breaking down the barriers between competitors, men whom membership of the club enabled to sit round one table, and, though none the less rivals, their rivalry was now conducted in a friendly spirit. The club had nothing like enough members yet, and possibly the time would come when it would be a necessity for engineers to join as a matter of status. The idea of a larger building with the club as a central feature was developing and would grow. The club would also continue its good work of putting British engineering at the forefront of industry, and in the wider aspect of its work would arrange a programme which, among other things, would include the development of new ideas and the regulation of markets.

Mr. F. Foster urged the necessity for a central building in which not only would the Engineers' Club be quartered and the technical societies housed, but engineering firms would have their offices. Such a building in a great centre like Manchester might be known as the Engineering Building, and to it all interested in and concerned with engineering might be referred. It would be a good step forward if a company were formed, land were purchased and an architect appointed to prepare the designs for a suitable building.

Mr. S. L Pearce, as a member of the first Committee of the club, spoke of some of its early difficulties and the manner with which these had been surmounted. The preliminary tendency for the club to lag was soon overcome, and there could now be no doubt that larger premises would have to be taken. As an earnest of this could be quoted the fact that the membership had steadily increased in spite of the war.

Mr. J. C. Maxwell Garnett, in commenting upon the prospective expansion of the club, referred to the proposal to establish a commercial library in Manchester, and remarked that there would be an immediate need for a new wing for a technical library. Such a suggestion might very well be developed in connection with an engineering building scheme.

Mr. H. T. Wilkinson (the newly appointed honorary secretary) emphasised the fact that the club was the first social club of engineers in the country; but it had, none the less, done a large amount of organising work which would have a useful effect upon industry. In particular it had formed sectional groups of engineers which had done, and were doing, work which could not be undertaken by the professional institutions. Such grouping would have an undoubted value in a political sense, and in the future could bring engineering influence to bear at times of elections. The club idea for engineers was already extending, and there were rumours that Glasgow and Birmingham engineers were becoming active in the right direction. With the development of the Engineers' Club in other centres than Manchester would come interchangeability of membership and increased co-operation among engineers throughout the country.

Mr. H. Allcock expressed pleasure at the lecturer's reference to the "housing scheme," for which Mr. W. T. Anderson (who was, unfortunately, absent from the debate owing to illness) had done so much. A great deal of the preliminaries necessary to the bringing of this scheme to fruition had already been dealt with. He also hoped that his own pet hobby, the adoption of the decimal system, would be one of the schemes to be dealt with in the broader work of the club. The Manchester Decimal Association had practically a "cut and dried" scheme which had received general approval, and was ready to lift down from the shelf when the time came.

Mr. J. Drummond Paton appealed for the consideration of a scheme by which the better class of workman could enjoy association, if not full membership, of the Engineers' Club. Such a scheme should embrace the colonies, and should make it possible for overseas engineers visiting the mother country to derive benefit from there being an open door at the Engineers' Club, no matter in what district it might be. It would be advantageous to co-opt prominent colonial men like Mr. Hughes to help give publicity to such a plan. In regard to a common engineering building, he thought one of the first things to do was to get guarantees from engineers to take so much office space; this step would influence financial backing.

Mr. F. Webb appealed for the adoption of some method whereby the club could be connected with the new Royal Exchange building in Manchester. At present there were not enough engine builder members of the club, these engineers having still "their little haunts," from which it might be difficult to move them. Probably the best way was to get the sons of such engineers to become members of the club.

Mr. G. D. Seaton, from the chair, said that the wider policy of the club was receiving close attention, and care was being taken to keep young blood on the committees.

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STANDARDISATION.

It is pleasing to note that once again the engineering institutions are contributing towards the expenses incurred by the British Engineering Standards Committee. As each year passes, the work of this committee becomes increasingly important. Such being the case it is fitting that every encouragement should be given to the work. Great as the results achieved have been it is generally admitted by those familiar with the work of the committee that much remains to be accomplished. Hitherto all the specifications have been in the English language, and the need for translating these specifications into foreign languages has long been recognised. The engineering institutions are helping to defray the heavy cost to be incurred in the preparation of these translations.

Although it is the manufacturer who will derive the profit from the circulation of these specifications, the engineering institutions will, nevertheless, benefit to a very large extent. But we are certain that no thought of gain actuated the institutions in contributing towards the cost of this great work. For many years it has been a characteristic of these institutions to give their support to the Standards Committee without hope or thought of reward other than that which is bound up with all good work; and, in large measure, it is due to their influence that the work of the Committee bears a hall-mark of its own.

In the past, although many manufacturers and machinery users have made large contributions to the funds, we feel that neither the manufacturer, nor the user, nor the consulting engineer have been as generous as they might have been. To a certain extent this is easily understood, for when one finds that large sums of money are being subscribed by important public and other bodies one is apt to conclude that the small contribution would be out of place. As far as the Engineering Standards Committee is concerned this is not the case. The great advantage of having a long list of contributors to an enterprise is that a long list means many supporters, in addition to ample funds. Relatively few subscribers to a cause means that the support of the majority will have to be secured after the work is completed. This is not always an easy matter, and the completion of the work may be unduly delayed owing to lack of funds unless the few make heavier contributions than can be expected of them.

We should like to see every manufacturer, merchant, engineer and user contribute according to his means, so as to enable the Committee to continue their work not necessarily [illegible] but at least free from the cares implied by the absence of sufficient capital. The many contributors would become shareholders, and as such would be entitled to a share in the profit to be derived from the work. Certain of the Committee's specifications must already have resulted in a considerable saving to those who work to them, and as we have said the work of standardisation is only just beginning. Standardisation may be regarded [illegible].

Since the engineering institutions are lending their support by contributing towards the cost of preparing the translations, we are of the opinion that the members themselves would do well to follow the example. We should like to see contributions not of £500 but of £5,000 from the engineering institutions. To do this, which we believe they would like to be in a position to do, instead of taking money from their funds we would have them make a strong appeal to their members. Such an appeal should, if possible, be a personal one. To this end meetings could be arranged in the principal engineering centres, and we would have the subject of standardisation introduced either by one who knows his subject well, or by one who has bought his experience during the past two years. In this way it ought to be easy to raise a sum greatly in excess of the £15,000, which is said to be the amount required by the Committee before the work of translating the specifications can be undertaken. These meetings, in addition to creating a good deal of interest in the work of the Standards Committee, would enable the engineering institutions to get into close touch with a great many of the smaller manufacturers.

These recommendations are entirely unconstitutional. In fact, they are about as unconstitutional as is everything else at the present time. Hitherto it has been customary for the politician and the quack to hold public meetings, and well do our people know it to-day. We believe that the time is ripe for a great educational campaign in the country. Such campaign would deal with the science of trading. Standardisation is the keystone of the science, and without it co-ordination is impossible. In looking back it is a little difficult to understand how our engineers were able to make any headway without standardisation. It is certain that in the future conditions will be such as to make standardisation on a big scale imperative.

We have referred in general terms to the great work carried out by the Standards Committee in the several branches of engineering during the past 15 years. An attempt is to be made to issue the specifications at *popular* prices. We look forward to the time when it will be possible to buy these specifications at the uniform price of a few pence per copy, and to the time when British manufacturers work to no other specifications. No pains should be spared in endeavouring to make the work international in character. The close agreement between the American and British rules for electrical machinery shows what can be done in this direction, and we hope that it may be found possible in the near future to induce many other countries to accept these standards.

Having got rid of the machinery specifications we hope that an attempt will be made to frame satisfactory rules for the wiring of buildings. Such rules will enable the architect, the contractor and the user to learn their lesson from the same book instead of from a score of books. Common rules will prevent the user being victimised by the unscrupulous contractor, and will protect the contractor from the fads of the consultant and architect. Although the Institution Wiring Rules have, beyond question, been productive of much good, in our opinion, it is better that the work should be continued under the auspices of the Engineering Standards Committee. Without wiring rules there is plenty of important work for the Institution of Electrical Engineers.

In their own interests as well as in their common interests we urge our readers to support the work of the British Engineering Standards Committee, not only by contributing generously to the funds of the committee, but also by adopting the rules and by persuading others to adopt them.

ADVANTAGES AND FUTURE OF ELECTRIC SHIP PROPULSION.*

BY W. L. R. EMMET.

While prophecy is generally an undesirable task for an engineer, the present conditions seem to be such that a statement of opinion is desirable.

The writer has for many years actively advocated the electric drive for the larger vessels of the navy, and as a result of a long campaign, this method has been adopted on a large scale by the Navy Department of the United States. Electric propelling machinery has been ordered for the last seven battleships which have been authorised, and is specified for the four new battle cruisers which form part of the present naval programme. These battleships are large and important vessels, requiring 33,000 H.P. each, and the battle cruisers present the most stupendous propulsion problem ever brought forth, since they require no less than 180,000 H.P. each.

Electric propulsion has from the first had many opponents, and it is still being very actively opposed by nearly all the shipbuilders of the country, by Sir Charles Parsons, Charles G. Curtis and others who have had important influence in marine engineering. Most of this opposition is undoubtedly sincere, but is not altogether disinterested, since shipbuilders want to use machinery which they know how to build, and since turbine inventors have in the past received large royalties from turbine-driven ships which are cut off by the advent of the electric drive. Although power still comes from turbines, the electric drive is, by licence agreements, free from royalty charges. The possibilities of large electrical apparatus do not appeal strongly to those who are not thoroughly familiar with its uses. Electric propelling machinery will be generally heavier and more expensive than the best developments of geared turbine machinery, and variations of opinion have rested upon the relative importance given to advantages and disadvantages.

The General Electric Co., of America, has, under the author's direction, also carried on extensive developments and operations in ship propulsion by turbines connected to ships' propellers by gearing. Machinery of this class for 79 large vessels has been contracted for by them, and many of these ships are in service and showing unqualified success. Our view, therefore, is not entirely one-sided, and although it may be considered that we are particularly interested in the development of the uses of electrical machinery, we believe that we have judged fairly, and that our efforts will lead to important and lasting success.

Advantages of the Electric Drive.—In explaining the advantages of electric drive, comparisons will be made only with the geared turbine drive. All other methods for propelling large vessels may be considered obsolete, although many ships are still being built with engines or with direct-connected turbines.

A wise rule in engineering is to advocate new things only for the purpose in which they afford the greatest advantages, and this rule has been closely followed in the promotion of electric propulsion, which was originally advocated mainly for large warships. This first move was made before the use of mechanical gearing for such a purpose had been suggested, but its advantages for this particular use are so striking that it is still believed that the wonderful development of gearing possibilities have not changed the original case.

The subject of electric drive is too large for full discussion in such an article as this. Its possibilities and advantages can be best suggested by taking as an example the case of the new battle-cruisers in which its use has been and still is the subject of much discussion and criticism. This may be considered as the extreme case where advantages are most important and in which the disadvantages of increased weight is most serious.

Four of these vessels are authorised in the navy bill of 1916. They are designed to make 35 knots each, requiring 180,000 H.P. delivered to four shafts turning at full speed about 250 revs. per min. These are the fastest and most highly powered vessels ever built. The electrical installation proposed in each of them far exceeds in extent any single installation ever made for any purpose.

Apparatus Proposed.—It is proposed to instal in these ships four high-speed turbo-driven generating units of the best type, similar in most respects to those used in power stations on shore. Upon each of the four propeller shafts will be mounted two independent induction motors. Cable connections and switching arrangements will be provided by which any combination of motors and generators can be immediately provided for and by which all the changes of connections for operation, reversal, &c., can be quickly made under all running conditions. The details of design and method of operation are quite simple; in fact, much simpler than in most electrical installations. The electric supply is produced for the one purpose of propulsion, and is varied or discontinued according to need. Connections are changed only on dead circuit, even in the ordinary operations of stopping, starting and reversing, and automatic means are provided by which any diversion of current from any cause produces an unbalancing which breaks the field circuit and de-energises the system.

The aggregate weight of this equipment with cables, switches, instruments and controlling apparatus is 1,865 tons.

Equipment if Gear Driven.—If such a vessel were gear driven, a plurality of ahead turbines would be connected through helical gearing to each propeller shaft, one or more backing turbines would also be connected through the same gearing, and if good cruising economy were sought it would be necessary to provide also cruising turbines connected through separate systems of gearing and arranged with couplings so that they could be detached during high-speed operation.

A just comparison of this method with the electric equipment proposed would require a complete design and analytical study of the geared equipment and its performance. The author has not made such a study in the case of these vessels, therefore no exact figures can be given. The space and number of turbine elements connected to each shaft will determine the space required for turbines, and this spacing will govern the length and weight of the shafts, piping, valves and supporting structures.

In some of the installations which have been proposed abroad for vessels of much less power than these, the multiplication of parts has been very great and the size and extent of turbines and supporting structures such that the adoption of similar methods in these ships would certainly give weights nearly as great as, if not greater than, those proposed for the electric drive. Shipbuilders in quoting for these vessels have stated that by using geared equipment they could save about 1,000 tons in weight and about £200,000 in cost, but whether these statements will bear analysis or not cannot be said without study of their detailed designs, if any have been made.

Detachment and Interchangeability.—Without further description or discussion of either type of apparatus, we are in a position to make a comparison which constitutes one of the most important advantages of the electric drive. In the geared equipment, each shaft has a system of turbines, gears, bearings, thrust balancing devices and lubricating systems all mechanically locked together. With high-speed machinery any kind of trouble with any of these parts will almost certainly necessitate the immediate stoppage of the whole system. To keep a high-speed turbine running out of balance or with bearing trouble is impossible, and the gearing part would present almost equal difficulty. In the event of mechanical trouble of such character a ship would have to be stopped until the wreck could be cleared. The work necessary to uncouple and disconnect any part of such very heavy apparatus would be a serious matter involving much time, including that required to stop the ship. After the disconnection was made the idle propeller would act as a very serious drag on a fast vessel.

In the electrically-driven ship there is no mechanical connection of the shaft to anything but the rotors of motors. These are self-contained, iron-clad structures and cannot by any possibility be subject to mechanical interference. The shafts are subject to the same possibilities of bearing or thrust trouble as shafts in other ships, but the presence of the motors does not increase the danger, and the speed being low it is remote in any case. With this equipment any motor, generator or turbine, if in any kind of trouble, can be speedily disconnected without stopping the ship and with only a small loss from the highest speed capacity.

Such interchangeability as this power of disconnection gives constitutes one of the most important advantages of electric drive in such a ship. With one motor out of eight in trouble, only one-eighth of the maximum capacity is lost and the ship's maximum speed is impaired by only about 1 knot. If a generator or turbine is in trouble the maximum speed is reduced only about 2 knots. With two generating units and four motors out the ship can make 26 knots, and with three generators and four motors out she can make 19 knots. If parts give trouble they are simply cut out and repaired at leisure or as opportunity offers. The value of this interchangeability in a warship can hardly be over-estimated, it largely overcomes the military danger incident to accidents to the driving power, a danger which has always been of primary importance.

Backing Power.—In turbine-driven ships, not electric, it is necessary to provide backing turbines which must run idle in the reverse direction when the ship is going ahead. These backing turbines involve complications which are very objectionable, and if these are reduced to a desirable minimum the backing power will be greatly inferior to that easily provided with electric drive. Experiment has shown that a turbine forced in an opposite direction involves about seven times as much friction loss as when driven in its normal direction. This loss is very appreciable in the backing turbines of ships and causes heating which must be dissipated by circulating steam, which causes further loss and waste. There are also serious difficulties and dangers in high-speed apparatus incident to the abrupt and wide changes of temperature where steam is suddenly admitted to a cold reversing turbine. Steam which expands without doing work has a high temperature, and if work is done upon it by a reversed turbine the heat is considerably increased. With superheat, these temperatures may be extreme, and they affect the main turbine as well as the other, since it also must be used for reversal of direction and since the two often occupy the same casing. The mechanical effect of such abrupt change of steam temperature upon fragile structures presenting very extended surfaces is a matter which has been little considered, but which has caused much serious trouble. With electric drive the turbine never need be stopped when the ship is under way, and its operation is easier than in a power station because the load is steadier. With modern high-speed turbines superheat affords large gains in fuel economy, and the ability safely to use high degrees of superheat may constitute one of the important reasons for adopting electric drive.

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* From the "Electrical World," slightly abbreviated

Efficiency of Transmission.—Various statements and estimates have been published concerning losses in high-speed gearing for which the authority is not known by the author. Tests at Schenectady have shown losses about double those generally estimated, with rapid diminution of efficiency as load falls. These tests were of a most accurate character with large smooth-running gears and by the motor-generator method where losses alone were measured, the same power being transmitted with and without the gearing.

With the electric drive in these battle cruisers, the losses from turbines to propeller shaft at full speed will amount to 7 per cent., and by adjustment of voltage the transmission efficiency can be kept equally good at all speeds. Considering gearing losses, reversing turbine losses, losses incident to necessary subdivisions of the turbines and additional packings it is believed that the actual transmission from turbine blades to shaft at full speed cannot be made more than 2 per cent. better in the geared equipment than it is in the electric. At reduced loads the geared equipment will be much less efficient. The normal cruising speed of these ships will require less than one-tenth of full load, and the drag of gearing, bearings, reversing turbines and idle parts of main turbines will be very serious.

Cruising Economy.—With the electric design the number of motors and turbines used can be adapted to the demand for power, while with the other all parts must be kept running. This gives very important gain in economy at all speeds below the maximum. At 19 knots only one turbine is required to drive the ship, and electrical arrangements are made by which it can be run at full speed instead of running at half speed, as it would if the ratio was fixed as by gearing. Thus the steam efficiency at 19 knots, a desirable cruising speed, is equal to the best attainable at any speed. Assertions which have been made by shipbuilders and others that equal cruising results can be obtained by the use of cruising turbines are obviously absurd. The cruising turbines themselves would be greatly inferior to the single main turbine so used, and they would be burdened with all the drags which are mentioned above. Cruising economy gives increased cruising radius without renewal of fuel supply. This has always been considered a matter of the greatest importance in warships, and it is a feature in respect to which electric drive can have no rival.

State of Development and Expediency.—Enough has been said to give an idea of the reasons for the use of electricity in such ships, but in addition it should be considered that everything used in such an electric installation is a matter of exact knowledge and wide experience, while methods of gearing on such a scale are backed by little experience and wide differences of opinion exist as to design.

The author believes that the differences of weight and cost which have been predicted by shipbuilders and others are not based upon just comparisons, but that even if they are true they are not sufficient to balance the practical merits of electric drive for such vessels.

For these reasons it is believed that when prejudices are overcome electricity will [illegible] in large high power warships. In such light [illegible] destroyers, for reasons of weight and space, it [illegible], but even in such cases with the lightest [illegible], and with very high pressure and superheat [illegible] develop a legitimate application. In [illegible] it may afford great advantages. With electricity turbine units can be installed in duplicate, [illegible] single or [illegible]. Machinery can be installed where convenient with motors near propellers and turbines near boilers; auxiliaries can be driven electrically from the main units. The highest superheat can be used without danger or complication, and [illegible] can be applied to other power [illegible], such as cargo pumping or handling. These advantages have led to the preference of electric drive at a higher price in certain large cargo vessels recently ordered, and will doubtless lead to many other applications in ships of various types.

The advantages here mentioned have been developed with a wonderful skill and foresight by the Swedish engineer Ljungstrom in the 900-H.P. ship Mjolner, which has been in successful operation for about two years. This vessel has shown a fuel economy decidedly superior to anything produced elsewhere in a steamship, and has maintained this high standard throughout her period of service. Such a result with such small power is very remarkable and significant.

APPARATUS FOR THE MEASUREMENT OF THE VOLTAGE AND FREQUENCY OF ALTERNATE CURRENTS.*

BY DR. JOHANN SAHULKA.

Prof. W. Peukert † has recently described a frequency meter, which is essentially a voltmeter, graduated with a scale which gives the frequency; it is connected to a coil of thick iron wire in series with a Nernst resistance. This apparatus can be calibrated so as to give the frequency directly. But it has the disadvantage of requiring the relatively high current of 1·5 amperes, because the current in the iron wire must be much greater than that in the frequency meter, and because it is only by taking a thick iron wire and a heavy current that it is possible to achieve the desired result of measuring the frequency at different voltages. The idea of using a voltmeter as a frequency meter is not novel. The author has made a somewhat similar suggestion in his German patent No. 283,542. He there shows how any voltmeter can be used as a frequency-meter, unless it is of the electrostatic type. The following notes relate to these suggestions :—

In Fig. 1 we suppose that a hot-wire instrument is connected between the conductors L_1 and L_2. In the one arm there is the hot-wire A_1 B_1 and an inductionless resistance, R; in the parallel branch, there is a similar hot-wire, A_2, B_2, and a condenser or inductive resistance, D. If the change-over switch K is moved over, the active hot-wire, A_1 B_1, which is connected to the instrument, is then connected to D, and the hot-wire A_2, B_2, is in series with R. Both branches are connected to a sliding resistance, W, which, owing to the action of a spring switch, S, is normally switched out of circuit. If the switch K has the position, shown in the drawing the voltmeter scale V can be made to read the frequency. This is done by the following procedure: The switch S is closed and the sliding contact C is so adjusted on the resistance W that the pointer on the apparatus points to a certain position, M, on the scale. The switch K is then changed over; the frequency can then be read off on the frequency scale.

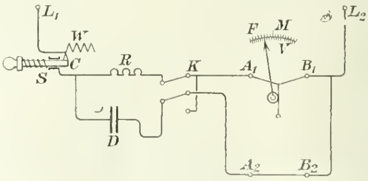

Fig. 1.—Showing the necessary connection for using a Voltmeter as a Frequency-Meter.

If D is a condenser then the frequency-scale can be calculated. Let us call the voltage, corresponding to the position M on the scale, by the symbol E_n. When the switch K is moved over, and the instrument is used as a frequency meter, let the reading be E. Let r be the resistance of the apparatus, when used as a voltmeter i.e., the sum of the resistances R and A_1 B_1; let C be the capacity of the condenser, and p the periodicity.

Then
$$p = \frac{E}{E_n \cdot 2\pi C r}$$

If a Hartmann and Braun hot-wire voltmeter is used, measuring from 30 to 150 volts, it would have a resistance of 760 ohms, while the hot wire has a resistance of 16 ohms. Let the fixed point on the voltage-scale be 110, and let C be 4 mfd. Then, $p=E/2{\cdot}1$. With this instrument it is possible to measure frequencies between 15 and 75. The readings on the frequency scale vary inversely with the value of the capacity chosen, so a simple adjustment requires to be made if another capacity is taken. The value of the resistance of the hot wire has nothing to do with the reading of the frequency meter, because the reactance of the condenser, even at the lowest frequencies, can be made equal to the impedance of the condenser branch. If the capacity is gradually decreased in value the range of the frequency meter can be raised as much as is desired.

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* Abstract of an article in the "Electrotechnische Zeitschrift," Heft 26, 1916.

† THE ELECTRICIAN, Vol. LXXVII., p. 350.

If D is an inductive resistance, then by suitably choosing its value, it can be arranged that the instrument shall be specially sensitive for a given frequency. For the above-mentioned apparatus a portion of the primary winding of a small transformer was used as an inductive resistance; this transformer was suitable for changing the voltage from 220 to 14, with a periodicity of 50; the secondary winding was removed, and such a portion of the primary was used that it was specially sensitive for 50 cycles on a voltage of 110. The frequency-scale must in this case be determined by calibration.

A disadvantage of the hot-wire instrument is that it takes a fairly high current; therefore, in the measurement of low frequencies a condenser of considerable capacity is needed, and it is difficult to find space for this inside the meter. Take a Weston voltmeter reading from 0 to 150 volts; its resistance will be about 2,500 volts; and if low frequencies are to be measured a condenser of a capacity of 1 mfd. is sufficient. The resistance of the three coils of the instrument was 154 ohms. It is easy to see that this resistance does not affect the measurements; still with high frequencies, inductive effects are noticed. The capacity of the condenser can be altered for lower values of the frequency, and corrections can be made by multiplying by a factor.

THE EFFECT ON THE EYE OF VARYING DEGREES OF BRIGHTNESS AND CONTRAST.

The above formed the subject of a Paper by Dr. James Kerr (Public Health Dept., L.C.C.) before the Illuminating Engineering Society on Tuesday, February 20th, the chair being taken by the president, Sir William Bennett.

In his opening remarks Dr. Kerr recalled that some of the earliest discussions of the society had been devoted to glare. At that time the view was generally expressed that, if possible, sources whose brightness exceeded about three candles per square inch (the average brightness of the white sky) should not be used unshaded. During recent years, however, a great deal of additional work on this subject had been done, especially by the American Illuminating Engineering Society. The result of recent experience had been to show the great importance of *adaptation* of the eye. For example, a match-flame was extremely glaring in a dark lane, leaving an after-image which persisted for several minutes, while in full daylight even a mantle or filament did not appear unduly bright. Consideration of this factor had led to the suggestion that in general the contrast between a luminous object and its surroundings should not exceed 100 : 1. The physiological justification for this ratio required investigation, but it seemed to be in rough accord with practice. The society had recently encountered several illustrations of the principle. Strong local lighting should always be supplemented by a certain amount of general illumination. In rifle-range lighting it seemed objectionable to have a very marked contrast between the bright target and the surroundings. In passing, Dr. Kerr suggested that the conditions of illumination of best-type used by oculists might well be more clearly prescribed. The illumination of the type should be stated, there should be no unscreened bright sources in the room, and provision should be made for varying the contrast between letters and background; the latter element was of importance in testing the eyes of soldiers suffering from shell-shock.

Dr. Kerr then passed on to a subject of topical interest, the conditions in cinematograph theatres, on which a Commission is now sitting. The conditions of vision were abnormal in this case, and special precautions were necessary as regards the effect on the eyes of children. The distance from the screen and the angle of view should be prescribed. As regards the lighting, it was vital that there should be no bright unscreened sources of light in the theatre, and the signs indicating exits, &c., should be of moderate brilliancy. It was a matter for consideration whether the practice of keeping the theatre in darkness was not incorrect, as this involved extreme contrast between the picture and the surroundings; this contrast should not exceed 100 : 1. Other suggestions related to the lighting of vestibules, passages, &c., which should be arranged to mark a gradual transition from the outside conditions to those within the theatre. Dimmers should also be employed to diminish the shock involved in a sudden extinction of the lights when a film was about to commence.

In the discussion Dr. C. W. Kimmins (H.M. Chief Inspector of Schools) and Mr. A. E. Newbould (Cinematograph Exhibitors' Association) spoke on behalf of the Cinema Commission, expressing their interest in Dr. Kerr's Paper, and inviting him to give evidence before the Commission on some of the points raised. Mr. Newbould also transmitted from the Commission a request that the society should form a small committee to co-operate with them in studying these problems, and Mr. Goodenough, the chairman of Council of the Illuminating Engineering Society, intimated that this proposition would receive early consideration.

Letters from other members of the Commission were read, and a number of members of the society spoke. A vote of thanks to Dr. Kerr closed the proceedings, the president announcing that at the next meeting, which would take place on March 22nd, a discussion on "Fluorescence and Phosphorescence" would be opened by Mr. F. Harrison Glew.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

I have followed with interest the discussion on a Decimal Money System, but, it seems to me, some of the writers are in error as regards certain difficulties that they imagine will arise should a coinage on the £1 unit be adopted.

I have been for many years a strong supporter of a decimal coinage, and, as our present money standard is the sovereign, I always assumed that any system adopted would be in decimals of a pound.

For several years I kept my private accounts on a decimal basis, taking the florin as the unit, but I found that by so doing and working to three places of decimals I was calculating to the 10th of a farthing or thereabouts. As this seemed quite unnecessary, I changed my unit and adopted the £1, so that I worked approximately to a farthing limit. The alteration made no real difference in the calculations, since it only meant the shifting of the decimal point.

Mr. Turnbull draws a sad picture of a grocer "trying to explain to all kinds of customers that 3s. 6d. was F 1·75," but this would not happen. Tables of equivalents would be displayed in the shops, and doubtless for some time goods would be marked in the old and new values, so that there would be no need for the shopman to explain. The buyer would see, for instance, the tickets: Potatoes, ·4 mil (1d.) per lb.; tea, 12·5 hund, or 125 mil (?) (2s. 6d.) per lb., and so on.

In a very short time buyers and sellers would alike know the new values, and the old ones would disappear. The old names might survive, just as to-day we often mention sums in guineas.

When a person visits a foreign country for the first time the money difficulty is not great. An Englishman in France after a day or two recognises that there are ten "pennies" in the franc, and that 1·25fr. is a shilling. In Germany he learns that the mark is a shilling, but there are only 10 "pennies" in it, so that he expects something more for his German penny than he gets for an English one. In Jersey both the English and French coins are used, and goods are marked in both coinages. Many people use both systems indifferently, and in one shop ask the price in francs, in another in shillings.

With the sovereign as unit the shilling remains 1/20th, and I cannot see what difference it makes whether it is written 1s., 1/- or 0·050.

As new decimal coins come into use their value and purchasing power will be learned by the best of all instructors - practical experience - and in a month or two the people will unconsciously learn the new system.

Naturally, the amounts of various articles sold for a given sum will automatically adjust themselves to the new conditions, and will probably average out so that the purchasing power of the sovereign remains unchanged.

I advise the advocates of the various systems to keep accounts for three months in the coinage they recommend, and I think they will find that if the sovereign is taken as the standard; whether it be called 1 or 10, no difficulty will arise, other than that of learning the equivalents; but if the shilling is taken as the unit no saving will be effected in the case of small sums, and calculations based on large ones will be much more complicated.

Nearly all your contributors appear to be in favour of a decimal coinage, and I think the best thing is to make as few difficulties as possible. I am quite willing to accept a shilling or a penny basis rather than retain our present cumbrous system, but to suggest a departure from the unit as well as the introduction of a new coinage is to seriously complicate the problem.

Kingston-on-Thames, Feb. 19. F. MAURICE SEXTON.

TO THE EDITORS OF THE ELECTRICIAN.

The quotation from Brook-Smith's "Arithmetic," given by a correspondent in your issue of the 16th inst., furnishes a typical illustration of the mind theoretical, which would exploit even the question of the reform of our currency for the glorification of its assumed superior knowledge in things appertaining to figures.

To use the words of Mr. Hughes, "the teachings of history and the lessons of experience cannot move such men." They are hopeless. But those who are not too proud to learn can easily find out that the sovereign has never, either in history or in practice, been the unit of value in the currency of this country. In the age of the pound sterling the penny was the unit, and the pound its multiple. After the creation of the sovereign of 20s. the shilling unit took the place of the penny. If we cannot learn from history, everyday life should teach us. If both these fail to instruct, then a penalty not exceeding *forty shillings* (note the expression) might assist. Workmen and others of moderate means reckon wages and purchases in shillings and pence. The tradesman and the merchant sell their wares on the shilling basis—per lb., per yard, per doz., per gross or per article. Professional charges are based on the guinea (21s., which is the old sovereign). The big figures in pounds, called extensions, are merely multiplication sums. Within one month even a financier and other superior persons could think in shillings. This I have proved from over 26 years' practical experience here and abroad.

To-day, as always, our present sovereign serves a double purpose. First, as the standard test of our gold standard of value, and secondly as a coin. It still retains its former use, which it will continue to do without assistance from high finance. For have we not heard that pounds can take care of themselves? As a coin in circulation, the sovereign has practically ceased to exist, and still the Empire carries on. The confused thinking exhibited by some of your expert correspondents between a standard test of gold and a coin is delightful. One gentleman apparently cannot see how 100 shillings (i.e., £5) can form a gold basis for international exchange. Next he will tell us that the basis of exchange between France and Italy must be the £ sterling.

But there is no excuse for any academic theory in regard to this question, which, after all, does not concern international exchange at all for the international money market is beyond British Acts of Parliament. A box of card counters and a dozen genuine enthusiasts (business men) on a Sunday afternoon can easily sift the practical and constructive systems from the merely destructive ones. The sudden conversion of high finance is suspect, to say the least.

If we ever get a decimal currency it will not be because of, but in spite of, high finance. For years it has stood in the way, not only of the simplest of all reforms, but of the introduction of neat, clean nickel coins in place of our heavy and dirty copper ones, and thus it has permitted the creation of a gigantic automatic machine industry worked by a copper coinage so cheap the like of which no other country has [illegible].

London, Feb. [illegible] G. O. PARSONS.

TO THE EDITORS OF THE ELECTRICIAN.

With reference to Mr. Turnbull's letter in this week's ELECTRICIAN, I am entirely in favour of a decimal system of money, but where I part company with him is in the particular system that he and others advocate. I do not think that Mr. Turnbull's argument that other nations experience no difficulty in having coins of small value for their units is very convincing, nor do I agree with him that the point I raised as to the larger number of digits involved is so trivial as he suggests. For example, consider an account containing 20 items, the first figure of each being any numeral from 5 upwards. In casting up this account 40 *extra* figures have to be dealt with if the shilling instead of the pound be the unit.

As I implied in my previous letter, I am considering the matter from the point of view of the business community, and not from that of the "man (or woman) in the street." I have little doubt that nine out of ten persons in the categories mentioned by Mr. Turnbull would prefer the money system to remain unaltered. It, therefore, seems to me that if a change is to be made it is better to adopt the system which is most suitable for the industries of the country rather than one the only merit of which (so far as I am aware) is that it can be easily understood by the less educated of the people.

London, Feb. 24. H. C. SILVER.

SINGLE-PHASE FROM THREE-PHASE SUPPLY.

TO THE EDITORS OF THE ELECTRICIAN.

In your report of the discussion in London, at the I.E.E., on Mr. Townend's Paper, you quote him as saying that it is impossible to obtain a single-phase supply off a three-phase system, by means of static transformers, without producing unbalancing of the three-phase system. I wish to say that it is not only possible, but that I have done it on several occasions, and with ammeters in all three phases not differing from one another in the least. I have even short-circuited the single-phase supply without the balance being materially upset.

I am aware that such an authority as Mr. B. G. Lamme has said that "in some cases it has been possible to load the three phases equally *in current* when delivering a single-phase load," and that "balanced currents do not in this case mean balanced power loads"; but against this I will quote from Gilman and Fortescue's recent Paper on the subject of "Single-phase Power Service from Central Stations" (Am.I.E.E.), in which they say: "It is evident that, if equal currents of the same phase displacement flow in all phases . . . balanced voltages are maintained." Now, in the experiments to which I allude, the three currents were of exactly the same phase displacement, and were, in fact, produced under identically similar conditions in each phase; and there is, therefore, no doubt that single-phase currents were really obtained—to the extent of some 40 kw.—from a three-phase system *without any unbalancing whatever.*

I rather think, from the wording of Mr. Lamme's remarks, that he had in mind some application of or modification of the Scott system; but I submit that the broad statement that such a thing cannot be done, which has been going the round of the American Press since Mr. Lamme put it forth so authoritatively, requires modification. If he qualifies it by the statement that it cannot be done "so long as the frequency remains unchanged," I think he is probably right. But for a step-up of three—and I believe also for a step up of two—in the frequency, it certainly *can* be done.

Birmingham, Feb. 19. A. M. TAYLOR.

THE ELECTRIFICATION OF WOOD SHAVINGS.

TO THE EDITORS OF THE ELECTRICIAN.

I have just seen the letter from Mr. W. Brooks Sayers in your issue of the 23rd inst. regarding the electrification of wood shavings.

The same effect was observed by me during the winter of 1911 while sharpening an ordinary lead pencil in an office which was heated by steam. The atmosphere in the room was exceedingly dry, and I noticed that every time I sharpened my pencil the shavings adhered to the sides and legs of the desk at which I was working. The effect noticed by Mr. Brooks Sayers is simply the same only on a larger scale.

When working with ebonite in the lathe the electrification of the turnings causes considerable annoyance at times, adhering not only to the work itself, but to all parts of the machinery. Occasionally I found it necessary to damp the ebonite with water to avoid the turnings masking the work.

Harrow, Feb. 23. W. G. Royal-Dawson.

LEGAL INTELLIGENCE.

Alien Enemy Patents.

On the 21st ult. Capt. Donald Henry Scott applied to the Board of Trade for a licence to use patent 26,941 of 1906, covering an improved method and apparatus for forming insulating tubes, granted to Max Meirowsky. The application of Messrs. H. Clarke & Co. for a licence to use the same patent was reported in The Electrician for Feb. 16.

Capt. Scott was represented by Mr. Rudolf Moritz, who said that Capt. Scott was on active service and had asked his father (Mr. Geo. Schultz), as managing director of Messrs. Schultz & Co., to look after his interests while he was away and push the manufacture and sale of insulation tubes under the patent. It was, he said, proposed to set up another place in London.

The Controller-General of Patents (Mr. Temple Franks) said he had looked at the agreement, and Capt. Scott was by that agreement (dated Sept. 21, 1912) appointed Meirowsky's agent to conduct the business of Meirowsky & Co. in this country, and was given the sole power to maintain and work and deal with this patent. He carried out that agreement, and conducted the business at Manchester till the war broke out. The outbreak of war probably determined the contract, and, as he understood, Capt. Scott's father went up to Manchester to take his place. Probably there had been some misunderstanding as to the real legal position, but under those circumstances Capt. Scott had practically arranged that the Meirowsky Company should be carried on. He, the Controller, saw no reason why the Court should not recommend the Board of Trade to grant a licence to him, and in the ordinary course that licence could be transferred to approved assigns. There was no doubt that the Court would suggest that his father, as representing Schultz & Co., would be an assignee who would be approved by the Board of Trade.

Mr. Moritz said he understood the Board of Trade Committee would consider the case of the Meirowsky Company, as they had given notice to that effect. I should imagine they would hardly appoint a controller. There is nothing now to control, except the leasehold interest, which is derelict.

The Controller: Were there no machines?

Mr. Moritz: Yes, of course there were machines. I suppose they would have to control the transfer of these. We have really stolen the machines. I suppose they would have to appoint a controller?

The Controller of Patents: Yes, I suppose they would, to wind up the business and dispose of the assets.

Mr. Moritz: Then we need not trouble you further. My client is willing to buy up the assets of Meirowsky & Co.

The Controller: If that is done it is an additional reason for recommending a licence be granted to Capt. Scott; but I think in any case we should recommend a licence, the circumstances being as they are.

In our report of the application by Messrs. H. Clarke & Co. it was incorrectly stated that Mr. Geo. Schultz had changed his name. It was Mr. D. H. Schultz, as son of Mr. Geo. Schultz, who changed his name, and he is now Capt. D. H. Scott. It has been suggested that the third paragraph of our report may possibly convey the idea that Messrs. Geo. Schultz & Co. were guilty of sharp practice. The firm acted under instructions from the Board of Trade, who were aware of what was being done, and the statement as to sharp practice did not relate to the firm of Geo. Schultz & Co.

In the Patents Court last week, Messrs. Fredk. R. Batt & Co. (Ltd.) applied for licence to use patent 25,101 of 1912, granted to one Bauer, for the manufacture of high-tension electrometers to be employed in connection with X-ray apparatus. It was stated that the patent covered the combination with a unipolar electrometer for connection to a high-tension circuit, of a casing surrounding the electrometer, the casing provided with means for reading the refraction of the electrometer, and being composed of material which readily gave up its charge to an ionised surrounding medium. The casing was readily penetrable by Röntgen rays.

Mr. J. H. Webb, secretary of the company, said they had received orders for the Bauer electrometer; they had had difficulty in getting them for the firm (Messrs. Newton & Wright) who had obtained a licence to manufacture, and he concluded they were not in a position to manufacture. Any firm making those electrometers needed to have special facilities. His own firm possessed special advantages for manufacture and sale. The Bauer electrometer was nothing more nor less than an electrostatic voltmeter, and to make one efficient in every way a firm required to have a very good knowledge of the working of such instruments. It was essential to employ the proper material in manufacture, otherwise the instrument became at once absolutely inefficient, as its use was on the secondary side of the high-tension apparatus. The meter had to be placed on the secondary circuit of an X-ray apparatus for making measurements of the working of the X-ray outfit automatically. According to the amount of current employed one got various refractions on the scale, and those were shown automatically. If they could supply to the War Office or to their X-ray Committee an instrument made under the Bauer patent, which was absolutely efficient, and made to their satisfaction, they would probably get a very large sale for it. He had been in communication with a firm of great repute in the manufacture of electrostatic instruments, and had made arrangements for early manufacture. Applicants employed 90 men manufacturing X-ray apparatus for the War Office. Every X-ray apparatus they used to sell in the pre-war days included a Bauer electrometer, as they held it to be an integral part of the outfit. Since the war, however, those Bauer electrometers had not been included.

Witness said the apparatus need not necessarily be used for surgical purposes, though a large number were. They proposed to pay a 5 per cent. royalty on the patented parts. He wanted to advertise his firm as being in a position to supply, and in all probability the Bauer electrometer would be separately priced.

The Controller said he thought it one in which a licence ought to be granted. The royalty would be subject to revision after the war, and it would be foolish at this stage to put on a prohibitive royalty. The Board of Trade wished to promote the manufacture of a useful appliance and it was well that the sale price, according to the cost of production, should be fixed within a reasonable limit.

L.C.C. Tramway Rating Appeal.

Following the decision of the London Quarter Sessions in favour of the London County Council in their appeal against the quinquennial assessment of their tramways in the borough of Finsbury, the Council and the Assessment Committees concerned have now agreed the figures in the remaining appeals. These related to tramways in Holborn and in Bethnal Green, and the Council's costs are to be repaid by the respective Assessment Committees.

In the case of the three Holborn parishes involved, the County Council have secured a reduction of £787 in the gross and rateable values, which now stand at £8,453 and £3,261 respectively. The gross value in Bethnal Green has been reduced from £5,819 to £3,019, and the rateable from £5,255 to £2,455.

The rateable value of the tramways in Finsbury was reduced by Quarter Sessions from £9,770 to £6,527, and the Local Government Committee of the County Council intimate that this reduction is equivalent to 33 per cent. of the rateable value in the list. As reductions had already been made by the Assessment Committee, the total reduction represents 47 per cent. of the assessment in force before the quinquennial valuation.

When the appeals relating to the tramways in Holborn and Finsbury came on for hearing, Mr. Clavell Salter, K.C., M.P. (on behalf of the Holborn Union Assessment Committee), raised a preliminary technical point—namely, that the County Council was not entitled to have the appeals heard, because the notices of objection to the valuation lists did not comply with the provisions of the Valuation (Metropolis) Act, 1869. The Court decided against the objection, but agreed to state a case. The Assessment Committee will not now proceed with the case.

The Local Government Committee of the County Council have had before them a statement showing the effect of the quinquennial valuation of 1915 upon the assessment of the Council's tramways undertaking. The total rateable value is £266,475. The rateable value of the tramways buildings compared with the valuations in force before the quinquennial valuation shows an increase of £12,462, mainly due to the substitution of turbines for reciprocating engines at Greenwich station; but some increase has been caused by the enlargement of the capacity of Abbey Wood car shed and Vauxhall and the Elephant and Castle sub-stations. The total rateable value of the lines has been reduced by £45,171. These reductions are in addition to those amounting to £51,087 (net) which were made in 1913-14 consequent upon motor omnibus competition.

Fowler v. Midland Electric Corpn. for Power Distribution.

On Monday Mr. Justice Eve delivered judgment in this action, by which plaintiff sought to recover the value of 18 £100 debentures issued by defendants, and interest. The company had paid £1,800 into Court, together with interest up to June 30, 1913, and a premium of £45, and the real claim was for interest subsequent to that day at 4½ per cent. The facts were reported in The Electrician for Feb. 9 (p. 587).

In giving judgment, his Lordship said the action raised the question whether the holder of a registered debenture which contained no provision for payment at a particular place, who through oversight or any other cause had neglected to make the usual demands for payment, could recover from the issuers of the debenture interest down to the date of actual payment. In other words, was it the duty of the issuers to seek their creditors "within the realm" and to pay the money without request. The company covenanted to pay the principle on June 30, 1913, and the holder, a lady, died in the previous January. They received notice of the fact the day after the debentures matured, together with the name and address of one of the executors. It was suggested on their behalf, said his lordship, that they should treat as the registered holder the person alone entitled to receive payments, that they were not bound to look beyond the register, and that when it was discovered that the registered holder was dead they were relieved from finding out who was the executor. He did not think that suggestion was well founded. The company was supplied the day after the debentures matured with the information as to the proper person to whom tender of payment might be made. He thought there was no defence to the action, and he gave judgment for plaintiff, with costs, for interest at 4½ per cent. as from June 30, 1913, ordering the payment out to him at the same time of the amount paid into Court by defendant company.

Wm. Wilde v. Walsall Electrical Co.

At Walsall County Court last week plaintiff sued defendants for £5. 19s. as damages arising out of the repair of a mercury vapour lamp.

It appeared that plaintiff, a photographer, used in his business a mercury vapour lamp, and on Dec. 2 last something went wrong with the lamp. Plaintiff's manager went to defendants' works and saw defendants' manager (Mr. C. M. Brown), who agreed to go down to plaintiff's premises. He found a wire had either fused or broken, and said he could soon repair it. He did so, but subsequently, when the lamp was again lighted, a bulb fused, and the lamp was destroyed. Plaintiff subsequently found that by mistake Mr. Brown had connected the positive wire with the negative plug, with the result that the current was reversed and caused the destruction of the lamp.

Mr. F. Cooper (for defendants) contended that Mr. Brown explicitly told plaintiff's manager that he had had no experience with mercury vapour lamps, and merely offered to do the best he could for plaintiff out of kindness.

His Honour gave judgment for defendant, with costs.

A Disputed Leaving Certificate.

Last week Mr. Justice Atkin heard the appeal of the British-Thomson Houston Co. against the decision of a munitions tribunal, in which Henry Sabin, a night watchman, was complainant.

Mr. Maddocks (for appellants) stated that Sabin was engaged as a night watchman. He was first paid 28s. per week, and later 43s. 9d. He applied for a rise in wages, and as this was not granted he asked for a leaving certificate, which was refused by the firm. On the matter going before the tribunal it was decided that unless the firm were prepared to pay Sabin 49s. a week it was unreasonable to refuse him the leaving certificate. There was no district rate of wages on which the firm could rely. Evidence was given before the tribunal from two firms that higher wages were paid than those prevailing in the appellants' firm. On the other hand, evidence was given that lower wages were paid in some neighbouring works.

Mr. Slesser (for complainant) contended that sufficient evidence had been afforded to enable the tribunal to arrive at a decision as to the amount which should be fixed.

Mr. Justice Atkin found that the tribunal had not evidence upon which they could find that the amount fixed was the prevailing rate of wages, and allowed the appeal.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72 Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

6,[illegible]98 Electric Control (Ltd.) & Ellefsen. Alternating-current motor starters.

Refers to a method of electro-magnetic control for use in starting alternating-current motors, in which, while the ohmic resistance of the rotor circuit remains unchanged, there is produced in that circuit an impedance, the degree of which varies directly with the frequency of the current induced in the rotor circuit as the motor speeds up in conjunction with strong eddy current effects produced in solid magnetic cores affecting that circuit, which in action tend to maintain the current constant although the rotor voltage decreases due to acceleration of the motor and to bring the current of the rotor circuit into phase with the voltage.

1916 Specifications.

[illegible]65 Macintosh Cable Co. & Sankey, P. W. Machines for making electric cables or the like. (15/1/16. cognate application 9,738/16.) 103,316.

[illegible] B.T.-H. Co. & Whitaker, F. P. Alternating-current dynamo electric machines, induction regulators and other electric apparatus. (15/1/16.) 103,317.

An alternating-current dynamo electric machine, induction regulator, or other apparatus having conductors connected in parallel and its core divided lengthwise into as many sections as there are conductors in parallel per pole, the conductors being wound through the slots in the core sections, so that each parallel winding [illegible] every position in turn from one end of the machine or apparatus to the other.

[illegible] Western Electric Co. & Nash, G. H. Telephonic receiving apparatus for aviators or others working under similar conditions. (25/1/16.) 103,341.

[illegible] B.T.-H. Co. & Shuttleworth, N. Regulation of electric induction motors. (26/1/16. cognate application 2,261/16.) 103,344.

Relates to the regulation of an induction motor by means of a commutator machine [illegible] therewith and separately excited from a variable frequency [illegible] exciter, and the arrangement on the exciter commutator of two sets of [illegible] directions the exciting windings of the commutator [illegible] corresponding brushes of the two sets.

[illegible] Automatic Telephone [illegible] Co. & Bygrave, L. C. Arrangements for trans[illegible] telephone systems. (26/1/16 [illegible]

[illegible] (28/1/16.) 103,351.

[illegible] (29/1/15.) 100,042.

[illegible] (5/15.) 100,389.

[illegible] (23/[illegible]/16.) 103,387.

[illegible] machinery and other [illegible]

[illegible] Electric cable [illegible] 103,4[illegible]

[illegible] Electric motor controllers. [illegible]

[illegible] plurality of polyphase [illegible] are for con[illegible] windings, [illegible] segments adapted to [illegible] phase reversal of the [illegible]

[illegible] Controllers for electric [illegible] (27/7/16.) [illegible]441.

[illegible] (20/10/16.) 103,461.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

January 22, 1917.

1,062 Howard & Reyrolle. Elec. switching apparatus.
1,071 B.T.-H. Co. (G.E. Co.) Antennæ for wireless signalling.
1,080 Bell. Elec. terminals or connections.
1,095 Robinson & Smith. Automatic elec. control of petrol elec. vehicles, &c.

January 23, 1917.

1,101 Poyser. Automatic stopping device for elec. locomotives, &c.
1,110 Stell. Elec. apparatus.
1,113 Main. Method of guiding elec. wire into groove of trolley wheels.
1,114 Crawford & Preston & Sanders. Elec. switches.
1,122 Donald. Travelling elec. contacts.
1,146 Denton & Filmer. Elec. furnaces.
1,155 Breeden & Lucas. Motor vehicle lighting dynamos.

January 24, 1917.

1,177 Cawthorne. Elec. fire alarms.
1,184 Lancashire Dynamo, &c., Co. Apparatus for operating feed devices of reciprocating tools, &c.
1,223 Bourgeot. Electrolytic treatment of metals, ores, &c.
1,233 Lambourne. Elec. signalling systems.

January 25, 1917.

1,256 Perrett. Sparking plugs.
1,278 B.T.-H. Co. & Martin. Dynamo-elec. machines.
1,279 Kilburn. (Naamlooze Vennootschap de Nederlandsche Thermo-Telefoon Maatschappij.) Automatic switching device for thermic telephones.
1,284 Jandus Arc Lamp, &c., Co. Differential gearing.
1,282 Martinez. Winding for elec. coils.
1,307 Creed & Harrison. Apparatus for producing perforated slip by elec. current impulses.

January 26, 1917.

1,310 Asncroft. Manufacturers of tungsten oxides, metal, &c., from tungsten ores, &c.
1,315 Fletcher. Elec. ovens.
1,343 Garden. Self-generating elec. pocket lamp.
1,346 Volkers. Small elec. motors. (17/2/16, Germany.)
1,347 Automatic Telephone Mfg. Co. Automatic telephone systems. (14/2/16, U.S
1,355 Saxby. Elec. batteries.

January 27, 1917.

1,390 Kennington. Terminal connections for accumulators.

January 29, 1917.

1,412 Anderson. Elec. governors for elec. motors, &c.
1,437 Graham. Electrical pushes.
1,449 Jenkins. Elec. switch slabs or panels, &c.
1,460 Soc. Francaise Radio Electrique. Wireless telephony. (15/2/16, France.)
1,461 Trefileries et Laminoirs du Havre, &c. Regenerating apparatus for furnaces.

January 30, 1917.

1,465 Murphy. Elec. warning attachment for ship's telegraphs.
1,482 Tammadge. Dry cells.
1,490 Gilbert. Toy elec. motor. (18/4/16, U.S.)
1,491 Gilbert. Toy motor installation. (18/4/16, U.S.)
1,501 Dunbar. (Eastern Telegraph Co.) Storing and correcting telegraphic signals.
1,511 B.T.-H. Co. (G.E. Co.) Systems of ship propulsion.
1,514 Withers. (Cox.) Telegraphy.
1,515 Obankhoff. Frequency changers and generators of alternating current.
1,517 Symes. Automatic telephone systems. (10/10/16, N.Z.)
1,525 Marsland. Order telegraphs.

January 31, 1917.

1,544 S.A. pour L'Eclairage Electrique des Vehicles. Dynamo-elec. machines. (4/2/16, France.)
1,546 Fuller & Watkins. Electric thermo-radio massage machine.
1,555 Cowper-Coles. Electrolytic production of metal wire and strip.
1,575 Farrer, Funck & Villiers Eng. Co. Contact breakers for ignition mechanism of engines.
1,576 Farrer, Funck & Villiers Eng. Co. Flywheel magneto devices for engines.
1,577 Farrer, Funck & Villers Eng. Co. Magneto devices for engines.
1,578 Murray. Elec. edge welding. (2/3/16, U.S.)
1,581 British Westinghouse Elec. & Mfg. Co. (Westinghouse Electric & Mfg. Co). Vacuum type elec. converters.
1,587 Berry & British Electric Transformer Co. Polyphase transformers.
1,588 Berry & British Elec. Transformer Co. Elec. furnaces and transformers for use therewith.

February 1, 1917.

1,609 Brush Electric Engineering Co. Liquid resistances for rotors of induction motors.
1,629 Watson & M.L. Magneto Synd. Ignition magnetos.
1,636 Cowper-Coles. Electrolytic production of metallic tubes with closed end.
1,641 B.T.-H. Co. (G.E. Co.) Electro-magnetic switches.
1,653 Laidlaw. Elec. transmission of signals.
1,661 Hearson. Elec. furnaces.

February 2, 1917.

1,674 Faulkner. Elec. furnaces for non-ferrous alloys.
1,678 McLean. Portable elec. hand lamps.
1,692 Ryland. Magnetic compasses.
1,712 Irwin. Production of sound waves for signalling.
1,713 Carr. Elec. measuring instruments.

February 3, 1917.

1,729 Waterhouse. Wiring ships, buildings, &c.
1,732 Cowper-Coles. Manufacture of zinc tubes.
1,739 Cie Gen. Electrique. Flexible cable funicular traction. (7/2/16, France.)
1,748 Davis. Elec. bells.
1,754 B.T.-H. Co. & Hastings. Elec. motor control.
1,762 Stewart. Stimulating growth of hair by weak elec. currents.
1,764 Mossay. Dynamo elec. machines.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"High Speed Internal Combustion Engines." By Arthur W. Judge, A.R.C.Sc. (London: Whittaker & Co.) Pp. ix.+350. 15s. net.

"Annales des Postes, Telegraphes et Telephones" (Paris: A. Dumas.) Pp. vii.+200. 12 fr.

"Underground Transmission and Distribution for Electric Light and Power," by E. B. Meyer. (London: Hill Publishing Co., Ltd.) Pp. viii.+312. 12s. 6d. net.

"Hydro-Electric Power," by Lamar Lyndon. Vol. I., Hydraulic Development and Equipment. Pp. vii.+499, 21s. net. Vol. II., Electrical Equipment and Transmission. Pp. vii.+360, 15s. net.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

London Supply Companies in 1916. The results of the working of the majority of the London electric supply companies during 1916 are now known, and, considering the high price of coal, the labour and transport difficulties and the lighting restrictions, they appear to be very satisfactory. Many companies were compelled to raise their charges in order to compensate for the increased costs and diminished consumption, but it is doubtful if the advance balanced the adverse factors referred to. Some of the companies, especially those supplying in industrial areas, where the demand for electric power is great, have done better than in 1915, but the record of some of those in residential districts is not so good. However, in only two or three instances has there been a diminution in the dividend, and in these cases accidental causes explain the drop.

The City of London, the County of London, the Westminster, the St. James' & Pall Mall Electric Light, and the South Metropolitan Electric Light & Power Companies maintain their dividends at the 1915 level, but the London Electric Supply Corpn., the pioneer of h.t. underground power transmission, and the small Smithfield Markets Co. have had a set-back. Our readers will join us in sympathising with the directors of the London Electric Supply Corpn. in their troubles, and we wish them a speedy return to the prosperous pre-war conditions. From the chairman's speech, which is reported in another column, the cause of the temporary set back will be readily learned. The location of the generating station on the riverside, which under ordinary circumstances would be a great advantage, turned out to be one of the causes why the generation costs increased by £24,267, while a bad "accident" during the year interfered with the supply of electrical energy, resulting in the sales dropping from 50,759,000 units in 1915 to 49,810,000 in 1916. These are, however, only transitory causes of a temporary decline in prosperity, and as soon as the company can get a good supply of cheap coal it will recover its former position. Even those companies whose gross revenue increased in 1916 have found that the additional revenue was swallowed up by the coal costs. For instance, the gross revenue of the South Metropolitan Electric Light & Power Co. amounted to £95,900 in 1916, against £80,600 in 1915 and £66,700 for 1914. Owing to the high price of coal nearly the whole of the additional revenue has been absorbed by extra expenditure, so that the net profit (£50,500) is only £1,300 greater than for 1915. Coal cost £26,700 last year, against £14,300 in 1915. Owing to the continued demand for electric current for power, the directors have placed an order for an additional 5 000 kw. set. From the report of the St. James' & Pall Mall Co., which appears in another column, it is satisfactory to learn that the Company has now recovered from the first effects of the War and that the demand for electric current for lighting, power and heating, and especially the latter, is increasing at the normal pre-war rate.

* * * *

The Club Idea Among Engineers. In another column we report an interesting and instructive debate on the Engineers' Club, which was held at Manchester last week. The opener of the debate, Mr. Edmund L. Hill, was one of the most active poineers, through whose efforts the Engineers' Club, Manchester, was formed several years ago, and until quite recently he was its honorary secretary. In reviewing the work of the club, Mr. Hill was able to produce evidence in proof of its success, and we think he is justified in claiming that the "clubbableness" of engineers has now been established beyond any doubt. The experience of the Engineers' Club in Manchester in this regard has been of great value, because, as Mr. Hill put it, "The institutions and learned societies do fine work but they entirely lack the friendly social element. Our Club has done most useful work in breaking down competitive barriers." If it had succeeded in doing nothing else, it might be said in this age of co-operative effort to have justified its existence. Mr. Hill's answer to the question, "How can we help each other and by doing so, the Empire, instead of cutting each other's throats?" seems to be, so far as engineers are concerned, to develop the Club idea and extend it into all the great industrial centres. We hope that Mr. Hill will succeed in doing in London what he helped so much to achieve in Manchester. During the course of the debate the new hon. sec., Mr. H. T. Wilkinson, remarked upon there being certain activity in the direction of engineers' clubs in Birmingham and Glasgow. We hope that those who are engaged on this work will keep closely in touch with the Engineers' Club in Manchester and decide upon an affiliation scheme which will indissolubly link these clubs together. They can make a good start by deciding that the name of the club in every district shall be 'The Engineers' Club. If uniformity of title is established it will prove a valuable link in a chain of organisations which will be able to act in a wider capacity than is possible by the technical institutions to which most classes of engineers belong. The suggestion made by Mr. Drummond Paton during the discussion, that the workman should also be admitted, if not to full membership of these clubs, yet to some form of association with them, is an excellent one and quite in keeping with the new trend of labour events since the outbreak of war. Mr. Paton also proposed that the Colonies should not be left out, but that engineer visitors from overseas should be welcomed by the Engineers' Clubs wherever they existed. At any rate, we may feel satisfied that now the ball has been set rolling the movement for the wider establishment of engineers' clubs will not be allowed to come to a standstill.

* * * *

Relief for Contractors. The New Courts (Emergency Powers) Bill, which amends the Courts Emergency Acts and the Increase of Rent and Mortgage Interest (War Restrictions) Act, &c., contains the following clauses :—

Where, upon an application by any party to a contract for the construction of any building or work entered into before August 4, 1914, the Court is satisfied that, owing to the prevention or restriction of, or the delay in, the supply or delivery of materials, or to the diversion or insufficiency of labour, occasioned by the present war, the contract cannot be enforced according to its terms without serious hardship, the Court may, after considering all the circumstances of the case and the position of all the parties to the contract and any offer which may have been made by any party for a variation of the contract, suspend or annul the contract on such conditions (if any) as the Court may think fit.

By Clause 2 relief is given where the fulfilment of a contract has been interfered with by a requirement, regulation or restriction of a Government department, other than the Admiralty or Army Council, in like manner as in the case where such interference is due to a requirement, regulation or restriction of the Admiralty or Army Council.

Clause 4 gives relief from disqualification for membership of the House of Commons through supplying the Government with certain property for war purposes or receiving compensation for requisitioned property.

* * * *

Trade Credit Associations. At a recent meeting at Manchester, which was promoted by the Column Club, Mr. D. Drummond Fraser advocated the foundation of a Credit Association for Manchester.

The Lord Mayor (Ald. T. Smethurst), who presided, said we had been told that in Germany the banks gave greater facilities than in this country to manufacturers, merchants and others for the development of trade and commerce, not only in their own country, but for important works abroad, which had enabled them to extend their sphere of influence in those countries.

Mr. Fraser, in the course of his lecture, explained how the immense sums held by the banks as deposits were gathered together on a continuous day-by-day banking principle, and how the principle had been adopted by the Government for the whole of their borrowing for war purposes during 1916. He then showed how the system could be applied in connection with mortgage credit facilities required for British agriculture and for credit facilities required in addition to those granted by our banks for the development of British overseas trade. "Why," he asked, "should Manchester wait for the proposed British Trade Bank managed from London?" Manchester had been the poineer of the war savings movement ; it was in the heart of a vast industrial area, teeming with works and manufactories of all kinds, and was the centre of the greatest producing part of the United Kingdom. It was the nearest port to 150 towns with one-fourth of the population of the country. One-third of the imports and one-fourth of the exports of the United Kingdom belonged to the district. If the banks collectively financed local interests after the war they would share in the increased prosperity thereby engendered. If the banks guaranteed a working capital not exceeding 5 per cent. of their deposits a fund sufficient to ensure its success would be forthcoming. That fund need only be called up *pro rata* from the banks over a well-spread period. These advances would be constantly reduced by the issue of bonds to the investing public. The system would give the utmost economy of a revolving working capital on a continuous day-by-day borrowing principle. Those bonds would provide a sound home investment for the people's savings. He laid emphasis upon the vast resources which the possible regular savings of the small investor represented, if only an adequate appeal could reach him. British people were by nature collective in their sympathies and operations, but their collective sympathies inclined strongly towards decentralisation. They dreaded a bureaucratic centralisation. England was the home of the guilds, friendly societies and communities. If we recognised the immense force of local patriotism and if we could enable members of a great community like Manchester to feel that, through their own local Credit Association, they could push their foreign trade, then indeed were we on the road to unlimited expansion.

Several questions having been answered, Mr. R. B. Stoker, in proposing a vote of thanks to Mr. Drummond Fraser, suggested that he should take action in co-operation with local banks to form a credit bank such as was suggested.

* * * *

Restriction of Steel Manufactures. The Minister of Munitions has ordered that no orders for drawn steel rod or bars, steel wire or steel-wire rope are to be accepted and no such material manufactured unless the purpose for which it is required has been approved.

Such approval must be evidenced by Admiralty contract reference and number, War Office contract reference and number, Marine Department Board of Trade permit reference and number for merchant shipping, Ministry of Munitions contract reference and number, Post Office contract reference and number, Commission Internationale de Ravitaillement or Commission Française sanction reference and number with Ministry of Munitions classification, Ministry of Munitions permit reference and number and priority classification.

Manufacturers may apply to the Director of Army or Navy Contracts, or to the Priority Branch of the Ministry of Munitions for the approval necessary to enable them to obtain such monthly supplies of drawn steel rods or bars, or steel wire, &c.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 17, 1917, *to* Feb. 23, 1917.

IMPORTS.

[illegible] Elec. carbons, £160; telegraph material, £119; carbon candles, £100; unenumerated, £6,3[illegible]9. *Japan:* Unenumerated, £493. *France:* Unenumerated, £[illegible]99. *Switzerland:* Unenumerated, £481. *Holland:* Elec. glow lamps, £739; unenumerated, £534. *Canada:* Unenumerated, £313.

EXPORTS.

TO AUSTRALASIA. *Auckland:* Elec. machinery, £130; elec. lamps, 1,000 n.o.; unenumerated, £299. *Melbourne:* Elec. machinery, £732; wire and cable, £274; unenumerated, £1,956. *Sydney:* Elec. machinery, £32; telegraph material, £22; wire and cable, £506; unenumerated, £1,856. *Wellington:* Elec. machinery, £310; wire and cable, £2,4[illegible]1; unenumerated, £1,623. *Adelaide:* Elec. lamps, 450 n.o.; wire and cable, £66; elec. machinery, £523; unenumerated, £173. *Christchurch:* Unenumerated, £66. *Br[illegible]:* Unenumerated, £22. *Lyttelton:* Elec. machinery, £400; unenumerated, £229. *Dunedin:* Unenumerated, £339. *Hobart:* Unenumerated, £405. *Launceston:* Unenumerated, £58. *Nelson:* Unenumerated, £35.

AFRICA. *[illegible] Town:* Elec. machinery, £72; unenumerated, £113. *Port Elizabeth:* Unenumerated, £278. *Durban:* Elec. machinery, £213; unenumerated, £1,324. *Beira:* Unenumerated, £21. *Na[illegible]:* Unenumerated, £413.

EGYPT. *Alexandria:* Unenumerated, £73. *Suez:* Unenumerated, £87.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS. *Bombay:* Wire and cable, £4[illegible]; unenumerated, £[illegible]26. *Calcutta:* Glow lamps, 5,872 n.o.; wire and cable, £277; [illegible], £100; telegraph material, £176; unenumerated, £924. *Madras:* Unenumerated, £158. *Colombo:* Wire and cable, £132; telegraph material, £130; unenumerated, £[illegible]26. *Singapore:* Elec. machinery, £407; unenumerated, £344. *Port [illegible]:* Telegraph material, £224; elec. glow lamps, 300 n.o.; unenumerated, £174. [illegible] *W[illegible]* [illegible], £121. *Bangkok:* Elec. lamps, 450 n.o.; unenumerated, £30.

[illegible] Unenumerated, £74. *Yokohama:* Unenumerated, £18.

[illegible] Unenumerated, £129. *Shanghai:* Unenumerated, £195.

U.S.A. *New York:* Unenumerated, £417.

[illegible] *Buenos Ayres:* Elec. lamps, 1,600 n.o.; elec. machinery, [illegible] £623; unenumerated, £678. *Talcahuano:* Unenumerated, [illegible] Wire and cable, £56; telegraph material, £26; unenumerated, [illegible] *Rosario:* Unenumerated, £574. *Val*[illegible] £13[illegible]

[illegible] £2[illegible]

[illegible] unenumerated, £406.

[illegible] unenumerated, £1,419. *Rouen:* Unenumerated, [illegible] Unenumerated, £134. [illegible] Unenumerated, £1,[illegible]13 [illegible] unenumerated, £53. *Boulogne:* Elec. machinery [illegible], £1,105.

[illegible] £63; unenumerated, £104.

[illegible] £679; unenumerated, £12.

FOREIGN GOODS (duty paid and free).

[illegible] Unenumerated, £51. *Bangkok* [illegible] £[illegible]1. *Christiania:* Wire and cable [illegible] *Dunkirk:* Unenumerated, £5[illegible]. [illegible] *York:* Unenumerated, £40[illegible]. *Sydney:* Unenumerated [illegible]

NOTE.—[illegible] number of items in these official returns under the [illegible] heading "unenumerated" relate to what is described as "[illegible] and electrical materials."

BUSINESS NOTICES.

[illegible] having been commandeered by the Government [illegible] have removed to 7, Prince[illegible] Westminster [illegible] Telephone No. 2269 Victoria (as before).

The [illegible] London agents is 27, Victoria[illegible] [illegible] at Queen Anne's Chambers having [illegible] by the Government.

The partnership [illegible] John Place, Ernest [illegible] and Maurice Harold [illegible] Place & Co., electrical and [illegible], London, E.C., has been [illegible] Alfred [illegible] Place.

The L. P. S. Electrical Co. has removed to 14, Howick-place, Westminster, London, S.W. Telephone: "Victoria 7346."

Owing to Caxton House having been requisitioned by the War Office, the address of the Institute of Metals will be in future 36, Victoria-street, London, S.W.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of April 2. *Further particulars are set out in an advertisement.*

ELECTRICITY SUPPLY.

EXTENSIONS.

Dundalk.—The L.G. Board have authorised the Urban Council to borrow £3,000 for extensions of the electric supply undertaking.

Heckmondwike.—At the last meeting of the Council it was reported that correspondence had taken place between the Council and the Yorkshire Electric Power Co. as to a further supply of electricity, but that no agreement had been arrived at.

In the course of discussion Mr Gledhill said he was still of opinion, as chairman of the Electricity Committee for several years, and as a close observer of the works, that it would be beneficial to close their works and purchase all they required.

Hull.—The L.G. Board have sanctioned a loan of £60,000 for extensions of electric generating plant and mains. A sum of £30,000 for mains and £15,000 for a sub-station.

Loughborough.—Last week the Council approved a report by the borough electrical engineer (Mr. R. B. Leach) on proposed extensions of the electricity works.

Owing to the increasing demand for electrical energy for power purposes, Mr. Leach reported that considerable extensions of plant should be provided. Having regard to the difficulty in obtaining plant at present, it was absolutely necessary that orders should be placed at the earliest possible moment if next winter's supply was not to be jeopardised. The estimated cost of the plant would be about £50,000, but it was recommended that only a part of the scheme should be proceeded with at present. Therefore it was decided to purchase a turbo-generator set, boiler, &c., at a cost of £27,225.

Stepney (London).—At their last meeting the Borough Council approved an estimate of £20,000 for the supply of two new boilers, &c.

West Ham.—The L.G. Board have written to the Council, stating that as the Ministry of Munitions do not consider that proposed electrical machinery was necessary the Board were unable to give their sanction to a loan thereof. The Council are asking the Board to reconsider the matter and to receive a deputation.

GENERAL.

Aylesbury.—The Council's area having recently become a borough, the resident engineer at the electricity works, Mr. W. A. Turnbull, has been appointed borough electrical engineer.

Greenock.—The borough electrical engineer (Mr. Frank H. Whysall) delivered a lecture to the members of the Greenock Electrical Society on the 22nd inst. on "Electricity Supply Costs."

There was a good attendance, presided over by Mr. Duncan Angus, president. Mr. Whysall commenced by discussing the various sources of power generation, mentioning that the large capital outlay made supply costs from water-power installations as great, if not greater, than those from steam stations. In regard to gas-engines, the best economy could be got only when working on 100 per cent. load factor. For large generating stations their capital cost and amount of space required put them out of court. A good case could be made, however, for gas-engines using waste heat from blast furnaces. Consideration was next given to reciprocating steam engines and steam turbines. Comparing the costs of generation and supply from a large station with the costs of a private plant, he emphasised the importance of load factor, costs per kilowatt of plant and diversity of supplies which placed the central station in a position of advantage. It was, therefore, more economical for a manufacturer to take his power supply from a central station, where such was available, in preference to running small inefficient steam or gas plant in his factory. That was true also in cases where steam was used for heating in the factory. In such cases the best results were obtained where the machinery was driven by electric motors fed from the supply authority's mains, and steam for heating purposes supplied by low-pressure boilers on the premises. Reductions in works costs and total costs of supply from central stations, would be brought about in the future by improvement in the load and diversity factors through the introduction of new power consumers, the encouragement of the electro-chemical industry, with continuous night and day demands for electricity.

A discussion ensued and at the close Mr. Whysall, on the motion of the chairman, was cordially thanked.

Huddersfield.—The income of the electricity department for the year ended Dec. 31, 1916, was £79,508 (compared with £63,944in 1915).

Working and general expenses were £54,787 (against £42,326), leaving net profit £24,651 (£21,618), which is being placed to relief of rates.

Hull.—The estimates of the various municipal departments have been referred back. The Tramways, Electricity and Telephone Committees reported that they were not in a position to contribute anything to relief of rates.

The Tramways Committee gave £10,000 last year. The net increased expenditure of the Corporation for the ensuing year is about £52,000, the bulk of which is in respect of war bonuses to employés, and the committees have, therefore, been requested to revise their estimates.

Lancashire Power Construction Bill.—Notice has been given by the Lancashire Power Construction Co. (Ltd.) that a bill is being promoted to authorise the rearrangement and conversion of the company's capital, &c.

Leicester.—Owing to the loss on the electricity department for the last half-year the Council are recommended to increase the charges for electric current for lighting and power.

Rochdale.—The Gas and Electricity Committee has appointed Mr. W. J. H. Wood, the borough electrical engineer at Bolton, as consulting engineer for three months, in order to prepare a report on the present position of the electricity department, and to advise on the best means of overcoming their difficulties in meeting the demands for electric current.

At the last meeting of the committee it was reported that matters were improving at the electricity works, but there was still delay due to the labour difficulty and to the tardiness in obtaining repairs to plant. But for the continued frost the £10,000 extension scheme would have been completed a month ago. When it is the department will be able to give greatly improved supplies of current.

Salford.—At a special meeting of the Council last week the employés whose salaries or wages do not exceed £300 a year were granted a bonus, the estimated cost of these bonuses being £23,000 per annum.

Tipperary.—In a recent report by Mr. J. P. Tierney it is stated that the electrical plant at the workhouse is totally inadequate, the battery has been overtaxed, and new plant will be necessary in the laundry.

Wigan.—The Electricity Committee recently voted a sum of £25 to Mr. Bull as an appreciation of his services during the four months that he has been acting as borough electrical engineer. A similar grant has also been made to Mr. Beck, station superintendent.

Worksop.—The Council has added a twopenny rate this year in order to meet the income tax on the profit on the electric supply and water undertakings. It was stated that the income tax was practically a 5d. rate.

TRACTION NOTES.

Aberdeen.—Considerable discussion took place at the last meeting of the Council on the question of the wages to be paid to female employés of the tramways department.

When the Council decided to employ women as conductors in May, 1915, it was resolved to pay them at the same rate as men. The Tramways Committee interpreted this to mean the same rate of pay as the men in their first year of service, but the women claimed that the same rate of pay meant the same scale of pay, rising by yearly increases from 5½d. to 7d. per hour. The Committee recommended the employment of "motoresses" at 6d. per hour (motormen's first year's pay), but this was remitted back for consideration of the whole question. The Committee now recommended that the conductresses get an increase of ½d. per hour after the first year's service, and another ½d. after the second year, making their maximum 6d. per hour, starting at 5d., compared with the men's maximum of 7d., starting at 5½d.

The recommendation was adopted by 15 votes to 12.

Bolton.—The Corporation has decided to purchase an electric tipping wagon.

Burnley—The Tramways Committee recommend the Council to abolish ordinary discount tickets and the periodical tickets issued to students and apprentices.

Glasgow.—In order to celebrate the extinction of the debt on the corporation tramways a luncheon was given on the 22nd ult. by the Convener (Councillor Montgomery) and members of the Tramways Committee.

The Lord Provost (Sir Thomas Dunlop, Bart.) presided. Among those present were: Sir James Bell, Bart. (who was Lord Provost when the tramways were taken over by the municipality in 1894), Sir John Ure Primrose, Bart., Sir Wm. Bilsland, Bart., Bailie Duncan Graham, Treasurer M'Millan, Mr. J. Dalrymple (manager of the tramways), ex-Bailie Oatts, and other former members of the Corporation.

Sir John Primrose, who proposed "The Imperial Forces," said that in raising the fighting men for the country the tramway department had exercised a most important part. He believed that from their ranks there had emerged 3,000 fighting men.

Sir James Bell, Bart., proposed "The Tramways Committee," and gave an interesting account of the progress and development of the tramways department. They had started with 108 tramcars drawn by horses, and their receipts were about £5,000 a week. There were 170 competing omnibuses. Last year they had a travelling public of 362,000,000, and of that number 232,000,000 travelled by halfpenny fares. The earnings amounted to £1,149,000, and of that no less than £485,000 was gathered in halfpenny fares.

Councillor Montgomery, who replied, said that the committee from the very beginning had had the ideal before them of giving the best and cheapest service to the community which it was possible to give, and in consequence of that the people of Glasgow had patronised the cars and given the tramways department a most extraordinary revenue. The revenue in 1902, when the tramways were first electrified, was £600,000, but to-day the revenue had doubled that. In fact, it would this year almost approach one and a quarter millions. They invested their funds in the best of all securities—namely, in the undertaking itself, and that was the next great secret of the department. The tramways department was the backbone of the Common Good, and, if he could see right, in the future it would comprise its entire anatomy. He congratulated Mr. Dalrymple and the staff on their work.

Acknowledging the toast of the staff, Mr. Dalrymple said they had almost come to the point when a majority of the staff was of the gentler sex. He had learned very much during the past two years, and he would not hesitate to have the whole service run by women.

Hetton.—The Urban Council has authorised a committee to obtain prices of motor and electric lorries for scavenging purposes.

Huddersfield.—As the Minister of Munitions has declined to give a Certificate "A" for the purchase of new tramcars, it has been decided to order the cars under class "C" Certificate, and the United Electric Car Co. will proceed with their Order.

Hull.—The Tramways Committee again recommended the Council to shorten the ½d. stages on all routes except the Anlaby-road route, and the elimination of a large number of stopping places

It is also proposed to charge a flat rate of 1½d. for passengers travelling the entire distance on any route.

Leicester.—The past half-year's balance-sheet, which shows a profit, was approved by the Tramways Committee last week.

Owing to the increased cost of coal and material, higher wages and war allowances, the committee recommend the Council to increase the fares again on the Stoneygate, Aylestone and Clarendon Park routes. The fare for the full journey will be 2d., but there will also be 1d. and 1½d. stages. The length of the present penny stages will be reduced.

Liverpool.—The Tramways Committee has drawn up a scheme for economising the car-mileage run at the extreme ends of the various routes and so afford a more frequent service of cars, &c.

The General Manager has been authorised to put it into operation as soon as the arrangements can be made. Reports have also been received from the City Engineer and the Tramways Manager on the revision of tramway stages, but the Committee has postponed consideration of them till after the war.

L.C.C. Tramways and Through Running.—At a recent conference between representatives of the L.C.C., West Ham, Leyton and East Ham Councils a new scale of fares was arranged to come into operation on through running routes on March 1. The new fares involve, in some instances, the abolition of ½d. fares.

Manchester-Oldham Tramways.—Owing to the shortage of skilled labour for the repair of tramcars, Manchester tramways department is unable to comply with the request of Oldham Tramways Committee to provide additional through cars between the two places.

Southend-on-Sea.—Owing to the difficulty of obtaining male drivers for the tramcars, inquiries are being made from other towns which have engaged women drivers, their experience of the adoption of this experiment.

West Ham.—Owing to the trouble in obtaining suitable male labour for the night car-cleaning staff, female labour is to be engaged to undertake this work during the day, the females to receive the same rate of wages as has been paid to men.

Further converting plant is to be installed at Bridge-terrace sub-station, and certain alterations made in the traction supply network to enable a larger proportion of the work to be dealt with through the medium of the general alternating-current supply. In view of the difficulty in obtaining money for extensions, the electrical engineer (Mr. J. W. Beauchamp) has reported that, in conjunction with the Tramways Manager, he had given consideration to the possibility of recovering certain portions of the traction cable network which could be rendered idle after the provision of the proposed machinery, and setting off the cost of the recovered cable against the cost of a new machine. The Tramways Committee have decided (subject to the usual sanction) to adopt Mr. Beauchamp's suggestion, and he has been authorised to obtain the necessary machine, switchgear and transformers, subject to arrangements being made as to the allocation of the capital charges, &c.

MISCELLANEOUS NOTES.

Prohibited and Restricted Exports.—On Feb. 23 the Privy Council made the following amendments in the schedule of prohibited and restricted exports.

Delete.—(*a*) Copper wire and cables containing copper, (*b*) copper gauze, (*c*) copper ore. (*b*) Copper unwrought and part wrought, including alloys of copper, and wrought copper in the form of copper and brass tubes, sheets, condenser plates, brass wire, bronze wire, perforated brass sheets, perforated brass linings and copper foil. (*c*) All articles wholly or partly manufactured of copper or its alloys, not otherwise specifically prohibited. (*b*) Wheatstone automatic transmitters and Wheatstone transmitters, Creed engines, Creed relays with pneumatic valves, and the following auxiliaries to Creed apparatus: High-tension pneumatic and magnetic keys, dictaphones and dictaphone cylinders, Einthoven galvanometers, and paper tape. (*c*) Telegraph (not wireless) instruments and material not otherwise prohibited. (*b*) Instruments and material for wireless telegraphs. (*b*) Telephone sets and parts. (*c*) Material for telephones, except telephone sets and parts. (*b*) Brazed brass tubes. (*a*) Solid drawn brass tubes. (*a*) Solid drawn copper tubes. (*c*) Wire-winding machines.

Add.—(*a*) Wire winding machines. (*a*) Copper ore, regulus, matte, concentrate and precipitate. (*a*) Copper, refined or unrefined, unwrought, wrought or partly wrought, including brass, bronze, yellow metal and all other alloys of copper. (*a*) All wholly or partly manufactured articles of copper or its alloys, except such as are exported before March 9, 1917, to all destinations not in foreign countries in Europe or on the Mediterranean or Black Seas, other than France or French possessions, Russia, Italy and Italian possessions, Spain and Portugal, and to all parts not in any of such foreign countries, except Russian Baltic ports, and articles partly manufactured of copper or its alloys, in which the total weight of copper and copper alloys does not exceed 5 per cent. of the total weight of the article, and does not exceed 56 lb. (*a*) Telegraphs (including wireless), telephones, and instruments and material therefor.

The following are included as "electrical apparatus, &c.," or "copper, &c.," in prohibitions under class (*c*), which prohibit exports to foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French possessions, Russia, Italy and Italian possessions, Spain and Portugal, and to all parts in any such foreign countries and to all Russian Baltic ports. The Director of the War Trade Department also notifies that they are exempt from the necessity of licence or certificate as far as the prohibitions relating to the export of steel are concerned:—

Electricity meters of all kinds, relays, synchroscopes, time switches, &c.

Prohibited Imports.—The list of prohibited imports set out in the "London Gazette" of the 23rd ult. are the following:—

Books (printed) and other printed matter, including printed posters, daily, weekly and other periodical publications, imported otherwise than in single copies through the post, clocks and parts thereof, wood and timber of all kinds.

Skilled Women's Wages.—By a new Order of the Ministry of Munitions, women engaged on skilled work, or any part of a skilled job, must receive 25s. weekly from the first to the fifth week, after which they are to receive proportional advances to the 13th week, when they will be paid the district engineers' rate of 10¼d. per hour.

The War Loan.—The directors and staff of Mawdsley's (Ltd.) (Dursley, Glos.) subscribed for £58,000 of the new War Loan.

Barnes Council decided to anticipate the profits of the electricity supply department and invest £10,000 in the loan.

Works of Reference.—Though the 20th (1916-17) edition of the "Manual of Electrical Undertakings & Directory of Officials" made its appearance somewhat later in the year than usual the war does not appear to have affected it in any other way, for it is even bulkier than the previous edition, and the information given is as accurate as usual.

It is impossible to review such a work as Garcke's well-known Manual in the space at our disposal, but it is sufficient to say that it is the completest and most reliable work of reference on all matters appertaining to the financial side of electricity supply, tramways, electrical engineering, telegraphs and telephones, &c. It contains information about 2,650 companies, brought up to the latest date possible. The sections into which the book is divided are, "The Progress of the Year," "Lighting, Power and Traction," "Telegraph and Telephone," "Manufacturing and Miscellaneous," "Colonial and British Possessions," and a directory of about 20,000 officials. A special feature is a large map of the United Kingdom showing all the electric traction, light and power undertakings. The published price of this valuable work of reference is 21s. net and it is published by the Electrical Press, Ltd., 13-16, Fisher-st., London, W.C.

Whitaker's Almanack, which is now in its 49th year, also worthily maintains its reputation for accuracy and reliability. Naturally, much space is devoted to the war, and there are interesting articles on its history, the financial side of the war, British Imports and Enemy Trade, Labour and the war, also on Home Production, British Empire Industries, &c. The price of the new edition, which is edited by Mr. Joseph Whitaker, F.S.A., is now 3s. 6d. net, but even at this figure it is one of the cheapest and best works of reference with which we are acquainted.

TENDERS INVITED.

Synchronous Condensers.

The Toronto Electric Commissioners invite tenders for Synchronous Condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28.

Turbine, Dynamo, Battery, &c.

Kilmallock (Co. Limerick) Electric Light & Power Co. require tenders by 10 a.m. March 5 for the supply of Hydraulic Turbine and Accessories, Dynamo and Motor Booster, Storage Battery and Switchboard. Specifications from Secretary.

Railway Stores.

The Great Central Railway Co. invite tenders for the supply during the 12 months ending Oct. 31, 1917, or during the 12 months ending April 30, 1918, of various stores and materials, including Asbestos Packing Sheets and Boiler Covering, India Rubber, Hardware, Oils, Wire, &c. Samples and patterns may be seen to March 5 in the Public Hall of the [illegible] Club, Gorton-lane, Manchester, and specifications may be obtained from the stores superintendent, Mr. Walter [illegible], Gorton. Tenders to the Secretary, Mr. Oliver S. Holt, Marylebone Station, London, N.W., by March 6.

Boiler, Coal Bunker, Conveyor, &c.

The Electricity Committee of the Harrogate Corporation invite tenders for the supply and erection of a by-product Steam Boiler, Overhead Coal Bunker, Coal Conveyor and Structural Steel Work. Specifications [illegible] electrical engineer, Mr. Geo. Wilkinson, M.I.E.E., to whom tenders are to be sent by March 5.

Motors.

Manchester Electricity Committee require tenders by 10 a.m. March 14 for the supply of nine 40 H.P. Three-phase Slip-ring Motors. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Coal Conveying and Ash-handling Plant.

Manchester Corporation want tenders by 10 a.m. March 7 for the supply and erection at Stuart-street station of Coal-conveying and Suction Ash Plant. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Steam and Electric Wagons.

Brighton Corporation require tenders by 10 a.m. March 9 for supply of 5-ton Steam Wagon and 3½-ton Electric Wagon, each with front watering tank.

Electric Lamps, &c.

The Victorian Railway Commissioners require tenders by 11 a.m. March 21 for supply of 200 Half-watt Lamps, 100 Lanterns and 100 Contact Couplings. Specification, &c., from the Commissioners' offices, Spencer-street, Melbourne.

The Metropolitan Water Board require tenders by 11 a.m. March 8 for three, six, nine, or 12 months' supply of Electric Lamps. Forms of tender from the Chief Engineer, Savoy-court, Strand, London, W.C.

Westminster Guardians require tenders by noon March 7 for six months' supply of Electrical Lamps, Fittings, Ironmongery, Engineers' Sundries, &c. Forms of tender from the Clerk, Prince's-row, Buckingham Palace-road, London, S.W.

Kensington (London) Guardians require tenders by the morning of March 8 for six months' supply of Electric Lamps and Fittings, Engineers' Fittings, Ironmongery, &c. Forms of tender from the Clerk, Marloes-road, Kensington, W.

Electrical and Tramway Stores.

The Electricity Committee of Bolton Corporation invite tenders for Materials and Stores for year ending March 31, 1918, including Lubricating Oils, Joint and Service Fuse Boxes, Jointing Materials, Wire, &c., Meters, Motors, Motor Starting Switches, Transformers, Ironmongery, Stoneware, Cable Troughs, Covers, &c. Specification and form of tender from the borough electrical engineer (Mr. W. J. H. Wood), and tenders to the Chairman of the Electricity Committee, Town Hall, Bolton, by noon March 7.

The Tramways and Electricity Committee of Belfast Corporation invite tenders for the supply of stores and materials, including mill furnishings, packings and asbestos goods, lubricating oils and petrol, trolley wire, overhead line material and galvanised wires, v. b. insulated cable, v. i. r. cables and wires, electrical accessories, lamps, arc lamp carbons and carbon brushes; bitumen, tapes, joint box compound, fuse wires, wood and stoneware troughing, c. i. frames street box and covers, c. and w. i. pipes, lighting feeder and section pillars, cable bridges, copper cable connectors, meters, indicators, time switches and house service cut-outs, &c. Forms of tender and particulars from Mr. T. W. Bloxam, city electrical engineer, East Bridge-street, Belfast. Tenders to the town clerk, Mr. R. Meyer, by 10 a.m. Wednesday, March 14.

Tenders are required by first post March 14 for supply of Electrical goods for one year to the Cheshire County Asylum, Macclesfield. Forms of tender, &c., from the Clerk.

Powell-Duffryn Steam Coal Co. require tenders by 10 a.m. March 7 for supply of Electrical Goods, Asbestos, &c. Forms of tender from Stores Manager, Aberaman Offices, near Aberdare.

The Bedwas Navigation Colliery Co. (Ltd.) requires tenders by 10 a.m. March 8 for 12 months' supply of Electrical Goods, &c. Forms of tender from the Secretary, Bedwas, Mon.

Barrow-in-Furness Corporation require tenders by noon March 5 for one year's supply of Electrical and Engine-room Stores, &c. Forms of tender from Borough Electrical Engineer.

Londonderry Corporation want tenders by noon March 17 for supply of Carbons, Meters, Cables, Fuse Boxes, Engine-room Stores, &c., for their electricity department. Specifications from the Borough Electrical Engineer.

Aberdare Urban Council require tenders by March 8 for one year's supply of Cable, Meters, Joint Boxes, Electric Lamps, Ironmongery, &c. Specifications from the General Manager of the electricity and tramways department.

Stockton-on-Tees Corporation require tenders by March 12 for six months' supply of Stores to the electricity and gas departments.

Belfast Tramways and Electricity Committee also require tenders by 10 a.m. March 3 for the supply of Tramway Stores, including Electrical Accessories, Cable, Lamps, Motors, Controllers, Trolley Heads, Castings, &c. Forms of tender from the General Manager.

Dundee Corporation require tenders by 9 a.m. March 28 for 12 months' supply of Meters and Electrical and General Stores to their electricity department. Specifications from the Electricity Dept. Offices, Dudhope, Crescent-road, Dundee.

Automatic Telephone Exchange.

The High Commissioner for the Union of South Africa invites tenders for the supply and installation of an Automatic Telephone Exchange at the Post Office, Pietermaritzburg, Natal Province. Specification and conditions of contract from the offices of the High Commissioner, 32, Victoria-street, London, S.W., where tenders must be lodged by noon March 8.

TENDERS RECEIVED AND ACCEPTED

Bedford.—The Council are recommended to accept the following tenders :—

British Thomson-Houston Co., turbo-generator and condensing plant, £8,647 ; Siemens Bros. & Co., cables £3,273, laying and jointing cables, £2,631 ; British Electric Transformer Co., six transformers, £1,136 ; Stirling Boiler Co., two boilers and mechanical stokers, £6,610.

Huddersfield.—The Corporation have placed an order for electric cars with the United Electric Car Co.

Sunderland.—The Council have accepted the following tenders ;

Babcock & Wilcox, boiler stanchion : British Mannesmann Tube Co., boiler tubes : Ferranti Limited, e.h.t. switchgear ; T. Ness (Ltd.), pitch and creosote oil.

Swansea.—The Council has accepted a tender of Thomas & Evan (at £145) for electrical fittings for the cookery and laundry departments of the Education Committee.

Government Contracts.—The following tenders were accepted by the British Government Departments during January :—

War Office.—British Insulated & Helsby Cables, Callender's Cable & Construction Co., Craigpark Electric Cable Co., Fuller's Wire & Cable Co., W. Geipel & Co., General Electric Co., W. T. Glover & Co., A. Green (Ltd.), Hooper's Telegraph & India Rubber Works, India Rubber, Gutta Percha & Telegraph Works Co., Liverpool Electric Cable Co., Midland Electric Wire Co. and St. Helens Cable & Rubber Co., electric cable and wire ; Siemens Bros. & Co., electric cable and wire and electric cells : Sutton & Co., stoneware conduits : J. Smith (Keighley) (Ltd.), cranes : India Rubber, Gutta Percha & Telegraph Works Co. and Peel-Conner Telephone Works, rod and sheet ebonite ; Aster Engineering Co., electric lighting sets ; Austin Motor Co. (1914), Coventry Simplex Engines, W. H. Dorman & Co., Heatly-Gresham Engineering Co., A. Lyon & Wrench and Record Engineering Co., generating sets ; Davey & Armitage, wood telegraph poles ; Dorman & Smith, swicthboards.

India Office.—Pritchett & Gold, &c., accumulators, &c. ; Siemens Bros. & Co. and Pell-Conner Telephone Works, telephones.

H.M. Office of Works.—Alpha Mfg. Co., electric wiring Admiralty transport building.

Post Office.—British L. M. Ericsson Mfg. Co., protective apparatus ; Creed & Co., telegraph apparatus ; British L. M. Ericsson Mfg. Co., telephone apparatus ; Craigpark Electric Cable Co. and Siemens Bros. & Co., telegraph cable ; W. Geipel & Co., W. T. Henley's Telegraph Works Co., Siemens Bros. & Co., Union Cable Co. and Western Electric Co., telephone cable ; British Insulated & Helsby Cables and Western Electric Co., cable drums ; Bullers (Ltd.), ironwork ; Siemens Bros. & Co., iron poles ; Bullers (Ltd.), steel poles and fittings ; London Electric Wire Co. & Smiths and C. Macintosh & Co., flameproof wire ; Dorman, Long & Co., R. Johnson & Nephew, Rylands Bros., F. Smith & Co. and Whitecross Co., g.i. wire ; Union Cable Co., v.i.r wire.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

London Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on Feb. 22, Mr. Robert H. Benson presiding.

The Secretary (Mr. H. C. Carter) having read the notice convening the meeting and the auditors' report,

The Chairman said : Gentlemen, the year just past has been an anxious one and a bad one for us and everybody else whose profit depends mainly on cost of coal and wages. Our generating costs are up by £24,267. Rates and taxes are up, too, by £6,218, making together £30,485 increase of expenses. On the other hand, sales of current have produced £8,239 more than last year, though we sold only 49,810,000 units against 50,759,000. The net decrease under these two heads is thus about £22,000, and accounts for the decline in net revenue, which, after bringing everything into the account, is £55,213 against £79,688 last year. To our great regret, in spite of all the efforts of our officials, from the managing director and chief engineer down to the youngest member of our technical staff, to economise in generation on the one hand, and on the other to obtain increases in the price received for current, the net result is 3½ per cent. only earned on our preference shares instead of 6 per cent., and, of course, nothing for the ordinary shares. I have to add to this plain statement of facts—facts which are directly related to the war, and principally due to the price of coal, which has cost over 10s. per ton more than in the previous year—that the situation of our generating station on the river at Deptford, which enabled us to use the cheapest coal, sea-borne and the best for our purpose, is not so economical now that we have to rely on rail-borne coal *plus* the cost of lighterage and handling, besides a varying and not always satisfactory quality. In fact, what in normal times is our great source of strength—the riverside position of our station—has become, owing to the war, our weakness. The usual table has been prepared and shows the comparative results for the preceding 15 years, during which 6 per cent. has been regularly paid on the preference shares, and dividends for the last 13 years on the ordinary shares varying from 2 per cent. to 4 per cent. It shows also surplus revenue, put to reserve in one way or another amounting to £176,567, to which there is due to be added this year £16,580, being the sinking fund for redemption of debenture stock, making a total of £193.147 out of revenue in 16 years. This policy is absolutely necessary in view of the risk of purchase by the authorities in 1931 at an unknown valuation. Part of this sum of £193.147 is invested outside the business, namely, in the sinking fund for redemption of debenture stock, which now amounts to £104.585, including £33.387 received (with interest) from the Westminster and St. James' Companies towards repaying by 1931 our capital expenditure of £130.000 in their districts. The remainder of the sum used out of revenue for capital purposes amounts to about £122.000. As the demand on the part of the public for electrical power increases, so it becomes necessary to buy additional plant and machinery of the most up-to-date character including mains, transformers, meters, tools, stations, offices, and last but not least, turbines. Once upon a time Lord Wantage used gallantly to relieve the shareholders' minds of all anxiety under this head. He made a rare man of business and shouldered other peoples' responsibilities with the courage of a soldier. Since his death we have had to rely on ourselves and you. Last year we had to spend £20.496 for new plant and machines, and £9.232 for smaller items, making the overdraft of capital account £98.745. The ideal concern is one which earns enough to pay for imperative capital expenditure out of revenue. In times like the present it is necessary not merely to economise in every direction, but also to incur no fresh capital liabilities that can possibly be avoided. The root of the difficulty is the old one familiar to you from the inception of these Parliamentary companies for the supply of that economic necessity, namely, electrical power for the public. Parliament has always been jealous lest we should make too much money out of the public! Now that all theories are in the melting pot owing to the war, we can only hope that when peace comes the policy will be reversed of favouring consumers at the expense of producers of necessary products, and taxing producers up to the point that they are unable to save money, but may positively lose it. The attitude of the official mind has been to drive a bargain so hard that the man on the other side of the table lost a little money. Indeed, money-losers and concerns which are unprosperous are a positive economic danger to the community. Are we not a wonderful self-governing people that we should for years and years have preferred to tax the thrifty producer and favour the extravagant consumer? We should have done better, and been more just, if we had simply held the balance even between producer and consumer; and now we see in the last few days the report of Lord Balfour of Burleigh's Committee. As it is, a war has been necessary to convince us of our folly. We console ourselves by saying that it is part of the genius of the English race, just as it is the foundation of the English law, to wait and see, to be unready, and to devise the remedy only after the trouble has come, and so to muddle through. Two remedies are possible for the much-harassed enterprise of producing electrical power in the London district; one is amalgamation or "association," as the Act of 1908 calls it, combining plants so as to reach the utmost economy in generation, but as yet no Company has seen its way to amalgamate under that Act. The other is to profit by the example of our American cousins, abolishing fixed rates and taxes as a charge, or clog, on industry and production, and to substitute a share of the profits to the municipal authority instead. I dealt with both these remedies once before in general meeting and refer to them now only to keep them alive in your minds and in public opinion. American municipalities get a larger sum out of their share of profits than our municipalities out of their rates. That public policy is penny wise and pound foolish which keeps so tight a hand over Power Companies as to check their development with the object of buying them up cheaply 14 years hence. The initiative for a better state of things than has existed heretofore cannot come from within the Companies, but must come from above. In conclusion, I desire to ask your sympathy for the staff, whose work and responsibility is hardest of all in these anxious times, depleted as they are. Your special thanks are due to Mr. Bain and Mr Partridge, and I would ask Mr. Bain to second the report and to give you particulars, as usual, both technical and commercial. You must not expect me to predict now the precise moment when the adverse conditions will terminate and the up-grade will begin. Necessity is the mother of invention, and though it may be temporarily impossible to obtain an increased price for power commensurate with the increased cost of generation, still, the tendency is for the price as well as quantity of units sold to increase. Whenever the cost of coal begins to go down and [illegible] good sea-borne coal is obtainable instead of irregular supplies of rail-borne coal, involving the expense of selecting and sorting, your prospects will rapidly change. I beg to move that the report and accounts for the year ended Dec. 31, 1916, be received and adopted.

The MANAGING DIRECTOR (Mr. R. Stewart Bain, C.A.) said the capital expenditure during the year amounted to £39,728, about £20,000 of which was on account of the new 10,000 kw. turbo-generator on order [illegible] of the L. B. & S. C. system. During the year 2,11[illegible] of motors had been connected in connection with the supply of power for [illegible] purposes, which brought the total at the end of the year to [illegible] in addition to which orders for a further [illegible] While receipts increased by over [illegible] by nearly £31,000, coal being responsible [illegible] [illegible] being increased [illegible] owing to [illegible] from the last quinquennial valuation. [illegible] getting delivery of coal, owing [illegible] bulk of their supplies had been by [illegible] the coal had generally been of an [illegible] The difficulty of obtaining [illegible] For these reasons the cost [illegible] from [illegible] and the average price received [illegible] of their large power contracts were entered into before the war at rates which then yielded a fair ratio of profit. The extraordinary increase in the price of coal, as well as the inferior quality, had rendered those contracts unprofitable; but he was glad to say that in every case power consumers had voluntarily allowed them to increase their rates from 10 per cent. to 20 per cent. Their generating station was situated on the river and designed with the intention that the coal supply should be by sea. Up to the outbreak of war that enabled them to buy coal more economically than stations dependent upon rail-borne coal; but when steamers became almost unobtainable and freights increased by six times the pre-war rate, arrangements had to be made to get their supply of coal by rail. As the nearest docks for a supply of rail-borne coal were at the other side of the river, trans-shipment proved costly and difficult. Their engineering staff had been indefatigable in dealing with the matter. Their company had suffered more from that cause than other London companies. The engineering staff, greatly depleted by their response to their Country's call, had had a very arduous year, and the manner in which they dealt with the accident referred to in the report was deserving of the highest praise.

After a brief discussion the resolution was carried. The retiring director, Viscount Duncannon, M.P., was re-elected and the auditors, Messrs. Gane, Jackson, Jeffreys & Freeman, were re-appointed.

St. James' & Pall Mall Electric Light Co. (Ltd.)

The ordinary general meeting was held on Tuesday, under the presidency of Mr. Walter Leaf, the chairman of the company.

The MANAGING DIRECTOR and SECRETARY (Mr. F. J. Walker, having read the notice convening the meeting and the auditors' report.

The CHAIRMAN, having referred in feeling terms to the deaths of Mr. Bennett Fitch, a director, and of Mr. Sydney T. Dobson, the late chief engineer of the company, said, fortunately, we had at hand a successor whom we could appoint without hesitation, to the place Mr. Dobson had so long and so admirably filled. The name of Sir Alexander Kennedy is known to all of you as that of a man who stands in the very front rank of living engineers. Sir Alexander had long been associated with Mr. Dobson in the management of the Central Co., and was thus intimately acquainted with what is now the vital portion of our own business, and in appointing him as our chief engineer we not only had the advantage of his unrivalled experience and ability, but are able to draw still closer our alliance with the Westminster Co., where Sir Alexander holds a like position. We see that our business has recovered from the shock of the war and resumed the steady progress which up to the middle of 1914 we regarded as normal. Our output has grown by close on 600,000, and this is the more satisfactory because it is due almost entirely to the second half of the year, and is more than maintained in the first six weeks of the current year. The number of units sold exceeds, indeed, that of the year 1914, the first half of which was peaceful, and has nearly recovered the position of 1913, when we sold 11,605,000 units, against 11,272,000 in 1916. If the present rate of growth is maintained, 1917 should easily surpass any year before the war. It must not be forgotten that last summer we had to face quite a new difficulty—the introduction of summer time. This had a distinct effect in reducing our returns during the two summer quarters. It was less than might have been anticipated, but cannot be exactly measured, as it is complicated with other factors; but it is certain that in these two quarters, as compared with those of 1915, there was a decrease of about 144,000 units, or a little over 2 per cent. of our output for lighting for the year. Our revenue also shows a good increase. This is mainly due to the increased output, but some of it arises from the increased prices which, in common with all the other London supply companies, we found ourselves bound to charge in order to cover increased cost. This charge has been willingly acquiesced in by our customers, who have seen the justification and the reason for it. The chief item is, of course, the increased cost of coal. This shows itself in our accounts in the increase in the cost of electricity purchased, amounting to £7,600 more than last year. The Central Co. has had to charge us more per unit, and we can only console ourselves with the thought that the increase would have been much larger had it not been for the efficiency of the new plant installed there. There have, of course, been other increases in expenses, notably in war allowances to the staff, alike to those who have gone out to serve their country at the Front and those who have served it no less loyally in their work at home. The munition work of which I spoke last time has been continued without cessation. The men have grown very expert at it, and have turned out the most excellent work. After making a fair charge for capital and other expenses we have been able to give them the whole of the remaining profits—a quite substantial addition to their income. Against these various items of increase we can set one reduction. We were enabled to obtain a re-valuation of our premises, resulting in a reduction of our payments for rates of £1,398. On the other hand, as I told you last year, the Central Company has paid no dividend, so that our receipts from investments have fallen off by £1,711. The upshot of all this is as follows: Our revenue has increased by £12,228, our costs by £6.510, showing a net balance of £5.718 to the good. From this has to be deducted the diminished return from investments, leaving us with a final balance of £4,007 more net profit than last year. We are thus enabled to pay the same dividend, with this important difference—that this time it is all paid out of profits, while last year we had to take for the purpose £1,500 from our contingency fund. The increase in output in 1916 was very largely due to connections made in 1915, and we cannot look for a repetition of this until building operations can once more be resumed. On the other hand, the increase which was shown at the end of 1916 has continued into 1917, and has already resulted in an addition to the output of 450,000 units, as compared with the corresponding period of last year. This is largely due to the rapidly-growing demand for current for heating purposes, and here, of course, we have been helped by the recent cold spell. I am glad, however, to add that there is a good increase in demand for lighting as well. With regard to the future, there is little that I can say with any confidence: all depends on the issue of the great and final crisis of the war which we are looking for in the next few months. There is every sign of a growth in expenses, in cost of coal, labour and materials. Our diminished staff has been sore put to it to meet the new conditions, and any additional strain will entail a disproportionate expense. A large portion of our increased efficiency is due to the installation of our large turbo-generator at Grove-road; it is estimated that this has saved us no less than £5,000 tons of coal during the year. We had on order another similar unit, from which we might have hoped, before the end of the year, to realise another large saving; but national needs must come first, and the Government has requisitioned this machine for other and more immediate uses. We are, however, endeavouring to get permission for another to be put in hand, but that cannot now in any case be ready for our next winter load, and we are thus unable to look for any saving under this head till the end of 1918 at the earliest. Indeed, at the present rate of increase, we cannot but look forward with some anxiety to the prospect of maintaining our output for the winter of 1917-18. We can only say that we, like the nation at large, have faced unprecedented difficulties in a way which shows an adaptability to the conditions of the great war beyond all our hopes, and that we mean to continue to do so till the end. Let me conclude with a word of reverent tribute to those of our staff who have laid down their lives for their country. In all 86 have joined the Colours. Of these 10 have been killed in action and one has died. In addition, five have been wounded and two are reported as wounded and missing. We owe them all a debt of gratitude; and I am sure you will all wish to convey to those who have been bereaved by death an assurance of our most sincere and respectful sympathy. I now conclude by moving the adoption of the report and accounts for 1916.

Mr. MARLBOROUGH R. PRYOR seconded, and the motion was carried unanimously. Mr. Walter Leaf, the retiring director, was re-elected, and Messrs. Deloitte, Plender, Griffiths, & Co. were re-elected auditors, the proceedings terminating with a vote of thanks to the chairman.

BRITISH L.M. ERICSSON MFG. CO. (LTD.)—The directors report for the year 1916 states that the profit constitutes a record and the prospects for 1917 are excellent. The net profit after charging £13,963. 3s. 5d. for depreciation, £6,579. 18s. 7d. for income tax and £2,500 for debenture interest, amounts to £47,145. 15s. 8d., to which has to be added £6,615. 17s. 4d. brought forward, making an available balance of £53,761. 13s. The directors recommend that after payment of the preference dividend amounting to £5,999. 8s., the balance be appropriated by paying 8 per cent. (tax free) to the ordinary shareholders (£8,000. 16s.), placing to reserve £9,000, placing to a reserve account for extra depreciation £5,000, and carrying forward the balance of £25,761. 9s. (subject to munitions levy and excess profits duty).

CENTRAL LONDON RAILWAY CO.—Lord Geo. Hamilton stated at the meeting on Friday that they were appropriating for depreciation and reserve £20,000, against £10,000 in 1915, and were able to increase the dividend on the undivided ordinary stock by ½ per cent., making 3½ per cent. for the year. The deferred stock received an additional 1 per cent., making 3 per cent. for the year, and leaving £12,079 to be carried forward, against £15,686.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors have decided, subject to completion of audit, to provide in full for allowances to employés on service and war bonuses to staff and employés, to place £40,000 to reserve and to recommend payment of the following dividends: On the preference shares, 12s. per share (being at full rate of 6 per cent. per annum), and on the ordinary shares 16s. per share (being at rate of 8 per cent. per annum). On account of these dividends 6s. per preference share and 6s. per ordinary share was paid in September last, and the balance remains to be paid. After payment of the dividends (less tax) and providing for other appropriations, there will remain about £17,000 to be carried forward.

LIVERPOOL OVERHEAD RAILWAY CO.—At the meeting on Tuesday the directors reported that the gross revenue receipts were £107,850. 1s. and the working expenses (including appropriation to reserve funds) £77,793. 16s. 11d. The total number of passengers carried during the year were 16,674,643, against 15,082,502 in 1915. The railway continued to be worked during the year under the agreement concluded with the Government on the outbreak of the war. After paying interest on debenture stock (£6,755. 4s.) and adding balance brought forward (£6,873. 0s. 10d.), &c., the amount available was £30,982. 0s. 7d. Interim dividends on the 5 per cent. preference shares £3,965. 10s.) and on the ordinary shares at 2¼ per cent. £6,250) absorbed £10,215. 10s., and final dividends for the half-year ended Dec. 31, at the rates of 5 per cent. per annum on the preference shares and 4 per cent. per annum (making 3¼ per cent. for the year) on the ordinary shares were declared, and a balance of £6,801. 0s. 7d. was carried forward.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—The Earl of Bessborough, K.P., who presided at the recent meeting, stated that passenger traffic receipts showed an increase of over £177,000 and 1,391,000 persons over 1915. A large part of those increases was due to the electrical services, and it was to be hoped that the traffic restrictions necessitated by Government requirements were only a temporary check to their steady progress in regaining the traffic they were losing to other modes of locomotion at the time those services were inaugurated. They proposed the same dividend as in 1915, carrying forward £7,270 less. The capital expenditure during the year had been quite inconsiderable, mainly on electrification extensions and the provision of additional rolling stock. The contractors for the electrification work were proceeding as well as could be expected, having regard to the difficulty in obtaining materials and labour. Certain widenings required for the extensions were in hand, and they proposed to proceed with them as rapidly as possible, so that no time might be lost when opportunity occurred in making greater use of electrical working.

LONDON ELECTRIC RAILWAY CO.—Lord Farrer, who presided at the meeting last week, said that the extension of the train service to Watford in connection with the London & North-Western Railway had been delayed owing to the difficulty of obtaining the necessary joint rolling stock, but arrangements had now been made for their company temporarily to supply rolling stock on reasonable terms, and it was anticipated that the through service could be commenced by about the beginning of April. The result of the Queen's Park extension and the through running to Willesden had, even in the present abnormal times, been excellent, and the directors anticipated further improvement from the extension to Watford. In reply to suggestions to raise fares, he said new factors had now entered into the problem, one of which was the falling purchasing power of money, and if the price of all the commodities the company had to buy continued to rise they felt that a readjustment of fares would be justifiable.

LONDON ELECTRIC WIRE CO. & SMITHS (LTD.)—The directors recommend a final dividend of 7½ per cent. and a bonus of 2s. 6d. per share (together 10s. per share), tax free, on the ordinary shares, making 12½ per cent. for the past year (as in 1915), adding £40 000 to general reserve, £1 000 to reserve for depreciation of investments, and £80,000 to special reserve for taxation and other contingencies, and carrying forward £26,874.

LONDON & NORTH-WESTERN RAILWAY CO.—Sir Gilbert Claughton, Bart., stated at the meeting on Friday last that they had expended on capital account during the year £520,172, of which £457,903 was in connection with the Euston and Watford Electric Railway. The extension of the Bakerloo Tube to Queen's Park was opened in February, 1915, and arrangements were afterwards made, pending the opening of the through route to Watford, for certain of the Tube trains to run through from Queen's Park to Willesden, where connection was made with the main line and local London & North-Western trains. After much unavoidable delay in the carrying out of the contracts owing to the war, the new electric line between Willesden and Watford had been complete for some time past, but they had not yet been able to obtain delivery of the rolling stock. Meanwhile, the line had been used by steam trains, and it had been of immense advantage in enabling the main lines to be kept free for the ever-increasing through traffic. Arrangements had been completed for a through service of electric trains to be run from Watford to Queen's Park, and thence over the Tube railway to Elephant and Castle by the use of the Tube Company's stock, and it was hoped to start the service almost immediately. The electric services of trains between Kew and Richmond and Broad-street commenced to run on Oct. 1 last, and had given some promise of a return of the large passenger traffic which that railway formerly enjoyed, but of course they could not look forward to the complete fulfilment of their hopes until the whole scheme of their electrified lines was complete, and that, he was afraid, they could scarcely expect until after the war.

LONDON & SOUTH-WESTERN RAILWAY CO.—At the annual meeting on Friday the chairman (Mr. Hugh W. Drummond) referred to the agreement with the Government, and said that it had been agreed that the railway companies should receive interest at 4 per cent. per annum on the cost of all new works since Jan. 1, 1913. A good instance of the fairness of that arrangement was the electrification of their suburban lines. They now found themselves in a position to say what would be the actual expenditure in connection with that portion of the electrification which they had carried out. Although the final accounts had not yet been settled, and certain work remained to be done, the actual cost would amount to approximately £1,365,000. The directors thought that £20,000 should be carried out of revenue to the electrification of suburban lines revenue suspense account, which left them in a position to recommend the same rate of dividend on the ordinary stock as last year—namely, 5¼ per cent. on the undivided ordinary and 1½ per cent. on the deferred converted ordinary stock. Their experience of the electrified portion of their suburban lines had been in every sense satisfactory.

METROPOLITAN DISTRICT RAILWAY CO.—The chairman (Lord Geo. Hamilton) stated at the meeting last week that the difficulty of securing labour and material for really adequate maintenance of the property had been recognised by the Government, and a special allowance was made to controlled railways to cover that deferred maintenance. It was doubtful whether the amount, so far as this company was concerned, was sufficient, and it had, therefore, been recommended that £15,000 be added to the reserves for renewals and contingencies, as against £35,000 last year. After the payment of 3 per cent. on the second preference stock, £20,688 was carried forward, against £13,952. While they were under Government control any raising of fares was, without the consent of the authorities, out of their power, even if it seemed desirable from the revenue point of view. They had always been believers in the lowest reasonable rate of fare, not only because, as a public transport company, they must always carefully consider their relations to the public, but also because they realised that in the long run they made a higher net earning for the shareholders by carrying many passengers at a low fare rather than fewer passengers at a high rate. Low fares and good service stimulated traffic, and that had hitherto been their aim. The present position, however, could not continue indefinitely, and some readjustment of fares might be necessary.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—Mr. J. Booth, who presided at the recent meeting, said the company had experienced a disappointment in regard to the new turbine plant, which had been delayed in delivery, and which had seriously handicapped the engineers, who had to deal with a growing output under very trying conditions. Notwithstanding the serious loss sustained owing to the stringent lighting restrictions and the Daylight Saving Act, the total output had increased by 22½ per cent. owing to the increased demand for power and the total income had increased by £2,250. The capital account had been increased by £7,000, chiefly for the new turbine set. The coal bill increased by £2,675 over 1915 and £3,943 over 1914. That was owing to higher prices, a larger output and that for nearly ten months of the year they had been working under unfavourable conditions. The sale for current for lighting had produced £1,310 less, but the sale for power had grown, so that the total revenue had increased by £2,250.

NEWCASTLE & DISTRICT LIGHTING CO. (LTD.)—The gross profit for 1916 was £39,363. 16s. 10d., and with £27,822. 13s. from 1915 the total was £67,186. 9s. 10d. Interest on debentures and loans absorbed £18,548. 5s. 3d., leaving £48,638. 4s. 7d. The directors recommend payment of a dividend at rate of 2½ per cent. (less tax) for the year ended Dec. 31 (£5,764. 1s. 3d.), the transfer to second mortgage debenture redemption fund of £2,395 and to reserve of £10,000. After writing £500 off debenture issue expenses, £29,979 3s. 4d. is carried forward. Although the profit earned during the year would have enabled a larger dividend to be paid, the directors consider, in view of the continued high price of coal and the abnormal conditions due to the war, it is wiser to restrict the dividend to 2½ per cent. The capital expenditure for buildings, plant and mains during the year was £9,793. 7s. 7d.

NORTH LONDON RAILWAY CO.—Lord Rathmore, who presided over the recent meeting, said they were paying the same dividend as a year ago (3¾ per cent. for whole year), and they were carrying forward £10,302 (against £8,137). The ordinary traffic had been interrupted by the enormous amount of Government traffic. The capital expenditure during the year was £23,251, nearly the whole of which had been expended on the electrification of the railway. The total amount expended for that purpose amounted to £100,865. Very little remained to be spent under that heading, and it would not be necessary to raise any further capital for that purpose. The idea of electrification was to work in with the larger scheme for the electrification of the London & North Western Railway's suburban lines, and they could only begin to obtain the full benefit of the electrification of their own railway when the greater scheme had been completed. When that was done he thought they might look forward with fair confidence to a return in some measure of the prosperity which their railway formerly enjoyed. War had upset their calculations so far, inasmuch as the London & North-Western had not been able yet to complete the electrification of their line between Willesden and Chalk Farm, which was an essential link in the scheme for running through services between Watford and Broad-street. They had commenced to run an electric service between Broad-street, Kew and Richmond, and though they had been able to obtain only a portion of the rolling stock they would ultimately require, the results had so far been encouraging. The falling off in passenger traffic had been arrested, and until the raising of fares and restriction of services after Dec. 31 last there had been increases week by week. Since then, not unnaturally, there had been a small decrease in passenger receipts, but the new trains generally seemed to give satisfaction.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the expenditure on capital account was increased during the past year by £991. 15s., making a total of £251,672. 6s. The expenditure on capital account exceeds the receipts by £15,319 16s. The cost of the joint station at Wood-lane to date has amounted to £225,022 3s. 7d., and joint debenture stock, amounting to £228,[illegible], has been issued. The number of consumers is now 1,400, and, with the exception of 20, they are supplied at 200 volts. The equivalent of 241,8[illegible] 30 watt lamps is connected, compared with 238,981 in 1915 and 234,0[illegible] in 1914. The year's revenue from the sale of current was £43,1[illegible], an increase of £767 over 1915. The reduced profit is due to the increase in the cost of fuel and labour, to the higher assessment for rates and an addition to the income tax of £1,871. Kensington Council has [illegible] the company's proposal to increase the charge of current to [illegible] per cent. to compensate the company in some measure [illegible] of these additional costs. This increased [illegible] brought into force during the last three [illegible]. [illegible] available profit of £23,729. 11s. 11d. the [illegible] depreciation, renewal and reserve fund [illegible] £2,016, Kensington and Notting Hill [illegible] (£1,880 7s. 10d.) interest [illegible] fund (£1,[illegible] 17s. 8d.), income tax [illegible] copartnership scheme (£250), leaving a balance of [illegible] of 6 per cent. preference [illegible], which absorbed £6,696, [illegible]. The [illegible] dividend of 3s. per [illegible] at 11[illegible] 11s. 3d., carrying [illegible] reduction in the net [illegible] copartnership [illegible] that [illegible] of [illegible] paid £2,[illegible] which it

equivalent to the bonus received by them for the past two years. Mr. Alfred Hoare has been elected a director in succession to the late Sir Richard B. Martin, Bart.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The accounts for 1916 show a net profit of £111,915. 5s. 3d. after charging the interest on the debentures. With £110,474. 5s. 11d. from last year the total is £222,389. 11s. 2d. From this amount is deducted the interim dividend of 5 per cent. (paid in July last) amounting to £22,410, leaving £199,979 11s. 2d. The directors propose to distribute a further dividend of 10 per cent., together with a bonus of 12s. per share (tax free), absorbing £67,230, and to supplement the reserved fund by £20,000 (making it £135,000), leaving £112,749. 11s. 2d. to be carried forward. The general business of the company during the past year has been satisfactory. The works and steamships have been maintained in their usual state of efficiency. In order to provide against the continued depreciation in securities in 1916, £50,000 has been appropriated from the reserved fund. In May, 1916, the company's works were declared by the Ministry of Munitions to be controlled establishments. The Right Hon. the Earl of Selborne, K.G., was reappointed a director of the company on July 13 last.

YORKSHIRE ELECTRIC POWER CO.—The chairman (Mr. A. G. Lupton) presided at the meeting last week, and in moving the adoption of the report and accounts, said that the underlying principle on which the company's business was founded was the economy of fuel which could be secured by the production of electricity on a large scale. The demands upon the company were increasing rapidly in every part of its area, and especially in the southern portion where great developments in the iron and coal industries were in view, in which the company must be prepared to take its full part. To provide for that the directors had been compelled to order further generating plant, for which provision was being made in the waste heat station at Barugh and in the buildings now in course of erection at Thornhill. The development of the company in the past had resulted in many undertakings taking a bulk supply instead of building separate generating stations for themselves, and it was gratifying to find that there was a general awakening to the principles on which the power companies were established by Parliament. The Incorporated Association of Electric Power Companies had taken an active part in the movement which was going on with respect to the suggested linking up of electric power stations with a view to effecting greater economies in fuel and capital and a general development in the use of electricity from public sources. They would be interested to know that last year Bradford Corporation and the company entered into a reciprocal agreement to supply electricity. The continuance of the war had caused many anxieties in consequence of the shortage of labour and the cost and slow delivery of supplies, but considering those adverse circumstances the results of the year had been very satisfactory.

Mr. A. H. Meysey-Thompson, who seconded the resolution, said that at last the company had arrived at the turning of a long lane, and they could now feel that they had done their share in clearing the West Riding of the pall of smoke which had so long hung overhead. The company had largely increased both its power of production and the capacity of the mains. He hoped that the reciprocal agreement with Bradford Corporation was an indication of a happier spirit in the relationship between the company and the municipalities in its area.

The report and balance-sheet were approved.

CITY NOTES.

MEMORANDA (Feb. 27).—Consols, 52$\frac{1}{16}$. Consols Pay Day, April 2. Stocks and Shares Ticket Day, March 13. Pay Day, March 14. Price of Silver, 37½d.

CITY OF CARLISLE ELECTRIC TRAMWAYS CO. (LTD.)—The accounts for 1916 show (after providing for debenture interest and £2,000 for redemption of second debentures) a balance of £775 to be carried forward.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.).—A final dividend has been declared on the ordinary shares at the rate of 9 per cent. per annum (less tax) for the half-year ended Dec. 31, making 7 per cent. for the year 1916. A sum of £15,000 (against £10,000) is placed to reserve for depreciation, and £18,000 carried forward, against £14,000. For the preceding year the dividend was the same.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors recommend a dividend of 3½ per cent. on the ordinary shares for the half-year ended Dec. 31, 1916, making, with the interim dividend paid in August last, 6 per cent. for the year.

MANSFIELD & DISTRICT TRAMWAYS CO. (LTD.)—A final dividend at rate of 8 per cent. per annum has been declared on the ordinary shares, making 7 per cent. for the past year. A sum of £4,162 has been placed to reserve and £1,896 carried forward.

TRAMWAYS, LIGHT & POWER CO. (LTD.)—The profit for the past year was £33,420, making, with £3,348 brought forward, £36,768, against £32,213 in 1915. The dividend on the 6 per cent. preference shares for the year was paid, and £5,000 placed to reserve, and £1,072 forward.

UNITED ALKALI CO. (LTD.)—A final dividend of 2s. per share is recommended on the ordinary shares, making 3s. per share (15 per cent.) for the past year.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Warrants for the dividend on the preference shares were posted on the 28th ult.

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NOTES.

The London Electricity Supply Companies.

Judging by the annual reports which are coming to hand of the various London electricity supply companies, it appears that these undertakings, generally speaking, are maintaining their positions satisfactorily under very adverse conditions. The importance of the electric heating load is now being realised more fully than was the case two or three years ago. It is now being demonstrated that a tariff of 1d. per unit not only attracts the consumer who wishes to use electrical energy for occasional heating, but is also remunerative to the supplier. For example, the chairman of the Westminster Electric Supply Corpn., in addressing the shareholders, remarked that a few years ago they could hardly have supposed that such a company, whose area was mainly in the residential and shopping districts of London, would sell as many units for power as for lighting. This company was the pioneer of power and heating at 1d. per unit in the West End of London, and the result has certainly justified its policy. We do not mean to suggest that 1d. per unit is as low as it should be from the point of view of attracting consumers to use electric heating to any large extent, but it is at least satisfactory as a start. On the other hand, there have been many difficulties in the way of substantial progress. The effect of the Summer Time Act has undoubtedly been felt to a considerable extent, though to what extent cannot be in all cases determined. The most serious handicap, however, has been the rising cost of coal. In this direction the London Electric Supply Corpn. have been particularly unfortunate. Under peace conditions they are exceedingly well situated on the banks of the river, but under war conditions the cheap sea-borne coal has not been available, and it has been necessary to fall back upon rail-borne coal, which has been delivered on the other side of the river, and on which, consequently, there has been the further cost of lighterage and handling. The net result is that coal has cost over 10s. per ton more than in the previous year, which is a most serious cost to face; and, further, the coal has been of an inferior quality.

In his chairman's address to the shareholders of the London Electric Supply Corpn. Mr. R. H. Benson called attention to the tendency of the Government of this country to tax the thrifty producer and favour the extravagant consumer. He mentioned two possible remedies. One is the amalgamation of companies, and the other is to profit by the example of our American cousins in abolishing fixed rates and taxes as a charge, and substituting a share of the profits to the municipal authority. He stated that the American municipalities obtained a larger sum from their share of the profits than our municipalities obtained from their rates. It appears to us that these are not really alternatives. There should in any case be association, and the sooner some such association is brought about the better; but whether sharing of profits is a desirable basis is questionable. The great advantage of such a scheme is, of course, that if there is no profit there is no share, but where there are reasonable profits the advantage is not so obvious. What is most important, however, is, as Mr. Benson points out, that the Government and municipal bodies should not simply check the development of private enterprise with the object of buying up such enterprises cheaply 14 years hence. Perhaps it is not too much to hope that in these days, when there is so much in the melting pot, the views of public bodies on such subjects may undergo a change along more reasonable lines. Mr. Benson is quite correct in saying that money losers and concerns which are unprosperous are a positive economic danger to the community. We have seen too much of this class of success in the electrical industry, and it is time Government realised that prosperity of private enterprise means prosperity of the country as a whole and not necessarily robbery of the public.

The Failures at Birmingham.

From time to time we have noted serious failures in the electricity supply at Birmingham, due to the large demands for power that have been made upon the undertaking of that city. A report has now been issued on the subject by Councillors Appleby and Beale, along with a report by members of the Electricity Supply Committee who were members of that Committee in 1911, in reply to Messrs. Appleby and Beale's report; there is also a report by the city electrical engineer, Mr. R. A. Chattock. From these reports it becomes evident that if the scheme for a new station, for which a site was selected in 1910, had been pushed forward, all would have been well. Of course, the Committee could not foresee the calamity of war, which came as a surprise to everyone in 1914, but the fact remains that there was a good deal of dilatoriness after October, 1911, when the Council were recommended to purchase the Nechells site and raise £500,000 for the station, which was to be ready for the winter of 1915-16. Had this scheme been pressed forward to a normal extent the work would have been far more advanced in August, 1914, than was the case. Four years were allowed for erecting the new station, but actually in July, 1914, 14 months before the date when the station, according to the original programme, had to be opened, nothing had been done beyond driving a few experimental piles and the provision of some railway sidings. Since December, 1912, there seems to have been a series of differences of opinion among the Committee as to accepting the engineer's proposals. The engineer did not receive the support of the whole Committee, and consequently no prompt action was taken notwithstanding the fact that Mr. Chattock had stated in 1910 that new plant would be required before the new station could be finished. It should be realised that the committee of a large undertaking, like that of Birmingham, incur heavy responsibility when they fail to take the advice of their engineer and fail to provide well in advance for the normal growth of demand which must inevitably arise. In the present instance the war has, of course, aggravated the difficulty very greatly, but even if no war had arisen it appears that the Committee would scarcely have been in a position to meet the normal demand with a proper margin of safety in plant.

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Linking-up in Lancashire and Cheshire. On the 2nd inst. an important meeting was held at Manchester, at which Mr. G. H. Roberts, M.P., Parliamentary Secretary to the Board of Trade, presided, when 125 delegates representing 42 undertakings were present. Mr. Roberts outlined the proposals made by the Board of Trade. It appears that the next step rests with the Interconnection Committee, by whom details are to be worked out and then submitted to the Board of Trade.

Effect of Electricity on Crops.—Important experiments on the application of electricity to agriculture are being made, under Government grant, at Huntington, in Hereford. As is well known, high-tension discharge accelerates the growth of plants, and may lead to a considerable increase in the yield of crops from a given area. Associated with these experiments are Prof. T. H. Blackman, Mr. W. Duddell, and Mr. I. Jorgensen, a Danish expert. Mr. W. J. Kerr, city electrical engineer of Hereford, is also concerned with the movement.

State Control of Mines. The Advisory Board to assist the Controller of Coal Mines has been constituted as follows:—

For Coalowners.—Messrs. Adam Nimmo, A. Pease, C. L. Rhodes, Bramwell, and Sir Thomas Ratcliffe Ellis.

For Miners.—Messrs. R. Smillie, W. Straker, H. Smith, S. Walsh, M.P., and Vernon Hartshorn.

The Controller will confer with the Board on general questions of policy affecting the industry. For the present the existing general and local committees will be continued, but the more direct control of the industry will probably call for changes in the existing organisation.

The S. P. Thompson Memorial. In addition to the proposal to which effect is now being given, to secure the library of the late Prof. S. P. Thompson for the Institution of Electrical Engineers, a scheme has been set on foot by the Finsbury Technical College Old Students' Association. It is hoped to collect a sum of not less than £250, part of which will be handed over to the Committee which has purchased the library above mentioned, and the remainder will be utilised for setting up a memorial at the City and Guilds Technical College, Finsbury, of which Prof. Thompson was for so many years the Principal.

Automatic Train Control. In the reports of Col. Pringle and [illegible] Col. Druitt on the railway collisions near Kirtlebridge (on the Caledonian Railway) and at Wigan (L. & N.W. Railway), which occurred in December last, the adoption of a system of automatic control of trains by which the brakes are applied when an engine driver passes a signal at danger is strongly advocated.

In the Kirtlebridge [illegible] Col. Pringle found that a postal train passed at the danger signal [illegible] chief feature which strengthened his [illegible] automatic control should include provision [illegible] signal and precluded the [illegible] when the train had come to a standstill. [illegible] under trial but decision as to which is best suitable for general adoption must await more favourable [illegible]. As the driver did not hear the fog signals explode, Col. Pringle suggests that the question of the audible detonator should be referred to the [illegible] Safety Appliances Committee.

In the Wigan case Col. Druitt, who found that an express ran past the danger signals, stated that "with the [illegible] inter-running of one company's engines over other companies' lines any automatic system, to be really effective, must be universal throughout the country, for it is possible that there may be more such inter-running in the future."

Summer Time.—The Home Office Committee, which has been considering the results of the Summer Time Act, 1916, has issued its report.

The Committee reports that the vast preponderance of opinion is enthusiastically in favour of summer time and of its renewal—not only as a war measure but as a permanent institution. It is, therefore, recommended that summer time should be renewed in 1917 and in subsequent years; that its operation should be from the second Sunday in April to the third Sunday in September; that the change from normal to summer time should be made on the night of Saturday-Sunday, and the reversion to normal time from Sunday-Monday; and that the variation from normal time should be one hour.

It is stated that the difficulties experienced were much less serious than critics predicted, and the Committee did not hear of any that could not be overcome with goodwill and organisation. After reciting some of its advantages, the Committee states that widely divergent views were received as to the percentage of reduction in the consumption of electricity and gas for lighting.

Training of Disabled Men as Sub-station Attendants.—The Queen visited on the 21st ult. the classes in progress at the Northampton Polytechnic Institute, Clerkenwell, E.C., for giving a preliminary training to disabled sailors and soldiers as electricity sub-station attendants. Her Majesty was received by Mr. L. B. Sebastian and Dr. R. M. Walmsley, respectively chairman and principal of the Institute, with whom, among others, were Mr. C. H. Wordingham (vice-president I.E.E.) and Mr. P. F. Rowell (secretary I.E.E.), representing the Institution of Electrical Engineers (in the unavoidable absence of the president, Mr. C. P. Sparks), Mr. F. M. Denton and Mr. S. D. Chalmers (heads of the electrical engineering and optical departments), and Mr. G. R. Buckley and Miss Collin (honorary secretaries of the Disabled Soldiers' Aid Committee). During the course of a prolonged inspection of the men, while under actual instruction in the power house of the Institute, Her Majesty showed the greatest interest in the work that was being done and made personal inquiries from each man as to his disablement and the progress he was making in his training. Her Majesty also inspected the optical workshops of the Institute.

Electricity in Mines.—Part II. of the Annual Report on Mines and Quarries for 1915, which was recently issued, contains particulars of the electric motors in use (above and below ground) in collieries in the United Kingdom in January, 1915. The following figures represent the total horse-power of motors in each of the inspection divisions:—

Division.	Surface.	Under-ground.	Total.
	H.P.	H.P.	H.P.
Scotland	33,151$\frac{11}{40}$	112,223$\frac{17}{20}$	145,375$\frac{1}{8}$
Northern	88,874$\frac{3}{5}$	99,658$\frac{1}{2}$	188,533$\frac{1}{10}$
York & North Midland	73,855$\frac{31}{40}$	61,446$\frac{37}{40}$	135,302$\frac{7}{10}$
Lancashire, North Wales & Ireland	16,180$\frac{1}{4}$	25,494$\frac{3}{4}$	41,675
South Wales	109,685$\frac{9}{10}$	124,569	234,254$\frac{9}{10}$
Midland & Southern	14,355	45,235$\frac{1}{4}$	59,590$\frac{1}{4}$
Total in 1915	336,102$\frac{4}{5}$	468,628$\frac{11}{40}$	804,731$\frac{3}{40}$
Total in 1914	294,092$\frac{9}{20}$	419,689$\frac{27}{40}$	713,782$\frac{1}{8}$

The number of electrically-driven coal-cutting machines in use was 1,419, an increase of 34 over the number in use at the end of 1914. The report states there were 12 fatal accidents definitely due to electricity, causing 12 deaths. Of the 12 accidents, four took place on the surface and eight below ground. The figure for electric shock accidents below ground, which had decreased considerably, now shows an increase—eight against four in 1914 and 13 in 1913. An examination of the details of these accidents shows that the majority of them were due to carelessness or to non-observance of the statutory regulations.

OBITUARY.

James Forrest.—We regret to record the death, which occurred at St. Leonards on the 22nd ult., of Mr. James Forrest, Hon. Sec. and for many years the Secretary of the Institution of Civil Engineers.

In 1856 Mr. Forrest became Acting Secretary of the Institution of Civil Engineers, and three years later Secretary, an office which he continued to hold until ill health compelled him to retire in 1896, when he was appointed Honorary Secretary. Some years before his retirement a presentation made to him by the Council enabled him to devote a sum of money, subscribed by the members, for the endowment of an annual lecture on some subject illustrating the interdependence of abstract science and engineering. The 25th of these "James Forrest" Lectures will be delivered in a few weeks by Sir John Wolfe-Barry. Mr. Forrest, who was 92 years of age, was connected with the Institution for 75 years.

Sir B. C. Browne.—We also regret to announce the death of Sir Benjamin C. Browne, the well-known Newcastle engineer. He was twice Mayor of Newcastle and in 1887 he was knighted by Queen Victoria. He was chairman of Hawthorn, Leslie & Co., Ltd., and a director of the Newcastle & District Electric Lighting Co. At various times he gave evidence before Royal Commissions on industrial disputes, &c., and he was a member of the Home Office Committee on the working of the Workmen's Compensation Acts.

Francis Nalder.—We regret to learn of the death of Mr. Francis Nalder, which occurred at Beckenham on the 28th inst. The deceased was 87 years of age and was the father of Mr. F. H. Nalder, of Messrs. Nalder Bros. & Thompson.

Deaths on Active Service.—The following deaths in action or of wounds or sickness while on active service are reported:—

Lieut. A. S. M. Best, R.E., 31 years of age, who has been killed, was a B.Sc. (London) and an A.M.Inst.C.E. Prior to the war he was assistant engineer in the Federated Malay States Public Works Department.

Sec.-Lieut. F. H. Best, S. Wales Borderers, brother of the above-mentioned, has also been killed, at the age of 22. He was educated at the City and Guilds Engineering College and passed the Intermediate B.Sc. (Engineering) examination in July, 1914.

Capt. C. M. C. Barker, Indian Infantry, aged 22, who has been killed, was the elder son of Mr. R. C. Barker, C.I.E., Director-in-Chief of the Indo-European Telegraph Department.

PERSONAL.

Mr. J. B. Ball, engineer-in-chief of the Great Central Railway, has been appointed chief engineer of the London, Brighton, and South Coast Railway, in place of Mr. C. L. Morgan, who has been elected a director of the latter company.

The Priority Branch of the Ministry of Munitions, whose functions are to determine the priority of all engineering and contract work, &c., has been constituted a separate department, and Mr. Edgar Jones, M.P., who has been appointed Controller, will be assisted by an advisory committee.

APPOINTMENTS VACANT AND FILLED.

Junior engineers-in-charge are required for a large power station in Scotland (d.c. and e.h.t. three phase with rotaries); also junior engineer for mains department. *See advertisement.*

A switchboard attendant is required for a.c. and d.c. municipal electricity works in the Midlands.

Ships' officers are wanted for a telegraph cable expedition. *See an advertisement.*

A shift engineer is required for a small municipal station.

Mr, J. K. Bruce, deputy chief officer of the London County Council Tramways, was appointed on Tuesday traffic manager as from April 1 next, at a commencing salary of £1,250, rising by annual increments of £50 to £1,500 per annum.

INSTITUTIONS AND SOCIETIES.

Institute of Chemistry.—In the course of his address, at the annual general meeting of the Institute, the President referred to the services of professional chemists in connection with the war. The high rank which many of the members and students had attained and the distinctions they had won gave the Institute every reason to be proud of the part they had taken in the conflict. After indicating a number of new industrial developments which called for the help of practical chemists, the President advocated the extension of the training of chemists, particularly in higher physics and physical chemistry, and therefore the adoption of a four instead of a three years' course. He emphasised the importance of mechanics to chemists who intended to practice in industry and recommended a training as wide as possible for chemists generally. Dealing with the recent discussions on general education and the reform of the school curriculum, he criticised what was termed "generalised science," by which he supposed was meant a composite course, including a little physics, a little chemistry, a little biology and a little of everything else, and suggested that school science should be as simple as possible and that the first place should be given to mechanics experimentally treated, as being essential to the study of all other experimental science.

Institution of Civil Engineers.—On Monday the 12th inst., at an extra meeting of the Institution, a lecture will be given at 5.30 p.m., by Mr. Edgar Crammond on "Foreign Trade and its Relation to the Investment of Capital Abroad." Members of the Institutions of Mechanical Engineers, Naval Architects and Electrical Engineers, and of the Iron and Steel Institute are invited to attend. This lecture is in accordance with the policy of the Council due to the feeling that the consideration of certain subjects outside the usual scope of the Institution proceedings is desirable at the present time. Discussions of the issues raised by the lecturer will be invited, and further extra meetings are to be held at which lectures on the "Decimal System of Coinage" and "Weights and Measures," and on the "Standardisation of Engineering Materials," will be given.

Royal Society.—Among the 15 candidates selected by the Council of the Royal Society to be recommended for election into the Society we notice the names of Mr. L. Bairstow, Prof. A. S. Eve, Prof. H. Jackson, Prof. J. W. Nicholson and Dr. R. H. Pickard. Mr. Bairstow has carried out a great deal of work in aeronautics at the National Physical Laboratory. Prof. Eve is a physicist identified more particularly with such subjects as radio-activity and ionisation. Prof. Jackson, of King's College, London, has been prominent in surmounting the difficulties in producing special qualities of glass in this country for laboratory and optical work. Prof. J. W. Nicholson is professor of mathematics at King's College and his work has been concerned largely with mathematical physics. Dr. Pickard is an organic chemist and Principal of the Municipal Technical School, Blackburn. This year the tendency has been to nominate a large proportion of chemists; physics and engineering appear to have received comparatively small consideration.

Institute of Radio Engineers (New York).—At a meeting of the Institute on Feb. 7, a Paper on "The Influence of Commercial Conditions on Transmitter Construction" was read by Mr. Julian Barth.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 9th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road South Kensington, S.W. Agenda: "To Measure the Pressure in a High Vacuum by Means of Logarithmic Decrement," by Dr. P. E. Shaw, B.A.; "A Diffraction Colour Box," by Mr. A. W. Clayden, M.A.; "Demonstration of Interference Effects with a Thorpe Grating," by Mr. A. W. Clayden, M.A.

Junior Institution of Engineers.

8 p.m. At 39, Victoria-street, S.W. Paper on "X-Ray History Electrically Illustrated," by Mr. C. Major.

MONDAY, March 12th.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, S.W. Lecture on "Foreign Trade and its Relation to the Investment of Capital Abroad," by Mr Edgar Crammond.

Newcastle Local Section, Institution of Electrical Engineers.

6.45 p.m. At the Mining Institute, Newcastle-on-Tyne. Paper on "The Principles Involved in Computing the Depreciation of Plant," by Messrs. F. Gill and W. W. Cook.

TUESDAY, March 13th.

Manchester Local Section, Institution of Electrical Engineers.

7 p.m. At the Engineers' Club, Manchester. Paper on "Voltage Regulation of Rotary Converters," by Mr. G. A. Juhlin.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Colonel C. B. Clay, V.D., Commanding

Officer for the Week.—Platoon Commander E. Greenop.

Next for Duty.—Platoon Commander H. de P. Birkett.

Resignations.—Platoon Commander G. H. Parker and J. O. Cheadle resign their appointments on joining the Army.

Monday, March 12.—Technical for Platoon No. 9, at Regency-street; Squad and Platoon Drill, Platoon No. 10; Signalling Class; Recruits' Drill, 6.30 to 8.

Wednesday, March 14.—Instructional Class, 6.15; Platoon Drill, Platoon No. 2.

Thursday, March 15.—Platoon Drill, Platoon Nos. 5 and 6; Ambulance Class by M.O., 6.30.

Friday, March 16.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9; Signalling Class; Recruits' Drill 6.25 to 8.25.

Saturday, March 17.—Commandant's Parade, 2.45. Uniform for Route March. Bugles and Drums to attend.

Sunday, March 18.—Special work at Bombing School. Parade Clapham Junction Station (City & S.L. Tube Railway), 9.45 a.m. Uniform, haversacks, water-bottles. Midday rations to be carried.

Easter Training.—Will be at Esher, *see* Special Order.

Musketry.—For all companies, *see* Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills will take place at Headquarters.

ELECTRICAL SYSTEM OF THE RAND POWER COMPANIES, WITH SPECIAL REFERENCE TO METHODS OF OPERATION AND EXPERIENCE.*

BY BERNARD PRICE.

(*Concluded from page* 656.)

Summary.—The object of this Paper is to describe the lay-out and operating characteristics of the electrical portion of one of the largest power schemes of to-day, and to place at the disposal of electrical engineers certain experience gained on that scheme during the last seven years. The Paper is confined to a consideration of the electrical system when viewed as a complete entity.

Automatic Protective Gear.—The automatic protective gear is of two kinds, viz., lightning arresters and discriminating cut-outs.

Arrester Gear.—Throughout the system ordinary horn gap arresters in series with water resistances are employed. Fig. 5 gives particulars as to the number of horns, the setting of air gaps and the value of the resistance adopted for the various conditions of service.

Discriminating Cut-outs.—The following types of discriminating cut-outs are employed:

Generators with their step-up transformers	Differential relays. D.T.L.O. relays.† Neutral fuse and relay.
80,000-volt transmission lines...	D.T.L.O. relays at Vereeniging. Reverse power relays at Robinson.
40,000-volt transmission lines...	Differential relays. D.T.L.O. relays.
Step-down transformers	Differential relays. D.T.L.O. relays.
Outgoing distribution circuits from generating stations and step-down stations	Differential relays. D.T.L.O. relays.
All other distribution lines	Differential relays.
Sub-station transformers	Differential relays with overload fuses.
Sectionalising points on network..	D.T.L.O. relays.
Radial circuits of minor importance	Inverse time limit overload relays.

The manner in which the various types of relays are distributed over the system, and the method of sectionalisation of the networks is illustrated by Fig. 6, which is a more detailed diagram of the network between Rosherville and Robinson giving particulars of the time-lag settings of the various relays.

In this connection it is necessary to bear in mind the following characteristics of the apparatus in use:

The differential system possesses perfect discriminating properties, that is to say, it can be relied upon to isolate instantaneously the faulty item of equipment, and that item alone; but for this very reason differential relays refuse to operate so long as the item they control remains undamaged, though that item may carry current to a fault situated at some further point on the system. This is true however large the fault current may be, and a differential relay therefore provides no safeguard to the system should some faulty item of equipment remain unisolated. The differential system protects only those portions of an electric circuit or circuits which are bounded by the protective current transformers, and, in practice these portions generally comprise the transmission and distribution [illegible] (with or without the switches at each end thereof) and all transformers (with or without their primary and secondary switches). It is not generally convenient to apply the system to protect 'bus bars with their numerous branch connections (although this can be done) and consequently a fault occurring on such 'bus bars or connections must be isolated by some other type of automatic device. Moreover, it is necessary to meet the contingency that the switchgear [illegible] a differentially protected item may fail to [illegible] the fault current.

For these [illegible] reasons it becomes necessary to combine with the differential system [illegible] relays for which the criterion of operation is the [illegible] of an overload as such, in contradistinction to a leakage. The outstanding feature of the overload system is that [illegible] can only be obtained at the sacrifice of instantaneous action. [illegible] relays carrying the same fault current can only be made to discriminate by giving one relay a longer time element than the other, and it must be remembered that in general the relay nearest the source of supply (and which is therefore required to operate later than the other) carries the heavier load by an amount equal to the amount of current [illegible] between the two relays. If the relays are of inverse time-limit, *i.e.*, if the time-limit is shorter for large than for small overloads, it is clearly most difficult to obtain satisfactory discrimination between more than two relays connected in series, where the fault current may be sufficiently high to operate instantaneously every relay of that type in its path.

The definite time-limit relay overcomes this latter difficulty and is a satisfactory instrument, provided the system can be arranged to avoid the use of more than three or four such relays in series, otherwise the time element of the relay nearest to the generating station becomes excessive.

The problem is simplified considerably by sub-dividing the various networks into a number of sections, each of which is normally joined to its neighbours through sectionalising switches. These switches are merely interconnecting switches controlled by D.T.L.O. relays adjusted to operate with relatively short time-lag on the occurrence of a relatively high overload. The rapidity with which these sectionalising switches open confines the fault to a relatively small section of the system and reduces the number of overload relays which are called upon to discriminate between one another in isolating the fault.

The author next considers at some length the behaviour of the network for various faults which may occur in practice. He deals with sub-station L.T. 'bus bar fault or fault on consumer's 'bus bars; fault on a sub-station transformer or distribution line; sub-station H.T. 'bus bar fault; fault on a step-down transformer or transmission line; 'bus bar fault at generating station or step-down station; and fault on a generator or step-up transformer.

To illustrate the efficacy of the methods of protection which he describes, the author next gives a summary of the operating experience in regard to all faults which have occurred during the year 1915 and during the first ten months of 1916.

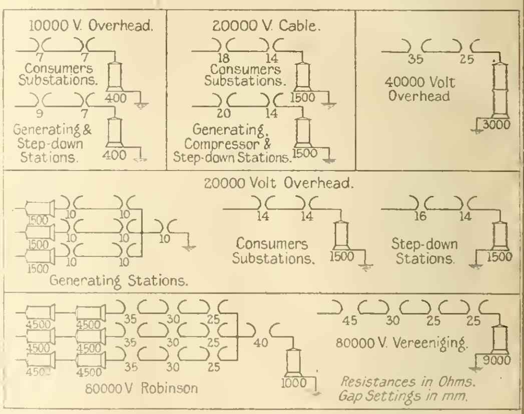

Fig. 5.—Lightning Arrester Gear.

Summary of Faults—	1915.		10 months, 1916.
Consumers' faults	50	......	24
Sub-station transformer faults	6	......	4
Sub-station 'bus-bar faults	3	......	4
Overhead distribution line faults	62	......	66
Underground distribution line faults	4	......	nil
40,000-volt transmission line faults	54	......	33
80,000-volt transmission line faults	3	......	2
Step-down transformer faults	13	......	7
Generator and generator transformer faults	4	......	8
Station 'bus-bar faults	8	......	5
	207		153

Whilst the number of faults is large, the discrimination of the cut-outs when operating to isolate such faults has been perfect in all but a relatively small number of instances, and as a consequence interruptions to supply have been relatively infrequent.

During 1915 the total reduction in supply during periods of interruption was only 131,000 units, which is equivalent to a supply for 76 minutes at the maximum rate for that year, or 0·023 per cent. of the units supplied to all consumers during the year. It goes without saying that the bulk of this reduction was caused by the 'bus-bar faults at generating or step-down stations, all of which were due either to mistakes in operation, accident or switch explosions. It is believed that the switch trouble has now been satisfactorily surmounted, and there is little doubt that the operating mistakes have been largely the result of the loss of trained men who are now engaged in military service.

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* Abstract of a Paper read before the South African Inst. of E.E.

† Definite time-limit overload relays.

As regards 1916, the total reduction in supply during periods of interruption was 124,742 for the first 10 months of the year. The station 'bus-bar faults, with one exception, occurred early in the year, and it will be seen that in spite of the large number of faults of other types which have since occurred the efficiency of automatic isolation has been almost perfect.

In order to show the extent to which the differential protective gear has benefited overhead line operation, the following figures have been extracted from statistics given in the original Paper :—

Faults on Distribution Lines and 40,000-volt Transmission Lines.

	1915.		10 months, 1916.	
Lightning flash-over without damage	42		26	
Lightning flash-over with damage	8		10	
	—	50	—	36
Faults from other causes without damage	26		30	
Faults from other causes with damage	40		33	
	—	66	—	63
Total number of faults		116		99

The only kind of fault which lightning can produce on an overhead line is an insulator flash-over, and it will be noticed that out of 86 line faults produced by lightning only 18 caused damage requiring repair. This excellent result is entirely attributable to the rapidity with which the circuits have been isolated by the differential relays. The chance of damage from faults due to causes other than lightning is, of course, dependent upon the nature of the cause.

CONCLUSIONS.

From the experience outlined in this Paper the following conclusions may be drawn :—

Network Lay-out.—Distribution networks should be laid out in the form of ring mains to constitute what has been termed a chessboard type of network. It is generally uneconomical to run more than one circuit over any given route, and by spreading the copper over divergent routes a means of supply is brought within minimum distance of the maximum number of consumers. Moreover, an open network of ring mains is more reliable than any other arrangement, because supply to a given point is then dependent upon two or more divergent routes.

Earthing of Neutral.—The earthing of the neutral of a system of the type in question is of great value for the following reasons :—

1. It enables a fault between any circuit and earth to be instantaneously isolated by the differential system of protection.

2. It enables a resistance to be inserted in the path of the current flowing to all faults between conductor and earth.

3. It enables lightning arresters to discharge without distress. Earthing of the neutrals converts every flash-over into a definite fault which the cut-outs are able to isolate, thus relieving the arresters from unfair duty.

4. It greatly reduces the severity of the surging which takes place at times of breakdown. Experience with and without an earthed neutral has afforded abundant proof that the system, when insulated at the neutral point, is subjected to very much more severe potential strain at times of high-frequency surge.

5. It prevents any static rise of potential on the system. Prior to earthing, conclusive evidence was obtained that in windy weather the potential of a section of the overhead system relative to earth may rise to a high value causing a discharge at some weak point.

Methods of Protection.—The differential system of protection is essential to reliability of supply on a scheme of the type considered, because it is the only system which will secure instantaneous and true discrimination for every form of network lay-out. Although it is impossible to construct a switch which will break the circuit absolutely instantaneously, a switch of good type will complete its travel within a small fraction of a second, and experience shows that if the relay has no time-element, the power arc formed across an insulator will, in the majority of cases, be extinguished before it has had time to permanently damage the porcelain. If even a small time-element is introduced, every line flash-over will result in a damaged insulator, whereas in four cases out of every five, a differentially-protected line can be switched back into service at once. It is partly on this account that divergent routes are efficacious in maintaining uninterrupted supply, because a line which has tripped out due to insulator flash-over is often in service again before the duplicate route is subjected to the influence of the passing lightning storm.

Reactances.—It is advisable to instal reactances on a system of this size, but these are of limited usefulness and should not be multiplied unduly. It must be remembered that the insertion of reactances necessarily increases the momentary drop in pressure occurring when a fault takes place, and consequently the loss of load due to operation of consumers' low voltage releases is accentuated.

Lightning Effects.—One of the difficulties of the lightning problem is the impossibility of investigating phenomena by special tests. All that can be done is to analyse evidence obtained in commercial service and test the conclusions drawn therefrom by the tedious process of further commercial trials, which generally give negative evidence. The deductions made from experience to date are :—

1. Lightning arrester gear is probably of some benefit, but this has not been definitely proved. It would appear better policy to spend money upon an increased factor-of-safety for the apparatus to be protected than to seek increased protection by a multiplication of arrester gear.

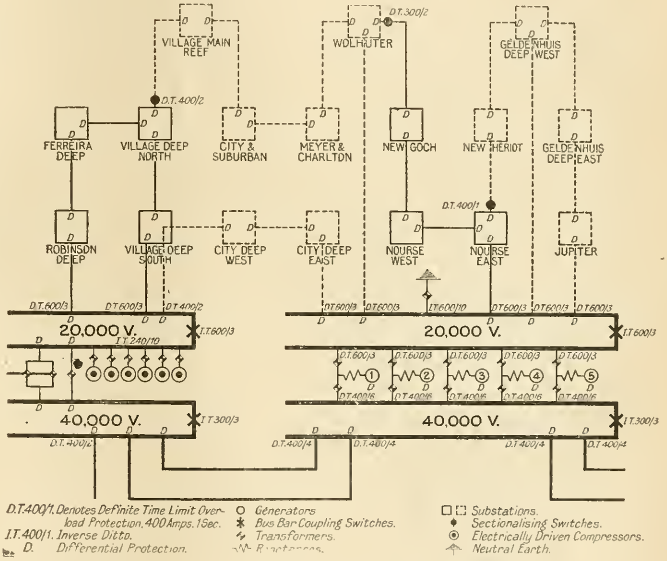


FIG. 6.—DIAGRAM OF TYPICAL DISTRIBUTION NETWORK.

2. The intensity of the induced effects of lightning is localised to a relatively short length of line in the immediate vicinity of the lightning flash. It is also noticeable that failure of insulators on consecutive masts along a given route is of rare occurrence, which points to the fact that the intensity of the reduced effect falls away very rapidly as the surge passes along the line. It follows from this that the failure of line insulators must remain inherent to a system, operating under the conditions obtaining in this district, and reliance must therefore be placed upon automatic discriminating cut-outs to maintain uninterrupted supply.

3. It is desirable to erect earthed guard wires above and on either side of the power conductors. A careful analysis of operating data collected during the last few years shows that all phases of the overhead circuits are equally affected by lightning, and it would appear, therefore, that any influence which the guard wires may have is as effective for the outer as for the inner power conductors.

The above remarks apply in general, but there is one point on the system, namely, the Robinson end of the 80,000-volt transmission lines which has provided direct evidence as to the inefficacy of certain methods of lightning protection.

During a severe storm four of the 6,000 k.v.a. transformers at Robinson broke down simultaneously, and there is reason to believe that the flash of lightning responsible for this failure occurred at a point within a few yards of the station. The 80,000-volt windings of these transformers are delta connected about 1·5 per cent. of the turns at each end of each phase, being provided with additional insulation between turns. Both transformers failed at points just beyond these end turns.

In the hope of avoiding a repetition of such trouble, large choking coils were installed in each phase of each incoming 80.000-volt line. Each of these coils stands 7 ft. high and consists of 48 turns 4 ft. in diameter. In spite of this one 9.000 k.v.a. and two 6.000 k.v.a. transformers again failed simultaneously during a storm in 1916 at points in the windings just beyond the specially insulated end turns.

It must be understood that the insulation between turns throughout the windings of these transformers is more liberal than that on the 40.000-volt step-down transformers installed at the other stations, yet these have not failed under lightning conditions as severe as those at Robinson.

It was presumed that as the factor-of-safety of the insulation on the 80.000-volt lines is much greater than on the 40.000-volt lines, the transformer in the former case and the line insulator in the latter are the weakest points in the circuit. An endeavour was therefore made to instal arcing rings on the 80.000-volt line insulators near Robinson, but the use of such rings at this high pressure proved unpracticable with the spacings in use.

Two expedients now on trial are the use of aluminium arresters on the two outer 80,000-volt lines and the earthing of the 80.000-volt neutral at Robinson as well as at Vereeniging. It is a striking fact that no failure attributable to lightning has ever occurred at the Vereeniging end of the lines and that the arresters at that end seldom discharge although storms appear to be as prevalent and as severe at the south end of the lines as at the north end.

This experience at Robinson leads to the conclusion that horn gap arresters, large choking coils and specially insulated end turns are of little, if any, value under very severe conditions.

Control System.—A reliable telephone system is essential and an alarm system is most valuable. Experience has shown that it is very bad practice to suspend telephone cables on the masts which carry the power conductors. The E.M.F. induced in the wires of such cables by a fault current punctures the insulation and will, in time, ruin the cables. Many miles of such cables which had been so erected in the early days of the scheme had to be transferred to separate routes at a distance of not less than 200 feet from the power lines.

It is convenient and economical to combine the pilot wires required for the differential system in one cable with the telephone circuits and it is well worth while to provide a few extra wires.

EFFECT OF DIRECTION OF GRAIN ON MAGNETIC PROPERTIES OF SILICON SHEET STEEL.*

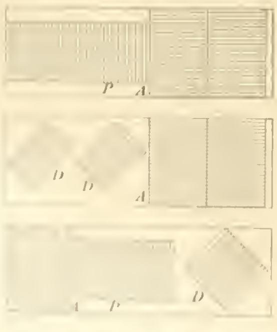
BY L. W. CHUBB AND T. SPOONER.

It has been known for some time that if a magnetic flux is caused to pass through a sheet of steel parallel to the direction in which the sheet was rolled, the material will appear to have different hysteresis loss and permeability characteristics than in the case of the flux passed through in some other direction, but little quantitative data have been published on this subject. During the past few years a large number of tests have been made on silicon steel with a view of determining the magnitude of this effect. Three directions of grain were investigated by the authors—with the flux parallel to, with the flux perpendicular to, and with the flux making an angle of 45 deg. with the direction of sheet rolling.

Fig. 1

Fig. 2

Fig. 3



Figs. 1, 2, 3.—Methods of Cutting Samples from Metal Sheets. A = Parallel. P = Perpendicular. D = Diagonal.

Test Methods.

The relation between the parallel and the perpendicular directions of grain was first investigated. Samples from 234 lots, representing over 3,000,000 lb. of silicon steel, were tested. The steel had a nominal thickness of 0·014 in. (0·0356 cm.). Four sheets were taken from each lot and sheared into strips 50 cm. by 3 cm., as shown in Fig. 1. The parallel strips were marked *A* and the perpendicular strips *P*. A 5 kg. sample was made up from both the *A* and *P* strips for watt loss tests, and an average 1 kg. sample of each for permeability tests. Watt loss tests were made at an induction of 10,000 gausses, 60 cycles by means of a standard Epstein apparatus. Permeability tests were made at inductions of 6,000, 10,000 and 16,000 gausses by means of a Burrows apparatus.* After completing tests on the samples as received, they were annealed and again tested. They were then reannealed and given a final test. The original sheets had been given one annealing at the mills.

After having completed the perpendicular grain tests samples were taken with the grain diagonal from 89 lots, representing over 1,000,000 lb. of steel. Four sheets were taken from each lot and sheared into strips, as shown in Fig. 2. The parallel strips were marked *A* and diagonal *D*. The treatment and tests were the same as for the perpendicular strips.

Test Results.

The results of the tests on these samples, expressed in per cent., are as given in Tables I. to VI. :—

Table I.—*Per cent. Decrease in Watt Loss due to Annealing for A and P Samples.*

Treatment.	No. of samples.	*A.*	*P.*
First anneal	234	9·3	7·5
Second anneal	234	3·5	2·8
Total	...	12·5	10·1

Table II. *Per cent. Decrease in Watt Loss due to Annealing for A and D Samples.*

Treatment.	No. of samples.	*A.*	*D.*
First anneal	89	10·6	8·4
Second anneal	†81	1·9	1·5
Total	...	12·3	9·8

Table III.—*Per cent. Watt Loss of P and D Samples with Respect to th Loss of the A Samples.*

Treatment.	*P* .	*D.*
As received	112·0	102·8
First anneal	114·2	105·6
Second anneal	114·9	107·0

Table IV.—*Per cent. Increase of Permeability due to Annealing for and P Samples.*

Treatment.	*B* = 6,000.		*B* = 10,000.		*B* = 16,000.	
	A.	*P.*	*A.*	*P.*	*A.*	*P.*
First anneal	14·9	29·7	36·8	39·4	5·2	– 1·7
Second anneal	9·6	0·3	13·0	5·3	2·5	2·8
Total‡	26·0	30·1	54·5	46·8	2·6	1·1

Table V.—*Per cent. Increase of Permeability due to Annealing for A an D Samples.*

Treatment.	*B* = 6,000.		*B* = 10,000.		*B* = 16,000.	
	A.	*D.*	*A.*	*D.*	*A.*	*D.*
First anneal	21·6	18·5	44·5	33·0	4·5	7·0
Second anneal	10·5	6·3	13·3	11·0	5·5	– 10·0
Total	34·4	25·8	63·7	47·5	9·8	16·3

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* Abstract of an article in the "Electric Journal."

* Described in Technical Paper 117 of the Bureau of Standards.

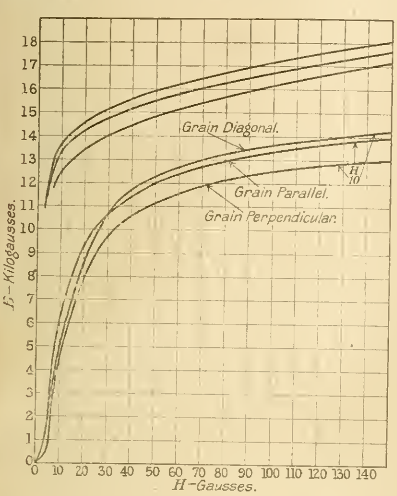
† Some of the second anneal samples were omitted, as they were be in annealing.

‡ All totals are based on material as received.

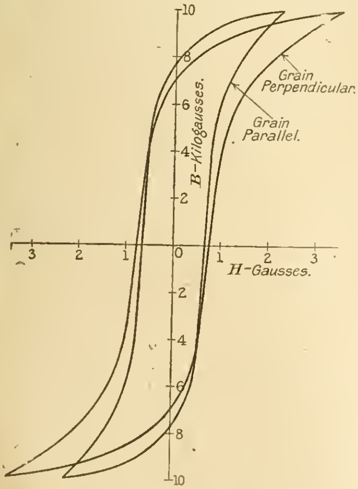
able VI.—*Per cent. Permeability of P and D Samples with Respect to the Permeability of the A Samples.*

Treatment.	B = 6,000.		B = 10,000.		B = 16,000.	
	P.	D.	P.	D.	P.	D.
s received	71·0	87·8	70·4	94·6	76·2	113·2
ist anneal	80·7	85·5	71·7	87·0	72·2	110·2
cond anneal	73·8	82·2	66·8	85·1	76·0	105·0

In order to obtain a more detailed knowledge of the effect of grain, veral sheets were taken from a typical lot of silicon steel and strips t from each sheet, as shown in Fig. 3. Epstein samples were ide up from each kind of strips, and then each sample was built o the Epstein apparatus with alternate lap and butt joints. Watt s and magnetisation curves were then obtained, and later hysteresis



IG. 4.—Effect of Direction of Grain on Permeability of Silicon Steel.
Material as received.



. 5.—Effect of Direction of Grain on Shape of Hysteresis Loop.

s were also taken to compare the shape of the loops for parallel in with those for perpendicular and diagonal grain. Table VII. ws that the hysteresis losses for the perpendicular *P* sample exceed se of the parallel *A* sample by 19 and 20 per cent. by ballistic and alternating-current test, respectively. Typical effects are also shown in Figs. 4 and 5.

The data in Table VIII. shows the hysteresis loss of the diagonal sample to be 0·6 per cent. higher than the parallel sample by ballistic test, and about 4 per cent. lower by alternating-current test. On the average, the losses in diagonal grain samples will be found to be from 2 to 7 per cent. higher than the parallel grain losses, as shown by the early tests on 89 lots of steel.

In the results shown in Tables VII. and VIII. the eddy-current loss was obtained by subtracting the hysteresis loss, as calculated from the hysteresis loop, from the combined loss as obtained by wattmeter. It was assumed that the eddy-current loss was the same no matter what the direction of grain. The eddy-current loss for the *A* and *P* or *A* and *D* samples of a lot was averaged and subtracted from the alternating loss to get the hysteresis loss from the alternating-current test.

Table VII.

Sample.	Alternating-current test, watts per kilogram.				Ballistic test, watts per kg.
	Total.	Eddy currents.		Hysteresis.	Hysteresis.
		Obs.	Mean.		
A	1·81	0·22	0·23	1·58	1·59
P	2·13	0·24	0·23	1·90	1·89

Table VIII.

Sample.	Alternating-current test, watts per kilogram.				Ballistic test, watts per kg.
	Total.	Eddy currents.		Hysteresis.	Hysteresis.
		Obs.	Mean.		
A	1·87	0·27	0·23	1·64	1·60
P	1·80	0·19	0·23	1·57	1·61

CONCLUSIONS.

The chief conclusions drawn from these experiments are as follows:

1. The watt loss of the perpendicular *P* and diagonal *D* samples was not so greatly improved by annealing as was that of the parallel *A* grain samples.

2. With respect to permeability, the *P* samples were improved by annealing about as much as the *A* samples, but the *D* samples were not so much improved by annealing as were the *A* samples.

3. The difference between the *A*, *P* and *D* samples is a function of the heat treatment, as well as the direction of rolling. This is especially evident in Table III., showing watt loss.

4. Perhaps the most interesting feature of the data presented is the fact that, while the *P* samples show a fairly uniform percentage difference in permeability from the *A* samples at the different inductions, the *D* samples are lower at 6,000 and 10,000 gausses and higher at 16,000 gausses.

5. From an examination of the individual tests (the results of which obviously could not be included here) it develops that occasionally the watt loss or permeability for the diagonal grain sample may be superior to that of the parallel grain sample cut from the same sheet.

6. In transformers the grain usually runs parallel or at an angle of 45 deg. with the direction of flux. A test on a composite sample of steel cut half parallel to the grain and half perpendicular may give no indication of the quality of the steel with the grain cut at an angle of 45 deg., and will often give a value far from the parallel grain quality. For this reason it would seem inadvisable to sample silicon steel in this way as recommended by the American Society for Testing Materials. If other than parallel grain data is required it should be obtained on a sample sheared with the grain in the same direction as it is to be used. It is usually satisfactory to make all tests with the grain parallel to the flux and then use a factor if the material is to be used under other conditions.

7. Distributing transformers, which in general are built of L plates having the grain at an angle of 45 deg. with the flux, for reasons of economy in punching, may have their iron losses satisfactorily calculated by adding 5 or 6 per cent. to the parallel grain test losses.

8. Whenever it is possible to avoid it, silicon sheet steel should not be used with the induction perpendicular to the direction of grain, since the magnetic properties under this condition are not as good.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

BY THOMAS CARTER.

(Concluded from page 661.)

XXVIII. General Rule for Finding Tapping Points easily on Lap-wound Armatures.

In common, no doubt, with many others who have to deal with the question of tappings for slip-rings or other purposes, the author some years ago got out a simple method of locating the coils from which tappings should be taken. The same method is probably used by others; in fact, some time after getting it out, the author found a description of an almost identical scheme in an article by Kehse in the "Electrotechnische Zeitschrift," Nov. 6, 1913. Dr. S. P. Smith, in the Paper referred to above, gives a somewhat different method for arriving at the same result, as part of a general consideration of armature windings, and the author is indebted to this Paper for an improvement in that part of his original rule which related to multiply closed windings, making it simpler and more definite than it was before.

The method used by the author is as follows:—

K=number of commutator bars.

Y_k=pitch of connections of ends of the same coil to the commutator, or, shortly, commutator pitch. This is always to be counted in the same way round the commutator, say right handed when facing towards the commutator.

p=number of pairs of poles.

a=number of pairs of circuits on the armature between positive and negative brushes.

n=number of phases in balancer.

There are a connections to each of the n rings, so there are na connections in all, with groups of K/na coils between adjacent tappings. The connections are distributed amongst the rings as follows:—

The first ring has the 1st, $n+1st$,……, $\{(a-2)n+1\}st$, $\{(a-1)n+1\}st$ tappings.

The second ring has the 2nd, $n+2nd$, ……, $\{(a-2)n+2\}nd$, $\{(a-1)n+2\}nd$ tappings.

The $(n-1)st$ ring has the $(n-1)st$, $(2n-1)st$, ……, $\{(a-1)n-1\}st$, $\{an-1\}st$ tappings.

The nth ring has the nth, $2nth$, ……, $(a-1)nth$, $anth$ tappings.

In lap windings, a usually is the same as p, and, in fact, for symmetry this is absolutely necessary, since p/a is to be a whole number, and therefore a cannot be greater than p. Nor can it be less, for $Y_k=a/p$, and Y_k cannot be less than unity. Hence $p=a$ and $Y_k=1$ is the condition to be complied with in a lap winding if it is to be suitable for tapping. Any other arrangement would lead to the necessity for connecting together immediately adjacent coils by taking tappings from each to the same slip ring. If these groups of coils lie always all in one slot they will not be very much out of phase with each other, and such a winding might conceivably be used with successful results, but if a tooth come in the middle of them, trouble may be expected. As a rule, $p=a$ is a suitable condition, from the point of view of electrical design, for a lap winding, departures from it occurring only in very low voltage machines, which are then the subject of special individual consideration. A further condition of symmetry is that the number of slots must be divisible exactly by p, which means that, in this case, s/a must be a whole number, otherwise coils lying under adjacent pole pairs, which have to be connected to the same ring, will not be in phase exactly.

From the nature of a lap winding, where each coil is connected to the one lying actually adjacent to it in space on the armature, the coils composing one pair of circuits are simply those subtended by two pole pitches when $a=p$ and $Y_k=1$, so that there are $K/a=K/p$ coils per pair of circuits. Now K/s is an integer, and s/a is an integer, therefore K/a is an integer, and the pairs of circuits are strictly equal as regards numbers of coils; and because K/p is also an integer, and $K/p=K/a$, the pairs of circuits are equal as regards phase also. Each group of $K/p=K/a$ coils has now to be divided into n smaller groups between tappings, each of $K/np=K/na$ coils. If $K/p=K/a$ is not exactly divisible by n, the groups between tappings will not be equal, and there will be unequal voltages between rings, possibly causing disturbances. It is therefore necessary in lap windings for complete symmetry that $K/np=K/na$ should also be an integer. Having got these groups, each of K/na coils, following each other successively round the armature, it only remains to connect their junctions by tappings to the slip rings, taking $p=a$ tappings to each ring, and distributing the tappings amongst the rings in the order already tabulated. As equalising connections are usually fitted to lap wound armatures, it is sometimes convenient to fit as many equalisers as there are slip rings, and then merely to take one connection from each equaliser to each slip ring. The usefulness or otherwise of this depends on the ease with which connections can be taken to the rings themselves from the windings; it is generally more convenient to connect a number of tappings to an equalising ring than to a slip ring owing to the relative positions of these with regard to the coils themselves.

If $K=120$, $Y_k=1$, $p=2$, $a=2$ and $n=4$, then $na=8$ and $K/na=15$ coils between tappings.

The eight tappings are therefore to be taken from bars 1, 16, 31, 46, 61, 76, 91, 106 and of these the 1st and 5th are taken to the first ring, the 2nd and 6th to the 2nd ring, the 3rd and 7th to the 3rd ring, and the 4th and 8th to the 4th ring.

XXIX. General Rule for Finding Tapping Points easily on Wave-wound Armatures.

Wave windings are to be treated rather differently, because of the fact that one coil is connected immediately to another lying not adjacent in space to it on the armature, but under the next pair of poles. The commutator pitch is

$$Y_k=(K\pm a)/p.$$

This means that if Y_k be counted round the armature p times, so passing through pY_k commutator bars, the bar arrived at is a bars away from the starting point, and if Y_k be counted always right handed, say, looking at the commutator end of the armature, the bars being numbered from 1 to K in the same direction, then, when $Y_k=(K+a)/p$, the finishing point is a bars to the right of the starting point, and when $Y_k=(K-a)/p$, it is a bars to the left. This distance between start and finish may be called the creep of the winding, and windings with $Y_k=(K+a)/p$ will be called forward windings, and those with $Y_k=(K-a)/p$, backward windings, because the creep is in the same direction as, or in the opposite direction from, that of Y_k in the two cases respectively. Fig. 31 shows a case with $p=3$ and $a=1$, and indicates clearly the two kinds of windings, the forward having the full line end, crossing the starting end, and the backward the chain line end, not crossing the starting end. Thus between points a bars apart on the commutator periphery in the direction of the creep, there are always p coils of the armature winding connected immediately in series with each other. Further, between points Y_k bars apart on the commutator periphery in a right handed direction, there is always one coil.

The problem is to divide up the K coils of the winding into an groups, with K/an coils in each group, that is, starting with a tapping on bar number 1, to find a bar between which and number 1 there are K/an coils, which gives the second tapping point; then to find a bar between which and number 1 there are $2K/an$ coils, which gives the third tapping point; and so on until the groups finish up at bar number 1 again. It is better always to start from bar number 1 in counting than to add on K/an coils to the successive positions found, as K/an may not be an integer, and it is easier to start counting from a commutator bar always than to begin at a point which on paper is, say, 5/6 of the way round a coil.

One way to count K/an coils from bar number 1 is to count K/an times Y_k bars round the commutator, casting out K as many times as possible, the remainder giving the number of bars away from bar number 1 at which the next tapping point will be found.

For example, if $K=206$, $p=3$, $a=1$, $n=4$, then

$$Y_k=(206+1)/3=69.$$
$$K/an=206/4=51\tfrac{1}{2}.$$

To count 51 coils round the armature, count 51×69 commutator bars, which is 3,519 bars. There are 17 times 206 in this, and the remainder is 17, which means that the second tapping should be 17 bars away from No. 1 in the direction of Y_k, that is, on bar No. 18. This, however, is clumsy, and, remembering that counting a bars in the direction of the creep is equivalent to counting p coils round the armature, a much simpler rule may be arrived at. For example, in this case the creep is forward, because a is $+1$, and therefore 51 coils are counted by counting $51/p=51/3=17$ bars forward, and so arriving at bar No. 18, exactly as before, but dealing with much smaller and therefore more convenient numbers. The next tapping is to be 103 coils away from 1 in this case, and there are thus 34 times p coils to count, and one coil over, which means counting 34 bars forward to give 102 coils, and other 69 bars to give the odd coil, so that the third tapping comes on bar number $1+34+69=104$. Similarly with the fourth, which is $154\frac{1}{2}$ coils from No. 1. There are 51 groups of p in 154 and one over, so count $51+69=120$ bars from No. 1, arriving at bar No. 121, which gives the fourth tapping, the complete set of tapping points being, therefore, 1, 18, 104, 121. As, in two of the countings, $51\frac{1}{2}$ and $154\frac{1}{2}$ are the correct numbers of coils, if exact grouping be desired, the connections may be made, not to bars Nos. 18 and 121, but to the middle points of the coils starting at these bars, which will bring these two connections to the opposite end of the armature from the commutator, and will make them actually come half-way between bars 18, and 87 and 121 and 190 respectively. For fractions other than $\frac{1}{2}$ in single-turn coils, take the nearest half, and in multiple-turn coils, connect the tapping to the point giving the nearest half-turn to the exact division. It is not possible to get anything but half-turns actually, as connections can only be made to the front or back ends of formed coils. If, for example, a coil has five turns, and one-third of it be wanted, the correct point is $1\frac{2}{3}$ turns from the beginning of the coil, but the nearest practicable point is $1\frac{1}{2}$ turns away. The unit of counting is, throughout, a complete coil, no matter how many turns it may have in itself, that is, all of the winding which happens to be between two points Y_k bars apart on the commutator; this is the simplest and most convenient unit to start from.

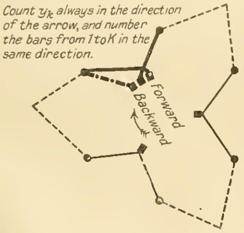

Count y_k always in the direction of the arrow, and number the bars from 1 to K in the same direction.
Forward
Backward

FIG. 34.—DIAGRAM OF FORWARD AND BACKWARD WAVE WINDINGS.

The rule, then, for wave windings is now clear. Divide K into an equal parts; find how many times p is contained in K/an, and what the remainder is; connect the first tapping to bar No. 1; count as many a's in the direction of the creep, from bar No. 1 as there are complete p's in K/an, and, following on in addition, as many Y_k's, in a right-handed direction, as there are single coils in the remainder of the expression $(K/an)/p$; if there be a fractional part of a coil in the remainder, that is, if K/an be not an integer, which is very probable, select a point, on the coil itself, between the bar found as above and the bar Y_k bars in a right-handed direction away from it, which gives the nearest half-turn to the correct value; this is the point to which the second tapping must be connected. The third tapping is connected to the point $2K/an$ coils away from bar No. 1, discovered by the same method. The xth tapping is connected to the point $(x-1)K/an$ coils away from bar No. 1, again found in an exactly similar manner. Then the tappings are distributed amongst the various rings in the way already described, a to each ring. This is a general rule, covering all cases. Note three things by way of comment: first, if any point found as above is more than K bars from No. 1, cast out K until the remainder is less than K; second, while the counting of one coil is accomplished by counting Y_k bars on the commutator surface, a fraction of a coil is to be measured not by counting the same fraction of Y_k round the commutator surface, but by measuring off a suitable amount along the winding of the coil, this being the only case in which the winding itself is directly used in counting. All whole number counting is done on the commutator surface, in units either of a's or of Y_k's; all fractional counting is done along the coils themselves. As a matter of fact, the whole of the method is really based on counting coils, but, by using the characteristics of the winding, the greater part of the counting is more conveniently done on the commutator surface. Third, in multiply-closed windings, if they are symmetrical, the rule brings the tapping point back to bar No. 1 before the full number of tappings has been obtained, the point at which this occurs depending on the number of closings. Instead of using bar No. 1 over again, some other bar must be found, as a starting point for another set of tappings, which has exactly the same potential as bar No. 1. Coils which are equidistant on the armature, and are in similar fields, are, as Dr. Smith points out, all at exactly the same potential, and such coils are found K/a bars apart from each other. The number K/a is called by Dr. Smith the equipotential pitch, and is denoted by Y_p. It is always an integer in a symmetrical winding, and hence, when the difficulty above referred to occurs, the first of the new set of tappings is at once found by adding Y_p to the number of the bar on which the previous set closed. This third comment represents the modification and simplification of part of the author's original rule above referred to, and was suggested by Dr. Smith's use of Y_p. With this acknowledgment, it is used in one of the examples now to be given. The rule gives the tappings in the correct order, and it is easy to select those that should be connected to any particular ring when $a>1$. The same rule is applicable to the finding of the correct points for attaching equalising connections on windings where it is necessary and suitable to fit them, and it also gives the proper tapping points for rotary converters as well as for static balancers.

XXX. EXAMPLES OF THE RULE FOR WAVE WINDINGS.

Example I.—$K=492$; $p=8$; $a=4$; $n=6$; $Y_k=(492\pm4)/8=61$ or 62; choose 62, which gives a forward winding; $s=164$, giving three coil sides per layer per slot; $s/a=41$; $p/a=2$; no idle coils, hence this is a symmetrical winding; $Y_p=492/4=123$; $na=24$; $K/na=20\frac{1}{2}$; $h=2$, so the winding closes twice.

In the table on p. 688 the connections denoted by two numbers with a stroke between indicate a tapping from the middle of the coil between the bars bearing the two numbers. Such a point occurs whenever there is a half-coil left over, and by this means the division is made quite exact.

If 61 had been chosen for Y_k, the winding would have been a backward one, and the a's would have had to be counted backwards on the commutator surface, while the Y_k's would still be counted forwards, or right-handed, on the commutator surface, and fractional parts of coils would, as before, be measured forwards along the winding of the coil itself. This winding would close singly, as 492 and 61 have no higher common factor than 1, which means $h=1$, so the winding is singly re-entrant quadruple.

Example II.—$K=321$; $p=5$; $a=-1$; $n=4$; $Y_k=(321-1)/5=64$, which means a backward winding; $s=107$, giving three coil sides per layer per slot. There is only one pair of

Tapping No.	Coils to count from bar No. 1.	No. of a's to count.	No. of Y_k's to count.	Total bars counted.	Add 123 $- Y_p$ when tappings recur.	Cast out K.	Fraction of a coil left over.	Connect to bar No.	Ring No.
1	0	0	0	0	...	0	...	1	1
2	20½	2	4	256	...	256	½	257 319	2
3	41	5	1	82	...	82	...	83	3
4	61½	7	5	338	...	338	½	339 401	4
5	82	10	2	164	...	164	...	165	5
6	102½	12	6	420	...	420	½	421 483	6
7	123	15	3	246	...	246	...	247	1
8	143½	17	7	502	...	10	½	11 73	2
9	164	20	4	328	...	328	...	329	3
10	184½	23	0	92	...	92	½	93 155	4
11	205	25	5	410	...	410	...	411	5
12	225½	28	1	174	...	174	½	175 237	6
13	246	30	6	492	615	123	...	124	1
14	266½	33	2	256	379	379	½	380 442	2
15	287	35	7	82	205	205	...	206	3
16	307½	38	3	338	461	461	½	462 32	4
17	328	41	0	164	287	287	...	288	5
18	348½	43	4	420	543	51	½	52 114	6
19	369	46	1	246	369	369	...	370	1
20	389½	48	5	502	625	133	½	134 196	2
21	410	51	2	328	451	451	...	452	3
22	430½	53	6	92	215	215	½	216 278	4
23	451	56	3	410	533	41	...	42	5
24	471½	58	7	174	297	297	½	298 360	6
25 = 1	492	61	4	492	...	0	...	1	...

Tapping No.	Coils to count from bar No. 1.	No. of a's to count.	No. of Y_k's to count.	Total bars counted.	Cast out K.	Fraction of a coil left over.	Connect to bar No.	Actual coils per group.	Ring No.
1	0	0	0	0	0	0	1	80	1
2	80¼	16	0	16	305	¼	306	80½	2
3	160½	32	0	32	289	½	290 33	80	3
4	240¾	48	0	−48	273	¾	274 17	80½	4
1	321	64	1	−64 + 64	0	0	1	...	...

circuits so the question of symmetry does not arise; $na = 4$; $K/na = 80\frac{1}{4}$; $h = 1$, so the winding is singly re-entrant.

The total bars counted are, of course, the algebraic sum of the bars found from the a column, which are counted backwards, or negatively, in this case, and those found from the Y_k column which are counted forwards, or positively, as always. It is always useful to repeat the first tapping in the table, as it completes the various additions by coming back to the start and so acts as a check. As there is only a quarter-coil beyond bar 306 the tapping is taken from that bar; the half-coil in the third line makes a connection to the back of the armature necessary; the three-quarter coil in the next line might mean either Y_k bars beyond 274, which would be a whole additional coil, or 274 17, giving half a coil additional, and the latter has been chosen, so as not to have the two 80½ groups adjacent. Thus the groups actually are 80, 80½, 80, 80½, which, while not an exact division, is sufficiently close to the ideal to be correct. Three rings in this case would have three equal divisions of 107, with tappings at 1, 108 and 215. In checking the correctness of these points, should it be thought desirable to do so, it would have to be remembered, in counting the coils between bar Nos. 1 and 108, that there are 214 bars from 1 to 108 in the direction of the creep, which means 1,070 coils in the forward direction, and this, with 321 cast out three times, leaves 107 coils as expected. Care must always be taken to use correct signs for the various countings.

Examples might be multiplied indefinitely, but enough have been given to illustrate the rule and to show how simply it may be applied to any case which can possibly occur.

XXXI. CONCLUDING NOTE.

This brings to a conclusion the consideration of balancers for three-wire continuous-current systems, and it is hoped that the object in view in the whole of the treatment has been attained, namely, the setting down of information on the subject in such a way that it will be of use to those who have to design machinery for three-wire systems, as well as of interest to those who are concerned in any way with the operation of such apparatus.

Some of the points in regard to the rotary balancer are new to the author, which, while it does not by any means prove them previously unknown, has made very interesting the development of the theory along the lines adopted.

The author takes this opportunity of expressing his thanks to his assistant, Mr. W. J. John, whose insatiable curiosity on the subject, and whose refusal to be satisfied with any explanations which did not cover all doubtful points regarding the working of balancers, were in a large measure the originating causes of the present study. As the result of the investigation has been more or less to satisfy the original questioner, the author trusts that what has been written will be found to be a fairly comprehensive statement of some of the more important points connected with the subject. A certain amount of well-known matter has been included for the sake of completeness, but that very fact may save future search for information on the part of some who have the patience to read through all that has been here put down.

ELECTRICITY METERS.*

BY J. RENNIE.

The earlier forms of meters recorded coulombs, the pressure being assumed at a constant value. When it is preferred to associate both the pressure and the current in the measuring operation, the instrument becomes an energy meter.

In a motor meter, the electrical energy drives the rotor of the meter, and so operates a recording train giving the record. But in order that the rotation shall be directly proportional to the driving power at any instant, an opposing or regulating device is included. In the earliest meters a rotating vane, by air friction, was used. The plan which is now almost universally adopted is a metal disc, the rotor, moving between the poles of one or more permanent magnets and producing the regulation according to the well-known Barlow's wheel, or Foucault-current brake. In the case of the alternating-current meter, the disc rotor is used both to produce the driving power and the Foucault-current regulation.

In electrolytic meters, the measuring devices take various forms. It may be a liquid decomposable by the electric current, and the decrease in bulk of the electrolyte is shown on a scale graduated in units of energy; or the liquid may be electrolytically transferred from a reservoir to a measuring vessel, which gives a means of assessing in energy units the amount that has been decomposed in a given time. Of the meters in use, the largest proportion are of the motor type, with a comparatively small number of electrolytic.

In direct-current energy meters, the rotor was drum wound to carry the pressure circuit, and the magnetic field was produced by one of the various ways of arranging the current circuit suitably. It was desirable that this current should be as small as possible, to reduce the energy lost in the meter, hence the large resistance added suitable for the pressure employed. The construction and the metal used for the commutator and the brushes have throughout continued troublesome questions. Silver was found very unsuitable for our climate, gold was tried, and then a wash of platinum. The choice has favoured silver more than anything else, combined with such a form of brush as kept clean and maintained the conducting pathway across the commutator bars. The driving spindle, usually vertical, carried a disc rotating between the poles of permanent magnets and producing the regulation required.

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* Abstract of an Address delivered to the Association of Supervising Electricians.

Points which called for care and attention were the form of the added resistance; the preparation of the permanent magnets and the volt drop in the current circuit of the meter. As for the resistance, the manufacture passed through the various vicissitudes of haphazard, or any how winding, to an ordered form, in which the winding was disposed so as to minimise the possibilities of short circuits, which had an effect on the accuracy. Then the wire being wound in separate sections, there was less risk of pressures greater than perhaps 15 or 20 volts between any two contiguous wires.

The drop in the current circuits of meters, required the reconciling of opposing claims. In the first place, a large drop gives a large driving power, and with it the presumption of better accuracy, and perhaps more hardiness. But large drop means loss of watts, and the problem has always been finding just the least driving power that will serve for the accuracy required.

For a suitable driving arrangement for alternating-current meters, an attempt was made to modify one of the arrangements already in use for direct-current meters, practically, a small ironless dynamo; this was easily managed by winding the added resistance non-inductively. But there was still involved the commutator. Very soon the inductive plan—Ferraris motor—was adopted, and eventually led to a most admirable type of meter.

That is not to say, however, that the problem of a suitable meter was at once and for ever solved. The production of two magnetic fields and of two currents with a phase difference between them was, comparatively speaking, easy; but when this had to be done within the small compass of a meter case, in the most economical fashion, and in the way best suited for the purpose of a realible measuring instrument, there arose a most interesting, if slightly puzzling, problem. It involved, for instance, the question of producing a suitable choking coil; methods of controlling and regulating variations due to change of frequency, and to change of pressure; variations in temperature; methods for the use of the current field, and its disposition towards the field produced by the pressure.

A detailed examination of the different kinds of alternating-current meter is not necessary for our present purpose, and on this part of our subject I shall confine myself to certain outstanding features.

As an example, a certain type of meter had a mechanical adjustment which was operated by moving horizontally a certain piece fixed in position by a screw, this screw being small and so lightly held that it could be slackened by using the thumbnail as a screwdriver. This invited criticism because any chance involuntary movement of a screwdriver or the fingers might unconsciously change the adjustment. The screws in such a case should always be hard home, to secure permanence, so far as that adjustment is concerned.

The screws used in the adjusting should preferably not be small or of the watchmaker type. Those for the connecting cables should be strong and serviceable, with not too quick a pitch and able to stand, without stripping, the use of a reasonably-sized screwdriver. Where a magnetic gap is employed, it is advisable that the faces of the gap should be machined. There have been instances, in which for convenience, the ends of the laminations were not even trimmed but left ragged, forming uneven surfaces. This unevenness would not of itself be objectionable, except that on such surfaces there is always a risk of material collecting and lodging, and it is surprising how much magnetic material there is about.

I would also mention a matter which is not now so frequently met with, a pressure coil in which the connection is provided by simply leaving out a sufficient length at each end of the wire. In our climate there is always the liability to electrolytic corrosion at the point where such wires emerge from the body of the coil, and it is also there that a bending strain is applied on making and breaking connection; hence the frequent result that a break happens at the most inconvenient place for repair. It is advisable on this account to make the first and last four or five turns of comparatively thick wire, say, Nos. 18 or 16, and to bringing out sufficient lengths of the thicker ends to make the connection. Further, the usual precautions should be taken to safeguard the bending risk at the exits from any winding.

In the 1882 Electricity Act, provision was made for measurement and, as I think, great wisdom was shown in the method adopted. It was practically left in the hands of a State department, the Board of Trade, to establish such Rules and Regulations as might from time to time be necessary or advisable. The effect of these Rules or Regulations could be re-considerd and altered as occasion showed necessary, without further Parliamentary action, which might have proved a very great inconvenience.

The system established by the Board of Trade under the meter clauses of the Electrical Lighting Clauses Act, 1899, may be briefly summarised as follows: The value of the supply was to be ascertained by an appropriate meter, duly certified, &c. A certified meter was to be a meter of a type that had been approved by the Board of Trade, and found accurate by an inspector appointed under the special Order.

The first requirement was securing approval for the type of meter. For this purpose, three or more specimens were to be submitted to the Board of Trade for examination and test, as they might from time to time deem desirable. When a type had been approved, a specimen was sealed and retained by the Board of Trade, together with a specification and suitable drawings. Any meter exactly similar to such specimen and of a range included in the approval, might be sealed by an inspector as a certified meter, provided that he had ascertained by test that it was a correct meter. The word "correct" was left undefined until 1909, when a definition was embodied in the Electric Lighting Act of that year. From the beginning, the accuracy required for approval was 2 per cent., plus or minus, from one-tenth load to full load, whilst for certification, the accuracy was 2½ per cent.; and these figures were well known to all concerned. A subsequent clause in the same 1899 Act requires the undertaker to supply through an appropriate and certified meter to any consumer who may so demand it.

The general effect of this was to leave the meter question almost entirely in the hands of the undertakers, and, for a time, applications for approval were very limited. Makers did not find that approval was any great assistance to their sales. Further, the requirements of the Board of Trade for approval becoming more generally known, it was seen that a specification for meter contracts might with advantage be reduced to a couple of lines, stating that the instruments were to be of type approved by the Board of Trade. By the year 1908 requests for approval became more frequent and increased at a growing rate until the advent of that general disturber of the peace, the present war.

These requirements in their final form, are grouped in three divisions. Division A includes matters of construction (looking at the instrument as a machine); Division B has special refernce to the electrical features; and Division C to the accuracy.

Requirements under A and B would be merely matters of inspection but for the fact that, even at this late date, correspondence or conference is nearly always required upon details. Sometimes experiment is needed, but not usually prolonged. In early specimens, it appeared, less consideration was given to the electrical than to the mechanical part. For instance, in the matter of insulation, it was not always remembered that the atmosphere in this country is never favourable to insulation, and is sometimes actually destructive of it. Again, in winding a circuit, it was often necessary to criticise forms and methods. Perhaps only in this division of the requirements did clash of opinions arise. In one case a meter was, on the part of the makers, held back from approval because of their unwillingness to change the method of winding the added resistance. Even in that case, however, they subsequently found it useful to conform to the requirements, which had meanwhile acquired the undoubted support of the meter trade generally.

In dealing with the third division, C (accuracy), experimental work is, of course, necessary, and at times somewhat lengthy, for a reason which you should know. When a meter has received the approval of the Board of Trade under the Electric Lighting Acts there is not, apparently, any known power for revoking that approval. A case arose in which, some time after approval had been given to a certain meter, difficulties emerged, and the makers, after a lengthy investigation, produced a new type. They applied to have the original approval revoked, but that was found impossible, and their only course was to withdraw the meter from sale. For this reason the examination in respect of division C of our requirements, and to a slight extent with regard to B as well, has to be done with an eye to the possibility of changes occurring through the flux of time and ordinary usage.

But there is still another influence affecting the meter and its record, the onus of which must be laid on your shoulders and upon those of the consumer. I mentioned very briefly certain circumstances attendant on the position occupied by a meter. It is possibly not usual to find magnetic effects in the neighbourhood of an ordinary household meter, but do not forget that they exist. Possible vibrations of the support must certainly be remembered. Also temperature and moisture. Temperatures may be higher than the normal, and changes of the temperature may also be greater than the normal. Dampness on the wall or in the neighbourhood of the support is to be avoided wherever possible. The errors due to the circumstances which I have mentioned can certainly be greatly decreased if in installing a meter you can secure their avoidance.

Again, there is the question of lighting and convenience of reading. I am strongly of opinion that much latent inaccuracy in meter reading and in instrument reading generally is to be traced to insufficient illumination of the dials or scales, and to their positions making the reading a difficult and awkward job. The dials may be too high above the eye level, and too low, making it difficult to get down. The instrument itself is by no means unsightly, and I have never understood why it should be relegated to the coal cellar—

to anywhere, in fact, provided it be out of sight and out of mind. This is altogether a wrong notion; do try to change it.

A large number of electricity meters have been submitted to and tested by the Board of Trade, and of these the construction and pattern of 77 different types were approved from 1891 until the present date.

The total of 77 includes 32 of foreign manufacture and 45 of home manufacture. The 45 of home manufacture were submitted by 10 British firms and the 32 foreign by eight foreign companies or by their agents here. No notice has been taken of repeated improvements on approved types, which were accepted and included within the original approval in each case.

Further, 30 of the meters were for measurement on direct-current circuits and 47 for alternating-current circuits. Of the direct-current meters 10 were of the motor type, and of the remaining 20 all were electrolytic. There were 11 of type in which mercury was used and nine used other electrolytes; hence the electrolytic principle operated in two-thirds of all the direct-current meters. Two of the mercury meters and one of the electrolytic were prepayment.

Whatever might be the future of meters, it will, I think always be desirable that every meter in a company's circuit should be tested at periodic intervals. As a beginning, the interval should not exceed three years, and preferably one year, but as time passes, and experience of the various types accumulates, one might lengthen the period. So far as present experience goes, probably the time interval, five years, under the Meter Laws in Canada, is the maximum.

And, now, having said so much about electricity meters, let me whisper the dreadful query, "Why electricity meters?" Is it necessary to add to the other expenses in the production of electricity those further of providing meters, installing, reading periodically and accounting?

If it could be shown that a meter in the house provides an opportunity for the undertakers obtaining knowledge of the circumstances of the consumption, then something might be said for the perpetuation of meters. But it must be remembered that the same object—control for the circumstances of consumption—is attained in the case of the distribution of water. A "stopcock" is an official who provides exactly the same control as we suppose the meter readers provide.

The number of electricity meters now on circuit in this country cannot be much short of three-quarters of a million, and if we take them at the round figure of, say, 30s. each, they represent a capital outlay of £1,125,000. Probably, four or five years represents the accurate life of a meter, and we might estimate that at the end of 10 years renewal was necessary. Let us take the depreciation as £110,000 per year, a moderate estimate.

Further, to keep the meter up to its accuracy, extensive repairs and adjustments will be necessary at the end of every third or fourth year.

Hence it would appear that for all accounts less than £10 per annum the interposition of a meter adds about 2½ per cent. to the bill, and for economy's sake there is much to be said in favour of dispensing with the meter.

As the amount of the bills for electric energy taken by the consumer increases to £50 or £100 the relative outlay concerned with each particular account becomes of less importance to the account, and whether its interposition is justifiable is a question to be argued on other grounds.

NON-INFLAMMABLE SWITCH OIL.[*]

BY DR. G. STERN.

Vogelsang[†] has lately described experiments with carbon tetrachloride which are intended to show that under certain conditions this fluid could be usefully employed in oil switches. The author, therefore, thinks it might be interesting to describe what has been done in the Allgemeine Elektricitäts Gesellschaft's laboratory with apparently similar results. On the occasion of a visit in 1910 to Chicago, the author found that carbon tetrachloride was being used with high tension fuses to suppress the arc which is formed on the blowing of the fuse. It was supposed to have advantages over oil on account of the fact that it was not so easily inflamed. However, it was found that the arc caused a considerable carbonisation of the fluid, and that the particles of carbon were liable to restart the arc if a heavy load was carried by the fuse. Moreover, free chlorine was always present. Further experiments with carbon tetrachloride were, therefore, discontinued, because it was found that the chlorine always attacked the fuse strip, and after a short time the fuse was liable to blow, while carrying the normal current. In fact, different metals were left lying in the laboratory for lengthened periods in carbon tetrachloride, and all were found to be attacked till they gradually became unrecognisable. Other chlorine-combinations were, therefore, tried, adding various substances, which were intended to fix the free chlorine. Switch-oils of this character, said to be non-inflammable, are now very largely advertised. One of these consists of pentachlorethane (C_2HCl_5), which is better than carbon tetrachloride, inasmuch as it boils only at 160°C. The specific gravity is 1·658, and the dielectric constant is 2·25. The fluid begins to solidify at -18°C. At ordinary temperatures it does not attack copper, iron or lead, though it does so if heated. If heated for a length of time in contact with water, hydrochloric acid is formed. It decomposes very decidedly under the action of the electric arc. A direct-current arc, carrying 25 amperes at 110 volts, was formed in the fluid, and large quantities of chlorine and hydrochloric acid were formed, and remained in solution, giving a strongly acid reaction. The copper electrodes were also much attacked.

These results seemed to show that the fluid was unsuitable for oil switches; but for the purpose of completing the examination, short-circuit tests were carried out by way of comparing its action with that of ordinary switch oil. The following table gives the results:—

Table, *comparing results with pentachlorethane and with ordinary switch oil (frequency 50).*

(1) *With "Non-inflammable Oil."*

Volts.	Amperes, max.	K.V.A.	Duration of arc in half-periods.
2,890	1,480	7,300	8
2,900	820	4,100	4
5,300	2,570	23,800	9
5,300	2,600	24,000	9
(2) *With Normal Oil.*			
2,900	1,050	5,300	1
5,300	1,630	14,000	3
5,300	2,450	22,500	3

When the non-inflammable oil was used, the escaping vapours were strongly acid and smelt of chlorine: the metallic portions were strongly attacked and the contacts much burnt. With the normal oil the contacts were only slightly burnt. These experiments show that the non-inflammable oil is a much less satisfactory extinguisher of the arc than the normal oil; under similar conditions in the two cases the arc lasts three times as long with the non-inflammable oil as with the normal oil. Taking, again, the insulating resistances of the two at 18°C., we find with non-inflammable oil that, when fresh, it is 1,200 megohms, and after the short-circuit it is 120 megohms, whereas with the normal oil it is 28,000 megohms in both cases.

The results of the following experiment are to be ascribed to the low insulation resistance of the non-inflammable oil. Disc electrodes, 4 cm. in diameter, were immersed at a distance of 5 mm., and an alternating pressure of 7,500 volts was applied. The temperature of the fluid rose 5·5°C. in an hour; the normal kind of oil did not heat to any measurable extent on 10,000 volts under similar conditions. Similar results were given by measurements on the breakdown voltage. With the "non-inflammable" oil and with needle points, the breakdown voltage over a gap of 10 mm. was 25,000 volts, but after a short circuit with the same fluid, the breakdown pressure was reduced to 7,000 volts. With the normal oil, the pressure was about 32,000 volts in the two cases under similar conditions. It, therefore, hardly seems likely that any advantages would result from the use of non inflammable oil, even if mixed with normal oil in any proportions; any such mixture might quite possibly accentuate the failings of both without producing any good result whatever.

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[*] Abstracted from the Elektrotechnische Zeitschrift, Heft 22, 1916.

[†] The Electrician, Vol. LXXVII., p. 510.

ELECTRICITY SUPPLY IN BIRMINGHAM.

The report of the Electric Supply Committee, presented to the Birmingham Corporation on Tuesday, contained the detailed report of Councillors Appleby and Beale, who were recently appointed to inquire into the causes of the recent interruptions of electric supply. The following is an abstract of this report:—

At the outset a sketch is given of the development of the electric supply undertaking since the opening of the Summer-lane station in 1906. The demand increased at a very rapid rate and in 1908 the engineer (Mr. R. A. Chattock) reported it would be necessary to build an additional generating station for the winter of 1913-14. A site was selected and in April, 1910, Mr. Chattock said that additional plant would be required before the new station could be finished, and he proposed that considerable additions should be made to the Summer-lane plant, which would be spread over the next four years, the last instalment to be completed in 1914. That would have the effect of postponing the necessity of a new station for two years (from 1913 to 1915) and the scheme was duly authorised. In October, 1911, the Council were recommended to purchase the Nechells site and to raise £500,000 for the station which was to be ready for the winter of 1915-16. The Council sanctioned the purchase of the site, which possessed railway and canal facilities, but no effectual tests were made of the nature of the ground, and they are of opinion that although its character was known to the engineer, and to some extent to the committee, the difficulties that would be experienced in getting foundations for a large establishment were not appreciated by either, and that this had a material bearing on the subsequent difficulties of the department. There were four years (October, 1911, to October, 1915) for erecting the new station, a period which they find should have been ample for the purpose. The failure to carry out this programme has been the cause of the interruptions of supply and consequent public inconvenience. Dealing with subsequent events, the councillors state that in July, 1914, 14 months before the date when the station had to be open, beyond a few experimental piles having been driven and some railway sidings laid, no work on the site had been done. In order to complete the station by the specified time, the whole of the foundations and the whole of the steel framework of the building should have been completed at this date, and if that had been done there should have been no difficulty in completing and equipping the first instalment of the station with two out of the three 5,000 kw. sets delivered by October, 1915, notwithstanding that war conditions had begun. After referring to the erection of temporary plant adjoining the Chester-street station, the report deals with the interruptions of supply since October, 1915, which were due to mechanical breakdowns, insufficient steam due generally to inferior coal being supplied and the breakdown of the coal-handling facilities at Summer-lane.

The report states that the failures were primarily due to an abnormal demand for electric current following the outbreak of war, which was greater than the Committee could reasonably be expected to have foreseen. This increased demand came at a time when the department was least able to meet it and the inability to meet the exceptional situation arose from causes which were not beyond the control of the Committee. Had the Committee carried out their programme of having the first portion of the new station ready by October, 1915, they would have had a plant installed more than sufficient for the normal requirements and a station in which additional plant to take the war load could easily have been placed as it was required. The shortage of supply and public inconvenience would not have occurred and large sums of money for temporary plant would have been saved, if it had not been for delays which were not unavoidable. The delays were due to various causes, for some of which the councillors find the engineer cannot be absolved from criticism and others of which were caused by the indecision of the Committee when decision and a definite policy were vital. The engineer's health broke down in 1912 and he was away for some months at a time when he could otherwise have proceeded with his designs for building and plant. If the difficulties of the foundation had been promptly taken in hand in July, 1912, and the whole question of how to carry the building been referred to an expert firm to design and carry out in conjunction with the engineer, and that if the engineer had appreciated the necessity of having his machinery decided upon and the position and weights to be carried known, in order to enable the foundation designers to make their plans earlier, many valuable months would have been saved and the station could have been completed and running in time. Even with things as they were, the station could probably have been ready in 1915 if there had been a more definite policy among the Committee of either accepting in principle the proposals of their own engineer, or, if they were not prepared to do so, of calling in a second and higher opinion to advise and assist him. Instead of that there appears to have been, since December, 1912, a series of differences of opinion among the Committee as to accepting or varying the engineer's proposals, leading to postponement of decisions during a period when decision and prompt action were absolutely essential, and resulting in further delays, for which we consider the engineer was not responsible. They consider that considerable allowance must be made for the engineer. His health broke down at a time when it was most important that he should be deciding the general lines on which he was to advise the Committee, and from December, 1912, onwards, he did not receive the support of the whole of the Committee. They find his original recommendations were eventually adopted and although it would have been unreasonable to ask the Committee to accept them without careful examination much time was lost in discussing alternative schemes which were in the end rejected. Although the amount of delay due to any individual incident may be found to be small, the results were cumulative and disastrous to the programme set by the Committee and approved by the Council.

The members of the Electric Supply Committee who were members in November, 1911 (Aldermen Jephcott, Ellwas and Bird, and Councillors Burman, Hawker, Heath and Marks), have issued a detailed statement replying to Messrs. Appleby and Beale's report. They state that in May, 1914, the plant of the undertaking, plus the set to be installed at Chester-street, appeared ample to meet the requirements of the situation and even after the war broke out the necessity for immediately increasing the plant was not apparent. For the first few months of the war it seemed probable that the industries of the city would decrease, and not until the Government realised the enormous munitions requirements of the war and commenced to place orders in Birmingham did the trade of the city revive. Then the committee at once took steps to provide further plant by action which the authors of the report approve. Work on the permanent site was discontinued early in 1916 because it was ascertained the Treasury would not sanction funds being raised to complete the works. They agree with Councillors Appleby and Beale in their conclusion that the failures were primarily due to an abnormal demand for electric current following the outbreak of the war, which was greater than the committee could reasonably be expected to have foreseen. It was easy to-day to say that delays in 1913 were the cause, but such delays were due to proper examination of the steps to be taken, and if the committee erred on the side of caution, it should be remembered that economy and prudence in expenditure were regarded as superlatively important at that time. So soon as the requirements of the situation were apparent no time was lost in meeting them and the large sum of money spent in temporary provisions was therefore simply a part of the contribution of Birmingham to the prosecution of the war, and had brought a substantial financial return to its manufacturers and citizens. Such expenditure during peace time would have been reprehensible, but it was unjust to condemn the committee now, because whilst it made what it believed to be adequate provision for peace requirements and refused to expend huge sums of money before being satisfied of the necessity, in common with the rest of the nation it did not anticipate and provide against the conflagration of August, 1914. Referring to certain negotiations for a bulk supply from a large company in the district, it is stated that the negotiations with the company and the Ministry of Munitions have been practically completed, with the result that a further 10,000 kw. of plant will be available for the supply of electricity to the city. At the end of the present year the generating plant erected since August, 1914, ought therefore to be 32,000 kw., that is 7,000 kw. more than the permanent station would have held had it been completed. That might not place matters beyond anxiety because of the huge increase in the demand, but it provided a more substantial supply than would have been given by the permanent works, for the non-completion of which the committee was criticised. The demand for current was being overtaken, but the spare plant was admittedly meagre and new connections were constantly demanded. The committee are very strongly of opinion that even now the permanent station should be proceeded with. Plans are now in preparation and in order to allay any anxiety that may be aroused by the observations contained in the report upon the disadvantages of the Nechells permanent site, the committee have asked the President of the Institution of Electrical Engineers (Mr. C. P. Sparks) to furnish them with a report.

The City electrical engineer (Mr. R. A. Chattock) also submitted a statement with reference to the report. He took exception to the suggestion that the difficulties in relation to the foundations were not appreciated by him or the committee and that that had a material bearing upon the subsequent difficulties of the department. He could not agree that the foundation problem was a formidable one, and after inspecting some piling work in London he recommended the use of piles. The committee, however, decided to consider alternative schemes for carrying the station upon ferro concrete rafts and upon piles, and some months were taken up over that matter in 1913. There was no material delay due to the alteration in the size of the switch-house. As regards the questions of coal quality and stock, there was no doubt the quality of practically all coals had deteriorated during the past 18 months; the heat value had fallen considerably and the percentage of ash had increased, with the result that it was impossible to obtain as much steam from the boilers as used to be the case.

Electricity and Milk Production.—The shortage of milk, due largely to difficulties of transport, suggests another field of agricultural work where electricity can do good service. The transport of milk and agricultural produce is largely a matter of providing light electric railways. In the pastoral districts in parts of Wales and Ireland, for example, facilities for carrying such produce are almost non-existent, and this has always been a check on agricultural production, as well as potential industrial resources. In the dairy electrical appliances have fully justified their value, and it only requires electric power to be available for them to be much more used. The prejudice against the milking machine has now been largely overcome, and experts believe that its action is more reliable than milking by hand, especially as skilled milkmaids are now difficult to obtain. Refrigerating machinery, again, plays a great part in preserving milk and enabling it to be transported for long distances, and electrically-driven centrifugal separators for removing the cream are great time-savers. The use of mechanical methods is also of assistance in maintaining cleanliness and in sterilisation.

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SOME POINTS IN AMERICAN PROGRESS.

A perusal of the bound volume of reports of the Electric Light Association, which has recently come to hand, gives a good idea of the trend of the electricity supply industry in the United States, and affords interesting reading on many topics. We may refer particularly to a very lengthy report on progress by the secretary, Mr. T. C. MARTIN. From this it is evident that extremely rapid progress is now being made by some of the electricity undertakings. For example, the peak load of the Consolidated Gas, Electric Light & Power Co., of Baltimore, rose to 40,580 kw. in 1915, being 33 per cent. higher than in 1914. During the same year the Minneapolis General Electric Co. increased its consumers by more than 7,000, and 1,990 already built houses were wired on contracts secured by the company's sales department. The maximum load of the Edison Electric Illuminating Co. of Brooklyn was 62,000 kw. in 1915, or an increase of 26 per cent. over the previous year, and the largest daily output showed an increase of 36 per cent. Perhaps it is to the Commonwealth Edison Co., of Chicago, that one looks for the greatest developments at the present time. In 1888 the largest electric generator of the Company was 80 kw., whereas now their largest is 30,000 kw. Mr. INSULL, who is identified with this development, realises very fully the importance of diversity factor in these large undertakings, and he has pointed out that if the railways in the Chicago district were electrified, a single system to supply them would have to carry a load of 728,000 kw., whereas, owing to diversity factor, the necessary service could be rendered by 577,000 kw. from the Edison system, making a saving of 150,000 kw. through centralisation. In the same way, if the idea could be carried to the extreme and all the railways, factories, mines, tramways, &c., in the United States were run by means of large generating stations, there would be a saving of some 12 to 15 million horse-power, and an annual saving in fuel consumption of about 250 million tons.

It is interesting to note that there is not much suggestion of saturation in the areas at present supplied, but the quantity of electrical energy supplied per head of population varies very largely, being in some parts as low as 200 kw.-hour per head per annum, whereas the consumption is 150 in the Middle West, and 500 to 710 on the Pacific Coast. In London we cannot boast of such figures, nor can other parts of Europe. If we look at a list of the undertakings in the United States the figures are impressive, starting with a peak load of 337,900 kw. for the Commonwealth Edison Co., though this has the comparatively modest load factor of 13·6 per cent. Naturally electrochemical works produce a more valuable result from this point of view, and thus we have the Niagara Falls Power Co., with a load factor of 78·7 per cent., the Ontario Power Co. at Niagara Falls with a load factor of 68·1 per cent., and the Hydraulic Power Co. of Niagara with 91·7 per cent.

Considerable attention is being paid to the reduction of waste in electricity works, and some details are given of the means that are adopted. The Mineral Point Public Service Co., as the result of tests, have made out a table showing the cost of coal per day and per hour, with the corresponding loss of money, when the load of any particular boiler is either above or below the most economical load as shown by the pointer of a steam flow meter. The firemen are paid a bonus to operate boilers at their best rating, the bonus ranging up to £2 per month, and averaging about £1. 5s. This bonus is based on the quality of work, taking into consideration evaporation, steam pressure, water level, CO_2 readings, flue gas temperature, position of fires and general operation. Under a bonus system adopted by the Manila Electric Railway & Light Co., the employés share 50 per cent. of the value of coal saved each month. During June, 1915, the amount so distributed was equivalent to an increase of about 10 per cent. in wages. The coal consumed per kilowatt-hour at the switchboard was 3·3 lb. of 12,013 B.Th.U. coal. The saving is based on the standard consumption of 3·5 lb. of a certain class of coal, and the distribution of the bonus is controlled by a schedule of points and penalties applied to each employé, the number of points to be credited each day being set out in a table, and apparently embracing the whole operating staff, from the assistant chief engineer down to the watchman. The difficulty one naturally feels in adopting a scheme of this kind is what is to happen when a new item of plant is put down capable of producing a kilowatt-hour at much less than the figure of 3·5 lb. of coal.

Among other points of interest to which we may refer is what is known as "flood lighting." This consists in the illumination of the exterior of buildings by means of projectors instead of methods of outlining a building by means of glow lamps. We are probably not so fond of the spectacular in this country as in the United States, but it may happen at times that the illumination of buildings or c areas is desirable, and it appears that this can be effected much more economically by flood lighting than by other means. It may, therefore, be worth while for our engineers to pay some attention to this matter.

As desirable commercial loads, reference is made to electric signs, electric furnaces and electric cooking and heating. Electric signs have reached a degree of importance which in all probability they will not attain in this country, but the electric furnace is certainly worthy of close attention. It appears that the United States now has a larger number of electric furnaces than any other country. It has been suggested that such furnaces might be used advantageously for off-peak power. It is questionable how far this idea might be followed, and it depends very largely upon the processes for which the furnace is required whether it is permissible to stop working when it is inconvenient for the supply undertaking to give energy, or whether it is a better financial proposition to pay more for the energy and to have the right of using it to suit the chemical side of the operation. With regard to electric heating and cooking, it is evident that progress has been made in the United States very much more rapidly than was the case two or three years ago.

An excellent example of the good effect of co-operation is the action taken by the garage owner, the manufacturer or dealer and the central station company in regard to electric vehicles. A difficulty arose because the City Council of Chicago passed an ordinance limiting to 30 minutes the maximum time a vehicle might stand at the curb. This step threatened to put the electric vehicle out of business, since such cars are usually driven by the owners, and no chauffeurs are available to take the cars away and bring them back. By means of co-operation, however, the difficulty was surmounted. The big shops appear to have arranged that when such a car arrives a clerk takes the key, sees that a chauffeur takes the car to the parking space and returns at the time desired. There is no charge to the owner of the car for this service, the necessary expense being borne jointly by the manufacturers, dealers and garagers.

Lastly, the Report to which we have referred contains some interesting particulars of attempts made by employers to maintain good relations with their employés. It would be well for employers in this country to pay attention to what is being done in America in this respect, more particularly at the present time, when this subject has become increasingly important.

In conclusion, it may be said that the "Proceedings" of the Convention of the National Electric Light Association form a volume showing that the Association pays attention to matters which the technical societies in this country leave out of their programmes. It may, perhaps, be described as a more human sort of volume than those to which we are accustomed, but it is largely the human element that counts, and we are inclined to think that our societies would do well to pay greater attention to this side of industry than they have in the past.

VOLTAGE REGULATION OF ROTARY CONVERTERS.*

BY G. A. JUHLIN.

Several different schemes have been devised for the purpose of voltage regulation, but, of these, only two have found extensive use in this country. They may be described by their characteristic features as follows: (1) Reactance control, and (2) booster control.

Reactance Control.

It is well known that if the field of a rotary converter is not properly adjusted for the E.M.F. supplied to the slip-rings, corrective currents are required which bring the field to its proper strength. This feature of the converter provides means for varying the voltage at the continuous-current terminals with a constant E.M.F. of the supply by what is known as reactance control.

If reactance is introduced in the line or in the transformer supplying a rotary converter, and wattless currents produced which flow through this reactance, the E.M.F. delivered to the converter slip-rings can be increased or decreased depending on the change in the field strength of the machine.

It is clear that the wattless currents may be produced by variation in the shunt current, in which case the voltage variation is independent of the load, or, if the voltage regulation be desired as a function of the load, the wattless currents may be produced by a series winding. The relations between the different E.M.F.s are of considerable importance, and although generally known are well worth a study. Fig. 1, (A, B and C) shows the diagrams of E.M.F.s for different conditions as regards wattless current. The following symbols are used in the diagrams: I_a=alternating-current load current; I_w=alternating-current wattless current; X=reactance in transformer and converter; R=total resistance of the circuit—*i.e.*, transformer and converter; Z=impedance.

With unity power factor at the converter, Fig. 1 (A) shows the relations between the different E.M.F.'s. $A\,B$ is the E.M.F. E_R desired at the continuous-current terminals reduced to equivalent slip-ring E.M.F. $B\,C$ denotes the E.M.F. due to the load current I_a flowing through the reactance X, and is equal to I_aX, and displaced by 90 deg. from E_R. $C\,D$ is equal to I_aR or the ohmic drop due to the load current, and is, of course, in phase with the converter voltage. $A\,D$ then represents the E.M.F. E required on the high-tension side of the transformer, reduced to the slip-ring E.M.F.

If the power factor at the converter differs from unity, the relation between the impressed and delivered E.M.F.s is somewhat more complex on account of the wattless current.

Fig. 1 (B) and (C) show the diagram of the E.M.F.s for the conditions of lagging and leading currents respectively. $B\,D$ is the impedance drop due to the load current and equal to I_aZ.

Referring to the E.M.F.s due to the wattless current I_w it is clear that the impedance E.M.F. due to this current must be at right angles to I_aZ. It consists of two components, I_wX and I_wR. I_wX is in phase with E_R when the power factor is leading, and in time phase with, but opposing, E_R when the power factor is lagging. I_wR is displaced by 90 deg. from I_wX. The E.M.F. I_wZ, due to the wattless current flowing through the impedance is then represented by $D\,F$ and the E.M.F. $I\,Z$ of the total current flowing through the impedance by the line $B\,F$.

In order to determine the most satisfactory value of reactance for a given compounding, it is necessary to know the change in wattless current with varying values of reactance. The E.M.F. of the high-tension side of the transformer is assumed to be constant, and as the E.M.F. desired is fixed at no load and full load, an expression for the E.M.F. E_T is easily obtained assuming the power factor at the converter to be unity at full load, from which the value of the wattless current is obtained. Fig. 2 shows the approximate relation between wattless current and reactance for different values of compounding.

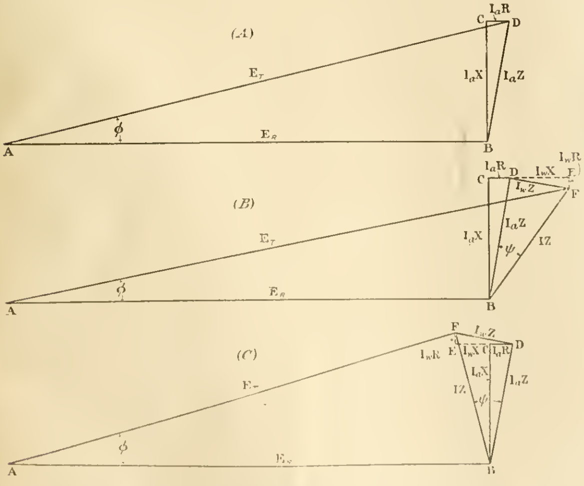

Fig. 1.—Diagram of E.M.F.s of Rotary Converter with Varying Power Factor.

A. Unity power factor. B. Lagging power factor. C. Leading power factor.

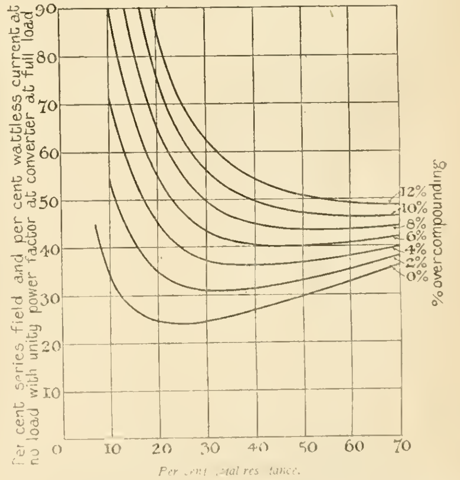

Fig. 2.—Curves showing Relation between Reactance and Wattless Current required in Rotary Converters for Different Amounts of Over-compounding. Resistance 3 per cent.

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* Abstract of a Paper read last night before the Institution of Electrical Engineers.

The curves are approximate in so far that the influence of saturation in the converter has not been taken into account. The influence of the saturation on the compounding will, however, be discussed later. The curves are based on the assumption that the E.M.F. of self-induction of the transformer varies in direct proportion to the current. The ohmic and reactance E.M.F.s are expressed as a percentage of the no-load E.M.F., and the power factor has been taken as unity at full load. The curves may, however, be used without any appreciable error in cases where unity power factor is desired at any other load.

Referring to Fig. 2, it will be seen that, except in cases of high percentage of compounding, the reduction obtained with increased reactance is very small when the reactance is higher than 30 per cent. and higher values than this are seldom met with in practice.

The question as to the point of the load at which unity power factor at the converter should be obtained, is of considerable importance. Large lagging currents can be carried by the converter at no load without difficulty, and, so far as the system is concerned, a lagging power factor is less objectionable at light loads than at heavy loads. If the lagging currents are large at no load, the leading currents required at full load or overload are reduced, which is advantageous for the converter as regards losses in the armature as well as the field copper.

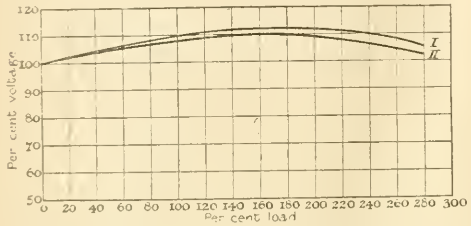

Fig. 3.—Curves Showing Compounding: I. with 71 per cent. Series Field; II. with 63 per cent. Series Field.

For railway service it is usual to adjust the field so that unity power factor is obtained at three-quarter to full load. In general, it may be said that it should be at a point somewhat above average load, and, in making the choice, due consideration should be given to the extent and duration of overloads.

Low reactance and large wattless currents give, in cases where the saturation of the converter is low, better compounding on overloads than high reactance and small wattless currents, but in machines where the saturation is high the reverse may be the case.

The author next dealt with the influence of saturation and leakage and gave the diagram of E.M.F.s of a converter arranged for 10 per [illegible] compounding from no load to full load. The total resistance drop [illegible] converter and transformer was taken to be 3 per cent. [illegible] per cent., including that of the converter armature. [illegible] power factor of the converter was assumed to be unity at full load.

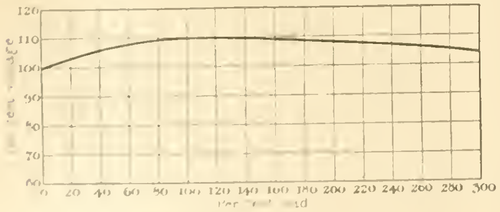

Fig. 4.—Compounding Curve.

In the example chosen the lagging current required at no load would be [illegible] per cent. of the full-load current, and consequently the [illegible] should be 63 per cent. of the effective [illegible] at full load, neglecting saturation in the [illegible], however, the field strength [illegible] than that actually obtained. [illegible] in direct proportion to the [illegible] therefore be compensated for by [illegible] This would mean that the [illegible] full load, nor would the required [illegible] necessary to increase the am[illegible] of high saturation, the difference may be considerable and would cause a diminution of the compounding. In the case under consideration, the increase in the series field amounted to 8 per cent.

Another point which is of importance in machines with high saturation is that the leakage is increased when large leading currents are produced. This means that an increase in field current is required, but, as no change is made in the field current, the result is a reduction in the leading current produced by the series field and consequently in the compounding. The difference in compounding obtained with and without allowance for saturation is shown by curves I. and II., Fig. 3.

In order to show the effect of saturated reactive iron upon the amount of series field required, and on the compounding, a transformer has been chosen in which the reactive iron is practically saturated at full load (saturation assumed to be reached at 22,000 C.G.S. lines); the reactance at this point is 25 per cent., but is 15·5 per cent. at quarter load. A diagram of E.M.F.s is given in the original Paper, and the compounding curve in this case is shown in Fig. 4.

The requirements as regards compounding are the same as in the previous case, and the transformer E.M.F. required is therefore also the same. The series field necessary to obtain the compounding is, however, much smaller, due to the high reactance at low currents; it amounts to 33 per cent., including the necessary allowance for saturation. The wattless currents at different loads are shown in Fig. 5, from which it will be seen that with saturated reactive iron at no load only 10 per cent. and at twice full load 45 per cent., of the value required with straight-line reactance are necessary. It will be noted from Fig. 4, however, that although the same percentage compounding is obtained at full load, the shape of the compounding curve is not as good.

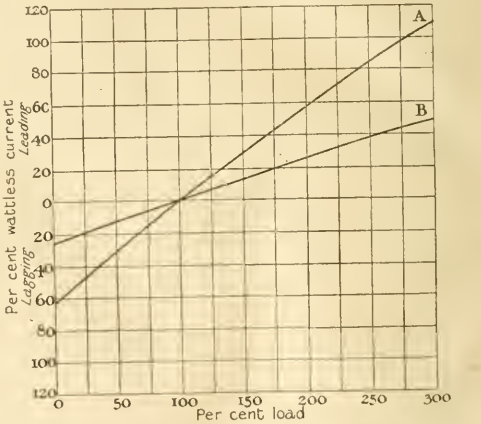

Fig. 5.—Curves Showing Wattless Current Required for 10 per cent. Over-compounding; 25 per Cent. Reactance.

A. With straight line reactance and 71 per cent. series field.

B. With reactive iron saturated at about full load and 33 per cent. series field.

The difference in the shape of the compounding curve requires some consideration, owing to the unequal voltages obtained at different loads, as in extreme cases this may lead to difficulties as regards division of load between machines provided with transformers having different types of reactance.

The author next gave the E.M.F. diagram for the use of voltage regulation obtained by shunt control, the regulation being 7·5 per cent. on either side of the mean, the total reactance 25 per cent. and the resistance drop 3 per cent. The mean voltage required on the converter was taken as the basis for the reactance and resistance, which are, therefore, expressed as a percentage of this voltage.

With any voltage variation, the value of the wattless current required with a given reactance depends on the conditions as to power factor desired on the high tension side of the transformer. The conditions most favourable to the converter are equal leading and lagging currents at the extreme voltages, as this will give minimum armature heating. The wattless currents required at different loads for the maximum and minimum voltages are shown in Fig. 6. There is no advantage, as far as the converter is concerned, in using saturated reactive iron, when the voltage variation is obtained by shunt control.

A possible disadvantage in connection with the rotary converter is that the saturated iron may cause sufficient distortions to the E.M.F. wave to make the corrective, higher harmonic, currents necessary to counteract these distortions objectionable from a point of view of commutation.

The question of power factor obtainable on converters, where voltage variation is obtained by reactance control, is of considerable importance. The power factor at the converter for a given load is fixed by the amount of wattless current, leading or lagging, necessary to obtain the specified regulation. The power factor on the high-tension side differs, of course, materially from that of the converter itself, as the voltage on the primary side is displaced from that of the secondary side through the introduction of the reactance. Furthermore, the magnetising current of the transformer affects the amount of wattless current on the high-tension side.

For the case under consideration, the power factor of the rotary converter and on the high-tension side of the transformer would be as follows :—

Voltage	107·5%	... 100%	... 92·5%
Power factor at converter $\cos\psi$	0·96%	... 1·0%	... 0·96%
Power factor on H.T. side $\cos(\varphi \pm \psi_1)$	1·0%	... 0·96%†	... 0·84%†

ψ being the angle of displacement of the currents at the converter. In arriving at these figures the magnetising current has been taken as 5 per cent.

In order to obtain unity power factor on the high-tension side at the mean voltage, 63 per cent. leading current would be required at full load to reach the maximum voltage. If 100 per cent. overload should be required at the maximum voltage, the leading current at this load would be 122 per cent., and the power factor at the converter would be 85 per cent. leading. At the low voltage, the wattless current would be 58 per cent. leading at 100 per cent. overload, and the power factor 96 per cent. leading at the converter. By careful consideration of the requirements as to voltage variation and power factor obtainable, it is possible to apply the reactance control up to fairly large variations in voltage without serious interference with the power factor.

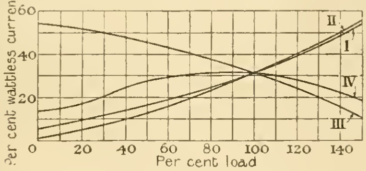

Fig. 6.—Curves Showing Wattless Current in Shunt-wound Rotary Converter.

I. Leading current with straight line reactance.
II. Leading current with reactive iron saturated at about full load.
III. Lagging current with straight line reactance.
IV. Lagging current with reactive iron saturated.

In cases where two distinct ranges of voltage are required, a combination of reactance control and tappings on the transformer is capable of wide application. The following table shows the power factor at the converter and on the high-tension side of the transformer which can be obtained without excessive wattless currents. These currents are also given in the table :—

	Max. volts. 440.	Mean volts. 420.	Min. volts. 400.
I_w	47%*	... 26%*	... 6%*
Full-load power factor at converter...	0·9%*	... 0·967%*	... 0·998%*
Power factor on H.T. side	0·99%*	... 0·998%†	... 0·97†
No-load, I_w	22%*	... 9%†	... 19%†

The range of voltage variation obtainable with reactance control is limited on account of the excessive wattless currents required, and the low power factor resulting therefrom.

The wattless currents necessary to obtain ±7½ per cent. voltage variation, with 25 per cent. reactance may be obtained from the E.M.F. diagram given in the original Paper. These values were based on the conditions of minimum heating in the converter, and the dower factor on the high-tension side of the transformer would for this reason be somewhat low. The figures are as follows :—

	Max. volts.	Mean volts.	Min volts.
I_w	31%	... 0%	... 31%
Full load power factor at converter...	0·955%*	... 1·0%	... 0·955%†
Full load power factor on H.T. side...	1·0%	... 0·963%†	... 0·84%†

Considerably better power factors can be obtained by increasing the wattless current, and it is safe to assume that 50 to 60 per cent. wattless current can be carried. Fixing the limit at 55 per cent., and assuming as before a reactance of 25 per cent., the following table gives the results as regards wattless current and power factor at the different voltages :—

	Max. volts.	Mean volts.	Min. volts.
Full load, I_w	55%*	... 24%*	... 6%†
Full load power factor at converter...	0·875%*	... 0·97%*	... 0·998%†
Full load power factor on H.T. side...	0·98%*	... 0·997%*	... 0·935%†
No load, I_w	28%*	... 3%†	... 31%†

These power factors, it will be agreed, are sufficiently high to be permissible on most systems, and indicate that the regulation considered is within the limits for practical working.

Some further slight improvement in power factor is possible by using higher reactance, but in view of the increased difficulties it is doubtful whether it is worth while to use higher reactance.

In general it may then be said that the limit of voltage variation, for which reactance control is applicable, is about ±7½ per cent., but it should be noted that if the question of power factor is not of great importance, greater range than this can be obtained with a wattless current of 55 per cent. at full load.

(To be concluded.)

PHYSICAL SOCIETY.

The Annual General Meeting was held on the 9th ult., 1917, at the Imperial College of Science, Prof. C. V. Boys, F.R.S., President, in the Chair.

The report of the Council was read by Dr. W. Eccles.

The report of the Treasurer was read by Mr. W. Duddell.

Both reports were put to the meeting and unanimously adopted.

Mr. T. H. Blakesley asked why the agenda of the meetings were not published in various papers, such, for example, as the " Journal " of the Society of Arts. This was a useful practice, and was customary at one time.

Dr. Willows explained that at present there was very often a difficulty in obtaining Papers until too late for circulation of the agenda in the Press.

Dr. Eccles pointed out that the printers were short-handed, and that this interfered with the prompt circulation of Press notices.

Votes of thanks to the Auditors, the Officers and Council, and the Governing Body of the Imperial College were carried unanimously, the respective proposers and seconders being Mr. C. C. Paterson and Dr. G. W. O. Howe ; Mr. T. H. Blakesley and Prof. Coleman ; Mr. F. E. Smith and Mr. D. Owen.

The following is the list of officers elected for the ensuing year :—*President :* Prof. C. Vernon Boys, F.R.S. *Vice-Presidents* (who have filled the office of President) : Prof. G. C. Foster, F.R.S., Prof. R. B. Clifton, M.A., F.R.S., Prof. A. W. Reinold, C.B., M.A., F.R.S., Sir W. de W. Abney, R.E., K.C.B., D.C.L., F.R.S., Prin. Sir Oliver J. Lodge, D.Sc., F.R.S., R. T. Glazebrook, D.Sc., F.R.S., Prof. J. Perry, D.Sc., F.R.S., C. Chree, Sc.D., F.R.S., Prof. H. L. Callendar, M.A., F.R.S., Prof. A. Schuster, Ph.D., F.R.S., Sir J. J. Thomson, O.M., D.Sc., F.R.S. *Vice-Presidents :* W. R. Cooper, M.A., B.Sc., Sir Napier Shaw, F.R.S., S. W. J. Smith, M.A., D.Sc., F.R.S., W. E. Sumpner, D.Sc. *Secretaries :* W. Eccles, D.Sc., Finsbury Technical College, Leonard-street, E.C. ; R. S. Willows, M.A., D.Sc., The Sir John Cass Technical Institute, Jewry-street, Aldgate, E.C. *Foreign Secretary :* R. T. Glazebrook, D.Sc., F.R.S. *Treasurer :* W. Duddell, F.R.S., 56, Victoria-street, S.W. *Librarian :* S. W. J. Smith, M.A., D.Sc., F.R.S., Imperial College of Science and Technology. *Other Members of Council :* H. S. Allen, M.A., D.Sc., Prof. E. H. Barton, D.Sc., F.R.S., Prof. G. W. O. Howe, D.Sc., Prof. J. W. Nicholson, M.A., D.Sc., C. C. Paterson, C. E. S. Phillips, F.R.S.E., Prof. O. W. Richardson, M.A., D.Sc., F.R.S., S. Russ, M.A., D.Sc., T. Smith, B.A., F. J. W. Whipple, M.A.

A Paper, entitled

"Note on the Calculation of the Coefficient of Diffusion of a Salt at a Definite Concentration,"

was read by Dr. A. Griffiths.

In the calculation of the coefficient of diffusion, by B. W. Clack, a simple relation is assumed between the density of a solution of a salt and the concentration. This simple relation is only approximately correct, and compromises are made which require justification.

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* Leading † Lagging.

* Leading. † Lagging.

This note—

1. Suggests a method of calculating the coefficients of diffusion which, to a high degree of theoretical accuracy, gives values for the coefficient which are independent of a precise relationship between desnity and concentration; and

2. Justifies the method of calculating adopted by B. W. Clack.

Mr. B. W. Clack: The coefficient of diffusion is not a constant, but varies with the concentration to a considerable extent. In most experimental work the coefficient varies at different positions in the apparatus, and any work which helps towards the proper interpretation of results is of value.

A Paper, entitled

"A Special Test on the Gravitation Temperature Effect,"

by Dr. P. E. Shaw and Mr. C. Hayes, was read.

In the "Philosophical Transactions" of the Royal Society, Vol. CCXVI., pp. 349 to 392, there is a Paper by one of the authors dealing with the possible existence of a temperature coefficient of the constant of gravitation. It was suggested in the discussion that the effect might be due to an inward displacement of the large lead spheres, at the higher temperatures, due to convection currents.

In the present Paper experiments are described in which this point is tested by micrometric measurements of the positions of the supporting wires. It is shown that, at the higher temperatures, there is a small *outward* displacement of the spheres, probably due to the expansion of the crosshead from which they are suspended. A slightly *higher* value has, therefore, to be given to the temperature coefficient of gravitation.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

In last week's correspondence it is stated that we would soon get accustomed to the florin unit, because we manage on the Continent. Certainly Britishers do try to shop on the Continent with pounds, shillings and pence, but generally they are done severely. As one experienced traveller stated, the only way to shop abroad with British money is to watch the shopman's face, put down money until a gleam comes into the said face, and then to withdraw the last coin hurriedly. Let us admit it—to use a mixture of decimal coins with sovereigns, shillings and pence is difficult, and to most people speed and accuracy would be unattainable. I have begged the florin advocates over and over again to try the experiment of instructing ordinary people, unskilled in decimals, in the conversion of our present money to the florin standard. They never try it. If they did I think their confidence would be much shaken.

The shilling unit steers clear of much of the difficulty, for people already think in shillings for shopping purposes. I recently noted that a steamer was chartered at 240s. Why not £12? The answer to this is that the charterers preferred to think in shillings. Wholesale grocers, drapers and many other such traders already use the shilling as a unit, while retail advertisers almost always quote sums like 80s., 65s., &c., rather than in pounds and shillings, as one may see in any advertisement columns of the newspapers. The General Electric Co.'s catalogue gives such prices as 56s., 100s., 150s., 160s., 240s., 360s., 175s. and 700s.; indeed, in the third volume of that famous catalogue there is hardly a price given in pounds. Surely facts like these must show that the shilling unit has advantages. Otherwise, how has it become so general?

Might I suggest that the Editor should get some Continental or U.S.A. friend to look through the correspondence and to send his ideas on what would be a workable decimal coinage for us. We Britons, with our insular prejudices, are all too liable to think that a system which has served other nations for [illegible] or other will not suit us. A frank letter from the outsider's point of view will be useful indeed.

Tynemouth, March [illegible]. C. TURNBULL.

LEGAL INTELLIGENCE.

Metropolitan Water Board v. Dick, Kerr & Co. (Ltd.)

On Monday the Court of Appeal (the Master of the Rolls, Lords Justices Warrington and Scrutton) delivered their reserved judgment in this appeal by defendants from a judgment of Mr. Justice Bray. In the action (reported in The Electrician for Aug. 4, 1916) the Metropolitan Water Board claimed a declaration that a contract to construct two reservoirs at Littleton, Middlesex, which defendants had agreed to construct for £673,000, was still in existence and that defendants were bound to perform it. The plaintiffs also asked for a declaration that they were entitled to certain plant and materials brought on the site of the works by defendants, and to all the proceeds from the sale of plant, tools; and they also asked for an injunction to restrain defendants from removing any further plant, tools, or material from the site. On Feb. 21, 1916, the Ministry of Munitions (under the powers conferred by the Defence of the Realm Consolidation and Amendment Acts and the Regulations or Orders made thereunder) served defendants with notice to cease work on the contract, a similar notice being served on plaintiffs.

For defendants it was contended that by reason of these notices the further performance of the contract became impossible and illegal, and that both parties were excused from further performance of the contract and released from further liability thereunder. As regarded the plant and materials, defendants contended that on the true construction of the contract they were merely a security for the due performance of the contract; that plaintiffs had only a limited property therein, and that upon the determination of the contract and in the events which had happened any property of plaintiffs in same had reverted to defendants.

Mr. Justice Bray held, on the terms of the contract, that the intention of the parties was to enable plaintiffs' engineer to extend the time for performance to cover every possible event which might delay completion of the contract, including the intervention of the Ministry of Munitions, and that the contract had not in fact been frustrated or its completion rendered physically impossible or commercially impracticable. The object of the contract would not be frustrated merely by delay caused by the length of the war. As regards the plant, tools and material, he held that plaintiffs were entitled to them, but that defendants were not liable either to pay to the plaintiffs the proceeds of sale of such of the plant as was sold under the instructions of the Ministry of Munitions or to pay damages for the removal of the plant so far as they acted as the Ministry's agent.

After hearing arguments the Court reserved judgment.

Mr. Upjohn, K.C., Mr. Hudson K.C., and Mr. D. M. Hogg appeared for appellants; and Mr. Holman Gregory, K.C., and Mr. Joshua Goodland for respondents.

In his judgment the Master of the Rolls said that the Water Board's original plans were modified by a supplemental agreement of May 10, 1915, for making one reservoir instead of two and revising some of the prices. After citing the terms of the original contract and the notice by the Ministry of Munitions, he said that the principles of law applicable to the case had been settled within the last few years. He cited Lord Loreburn's judgment in the Tamplin Steamship Co. v. Anglo-Mexican Petroleum Co., and said that on applying the principles laid down in that case to the facts of the present case, he found that the contract could not be performed after the receipt of the notice of February 21, 1916, by reason of the lawful act of the Minister of Munitions, making it illegal and a criminal offence to continue work under the contract. That was not in form a temporary prohibition. The continuance of a state of war had in many cases been held to be too uncertain to be regarded as temporary. The contractors treated it as of such a nature as to terminate their liabilities under the contract, and the fact that the restraint which had been in force for six months at the date of trial had now been in existence for 12 months was a matter the Court was entitled to have regard to. It might be sufficient to decide the case on the ground of illegality alone. The contract was one for the execution of very extensive works, the cost of which would probably not fall short of £750,000, and involve the employment of several thousand men. It was to be performed within six years subject to the power of the Board's engineer to enlarge the time in certain events. It gave the Board a limited property in all the plant provided by the contractors, which, roughly speaking, was worth £100,000. All that plant had been claimed by the Minister of Munitions. There was no provision in the contract enabling the contractors to recover a penny from the Board towards the cost of restoring or replacing the necessary plant. It was impossible to consider that otherwise than an event not in contemplation by either party at the time. Clause 32 of the contract contained provision for delays due to certain specified causes, such as strikes, but in his opinion those events did not extend to the case of illegality, nor did they prevent the Court from considering whether interference due to a subsequent Act of Parliament had been of such a nature as to render the contract substantially a new contract. The appeal must be allowed, and that would involve the discharge of the injunction as to the plant, and the substitution of a new declaration. The Board would have to pay the costs of the action there and below. The judgment would be without prejudice as to the rights of either party to the proceeds of sale of the plant or as to any retention of moneys under the contract, which must be dealt with in a separate action.

The two Lords Justices delivered judgment to the same effect.

Alien Enemy Patents.—Capt. D. H. Scott has been notified by the Board of Trade that a licence has been granted to him to use the Merowsky patent referred to in our report of last week (p. 669)

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Pre-War Contracts. An important judgment was delivered by the Court of Appeal on Monday in an appeal by Messrs. Dick, Kerr & Co., electrical and general engineers, against a judgment of Mr. Justice Bray, who had decided that a contract entered into before the war for the construction of reservoirs was still in existence, notwithstanding that the Ministry of Munitions had served notice upon both plaintiffs and defendants not to proceed with the work. The Court of Appeal have unanimously reversed Mr. Justice Bray's judgment and have decided that the contract was incapable of performance on the ground of illegality, and therefore that the firm were discharged from liability for the execution of the contract. As the judgment is a very important one, affecting many engineering contracts, we have reported the facts and the judgment at some length on another page.

* * * *

Electric Heating and Cooking. It is interesting to observe from the reports of the various electric supply companies which are given in another part of the current issue of The Electrician that considerable progress has been made during the past year in the development of the heating and cooking load. In many places, especially in good class residential districts, such as the West End of London, in Harrow, Oxford, &c., the increased demand was very pronounced, and made up for the loss due to the lighting restrictions. It is clear that after the war, when the prices of heating and cooking appliances again become normal, and the charges for electric current are lowered, there will be a considerable field in which manufacturers and supply companies should combine to cultivate.

* * * *

Electric Iron Risks. We publish on another page an instructive extract from a report issued by the American fire prevention authorities, the National Fire Protection Association, in which the risks of fire arising out of the use of electric irons are analysed. In many respects the report is peculiar to American practice, but there can be no overlooking the fact—nor would we try to do so—that an electric iron if left inadvertently in circuit on a table top will burn through the wood and, given certain conditions, will start a fire. We use the term "certain conditions" advisedly, because the fire hazard does not by any means apply to all classes of iron. The ordinary domestic iron of 350-400 watts loading differs from a factory iron which would be heavier and be loaded up to 750 watts or even 1,000 watts. We have heard of a domestic iron being left on all night by a careless servant and discovered the next morning on the floor of the kitchen which it had reached by way of a hole slowly charred through the table top. But there was no fire nor would there have been, although the iron was on its way through the floor-boards, when it was found. We do not agree with our contemporary "Canadian Electrical News" that the electric iron is a very dangerous fire hazard. Many hundred thousands are in use and the percentage of fires which can be traced to them is low. So far as we can gather the insurance companies have taken no steps to place electric irons on the "proscribed list"; they are less likely to do so if the experiments made with thermostats are as successful as they are stated to be. But actually the iron ungarnished by thermostats is used with no subsequent conflagration by so many people, industrial and domestic, that it is a moot point whether these safeguards which are always costly are really required. It might as logically be argued that in the price of every gas iron a fire extinguisher should be included or that each box of matches should contain a homily on the dangers of naked flame.

* * * *

Motor Trade and Municipal Trading. At a recent meeting of the Edinburgh Division of the Motor Trades Association it was agreed to oppose the following clause in the draft of the "Supply of Electricity Bill," which is being promoted by the Incorporated Municipal Electrical Association:—

Any undertakers may provide and maintain suitable accommodation for the storing, charging, inspecting and repairs of electrical vehicles, and may electrically charge, inspect, repair or maintain any vehicle using electricity for purposes of propulsion, and with respect thereto may demand and take such remuneration or rent and charges, and make such terms and conditions as may be agreed upon.

Control of Aluminium. The Ministry of Munitions has cancelled all existing permits for the sale, purchase or remelting of aluminium scrap and swarf as from March 1, and all dealings are now governed by the following regulations:

1. No existing aluminium scrap and swarf may be used for any purpose excepting at the works where the same has been produced and for contracts for which aluminium has been released by the Director of Materials and as portion of the amount so released.

2. All existing aluminium scrap and swarf not being used at any works where the same has been produced, for contracts for which aluminium has been released by the Director of Materials, and as portion of the amount so released, shall be sold and sent within three weeks from the 1st inst., to the refiner or one of the refiners nominated by the Ministry of Munitions for the district where such scrap and swarf is situated.

3. When aluminium scrap and swarf is produced hereafter such scrap and swarf must be used at the works where produced for contracts for which aluminium has been released by the Director of Materials, and as portion of the amount so released, or otherwise sold and sent at or before the end of each month to one or other of the refiners nominated by the Ministry of Munitions.

Applications for permits should be made to the Director of Materials, A.M. (2) H., Hotel Victoria, Northumberland-avenue, London, W.C.

* * * *

An All-British Steel Syndicate. It is announced that prominent steel-makers throughout Great Britain are considering a scheme to form an all-British syndicate of steel-makers, with a view to shutting the door effectively against foreign steel-makers on the conclusion of the war. The merchants on their part have formed themselves into an association to safeguard their interests.

* * * *

Excess Profit Duty Decisions. The Board of Referees have decided to raise the statutory percentage for companies engaged in the business of electric traction at Shanghai to 9 per cent., and for private firms to 10 per cent.

Companies engaged in the supply of electric light and power at Hankow are to be entitled to a statutory percentage of 9 per cent., and private firms 8 per cent.

* * * *

Engineering Wages. Important awards have been made by the Committee on Production (Sir Geo. Askwith, Sir David Harrel and Sir Geo. Gibb) as to wages in the engineering and shipbuilding trades.

The increased amount given by the present awards, which apply to all federated engineers and shipbuilding firms in Great Britain, is 5s. per week, payable as from April 1, and 2s. 6d. per week to boys and youths. The awards apply to timeworkers, pieceworkers, premium bonus workers, &c., and the amount awarded is stated to be intended to assist in meeting the increase in cost of living.

In the award for the engineering trade there is a provision that in districts where the advances in time rates since the beginning of the war amount to less than 7s. per week a further advance is to be given sufficient to bring the amount up to 7s. The addition of the 5s. now awarded thus brings the war advances to timeworkers in those trades up to not less than 12s. per week. The piece workers in those trades, as in the shipbuilding trades, have already received an advance of 10 per cent. on piece rates as a result of findings of the Committee of Production, and they are now to receive in addition the amount of 5s. given to time-workers.

Over a million workers are affected by the above award.

* * * *

Trade After the War. The Newcastle and Gateshead Chamber of Commerce recently considered the report by the Committee on "Trade After the War."

The Committee recommended a thorough reform of trade organisation, and, with a view to greater efficiency in introducing our trade products abroad, suggested the association of manufacturers, the employment of linguist travellers and various educational reforms. They also recommended the reform of the Consular Service, the setting up of State-aided trade banks, and the creation of a Ministry of Commerce, as well as reciprocal trading within the Empire, national development of Empire resources, and the eradication of enemy influence in public and private life by restrictions on alien immigration and trading facilities. The patent laws should also be revised, restrictions and special taxation be placed on enemy shipping using our ports, and a round-table conference held to discuss between capital and labour various problems likely to arise.

Mr. J. E. Dawson, chairman of the Committee, moved the adoption of the report, and said the Committee had three main ideas. They had thought first of the many alien enemies in the country, and that the influences exerted by them, if not eradicated, should at least be more controlled. It had also been felt that we had many deficiencies as to methods and organisation. The most fascinating side of the Committee's considerations dealt with the Imperial idea. Before the war we had vague ideas of large dependencies. We had now seen these dependencies take their part as an integral portion of the Empire, and we could not discard the idea of a great Empire, with England as its soul. The war was going to leave us with a great incubus of debt, and we must develop the Empire and reciprocal trading within it, to provide something to be taxed. He personally should like to see Free Trade within the Empire.

The report was unanimously adopted.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 24, 1917, *to* March 2, 1917.

IMPORTS.

[illegible] *U.S.A.:* Telegraph material, £625, elec. machinery, £551; unenumerated, £8,104. *Japan:* Unenumerated, £3,370. *France:* Unenumerated, £40. *Switzerland:* Elec. machinery £5; unenumerated, £118. *Holland:* Elec. glow lamps, £4,112; unenumerated, £25. *British India:* Unenumerated, £25. *Spain:* Carbon candles, £1,085.

EXPORTS.

TO AUSTRALASIA. *Auckland:* Elec. lamps, 1,050 no.; unenumerated, £82. *Melbourne:* Elec. machinery, £554; unenumerated, £831. *Sydney:* Elec. machinery, £187; unenumerated, £1,281. *Wellington:* Unenumerated, £192. *Adelaide:* Unenumerated, £287. *Christchurch:* Unenumerated, £179. *Brisbane:* Unenumerated, £389. *Dunedin:* Elec. machinery, £80; unenumerated, £134. *Hobart:* Unenumerated, £268. *Perth:* Unenumerated, £1,102. *Fremantle:* Elec. machinery, £61.

AFRICA.—*Cape Town:* Elec. machinery, £147. *Port Elizabeth:* Unenumerated, £176. *Durban:* Elec. machinery, £599; unenumerated, £1,265. *Beira:* Unenumerated, £11. *Delagoa Bay:* Elec. machinery, £147; unenumerated, £237. *St. Helena:* Unenumerated, £20. *Mauritius:* Unenumerated, £10.

EGYPT.—*Port Sudan:* Unenumerated, £139.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £682; elec. lamps, 4,000 no.; elec. machinery, £187; unenumerated, £600. *Calcutta:* Elec. lamps, 2,000 no.; wire and cable, £728; elec. machinery, £758; unenumerated £652. *Madras:* Unenumerated, £190. *Singapore:* Unenumerated, £605. *Penang:* Unenumerated, £504. *Bangkok:* Elec. lamps, 200 no. *Karachi:* Unenumerated, £122

JAPAN. *Nagasaki:* Unenumerated, £74. *Tokio:* Unenumerated, £11.

CHINA.—*Hongkong:* Unenumerated, £242. *Shanghai:* Unenumerated, £12.

U.S.A. *New York:* Telegraph material, £150; elec. machinery, £73; unenumerated, £105.

CANADA. *Montreal:* Elec. machinery, £278. *St. John's, N.B.:* Unenumerated, £169.

SOUTH AND CENTRAL AMERICA. *Buenos Ayres:* Elec. lamps, 1,450 no.; unenumerated, £1,232. *Valparaiso:* Wire and cable, £72; unenumerated, £174; *Lourenco Marques:* Unenumerated, £79.

WEST INDIES.—*Barbados:* Wire and cable, £65.

HOLLAND.—*Rotterdam:* Unenumerated, £175.

FRANCE.—*Paris:* Elec. machinery, £1,099; unenumerated, £2,740. *Marseilles:* Unenumerated, £64. *Dieppe:* Unenumerated, £907. *Boulogne:* Elec. machinery, £83; unenumerated, £277. *Dunkirk:* Elec. machinery, £25.

FINLAND.—*Helsingfors:* Wire and cable, £460.

NORWAY. *Bergen:* Wire and cable, £1,147; unenumerated, £77. *Christiania:* Wire and cable £117; unenumerated, £30. *Trondhjem:* Wire and cable, £3,683; unenumerated, £3,884.

RUSSIA.—*Petrograd:* Wire and cable £701; unenumerated, £1,211.

MALTA.—Unenumerated, £55.

GIBRALTAR.—Telegraph material, £70.

ITALY.—*Genoa:* Unenumerated, £65.

FOREIGN GOODS (duty paid and free).

Melbourne: [illegible] £407. *Christiania:* Wire and cable, £37. *Bergen:* [illegible] £1,217. *Bombay:* Unenumerated, £90. *Durban:* Unenumerated, £92 [illegible] £151. *Mauritius:* Unenumerated, £37. *Rotterdam:* Unenumerated [illegible] *Trondhjem:* Unenumerated, £1,338. *Consberg:* Unenumerated, [illegible] *Amsterdam:* Unenumerated, £65. *Barbados:* Unenumerated £17. *Casablanca:* [illegible] £46. *Dieppe:* Unenumerated, £300. *Port Swettenham:* [illegible] *Singapore:* Unenumerated, £189.

IN TRANSIT.

[illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical material."

EDUCATIONAL.

University of Sheffield.—Prof. W. Ripper, the head of the applied science department, has been elected Vice-Chancellor in succession to Dr. H. A. L. Fisher.

Mr. Douglas Vickers, a director of Vickers (Ltd.), has been appointed treasurer in succession to the late Col. Hughes.

The Governors have also decided to divide the Faculty of Applied Science into separate faculties of Engineering and Metallurgy.

Rutherford Technical College.—Newcastle-on-Tyne Education Committee has approved a proposal that the directors should acquire new and up-to-date telegraph apparatus for the Marconi, Telefunken and Poulsen systems, at a total cost not exceeding £2,000.

Education Estimates.—A Parliamentary Paper was issued on Tuesday giving the estimates for the Civil Service and Revenue Departments for the year commencing April 1 next.

The Board of Education require £[illegible],150,780, including £100,000 for [illegible] and £1,035,000 for scientific and industrial research ([illegible] on account).

BUSINESS NOTICES.

The London offices of Messrs. Nathan & Allen, the Wardle Engineering Co. (Ltd.), and Messrs. Parmiter, Hope & Sugden (Ltd.) have been removed to 25, Victoria-street, London, S.W. The telegraphic address remains "Nathalleet Vict. London"; telephone: "Victoria 7,266."

The offices of the Federation of British Industries have been removed to 39, St. James's-street, S.W. Telephone, Regent 2,040.

Cecil M. and Frank M. Sanders (trading as Sanders Bros. & Co.), metal brokers and agents, 139, Fenchurch-street, London, E.C., have dissolved partnership. Debts by Mr. F. M. Sanders.

Fredk. Blythe and Robt. T. Lanceley (trading as the Acetylene Welding Engineering Co.), Moor-lane, Mansfield, have dissolved partnership. Debts by Mr. Blythe.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of April 2. *Further particulars are set out in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

The Telephone Development Co. (Ltd.) is being wound up voluntarily. Claims to the liquidators, Mr. J. E. Kingsbury and Mr. Albert Aims, 22-28, Broad-street-avenue, London, E.C., by March 19.

Claims against Joseph G. S. Cunnington and Harry R. Allison (trading as Laing, Wharton & Cunnington), electrical engineers, &c., 7, Great Newport-street, London, W.C., are to be sent to Mr. E. L. Hough, Bankruptcy-buildings, London, W.C., preparatory to the payment of a dividend.

Winding-up Petition.—A petition presented by the Board of Trade for the winding-up of the Australian Metal Co. (Ltd.) will be heard in the High Court, London, W.C., on March 13.

ELECTRICITY SUPPLY.

EXTENSIONS.

Glasgow. The Corporation propose to put in turbo-alternators (15,000-kw.) and condensing plant at their new generating station at Dalmarnock.

Todmorden.—Last week there was a lively discussion on a proposal to expend £10,000 on additional electrical plant.

The Finance Committee recommended that the proposals of the Electricity Committee be deferred for six months.

The chairman of the Electricity Committee (Councillor Brooke) contended that a new 1,000 kw. turbo-generator and other plant were absolutely necessary.

Councillor Greenwood (chairman of the Gas Committee) denounced the proposed expenditure. He said there was already an annual loss on the electricity department of £2,000 and the new proposal would simply increase it.

The proposals were, however, approved.

Woolwich. The London County Council agreed on Tuesday to make arrangements for an additional supply of power in the Woolwich district from the Greenwich generating Station.

For this purpose additional cables and machinery will be required. At present it is impossible to give a close estimate of the cost of the work but it is thought that it will not exceed £30,000 and the whole of it will be re-imbursed by the Government.

GENERAL.

Aberdeen.—The agreement for the supply of electricity by the Corporation to the Great North of Scotland Railway Co. has been renewed for another year.

Batley.—The minimum charges for electric current has been increased as follows:—

Lighting, 25s. per annum; power, 13s. 4d. per quarter; and lighting and power, 13s. 4d. per quarter, exclusive of meter rents.

Belfast.—The Council is applying for an order to supply electric current to a hospital for wounded soldiers and sailors outside the city boundary.

Birmingham.—The Birmingham Tame and Rea District Drainage Board has entered into an agreement for the disposal of ashes from the electric supply department. For an agreed period the board have undertaken to deal with about 70,000 tons per annum. The work involves the purchase of canal boats, horses, tip wagons, 2 ft. gauge railway, &c.

Burton-on-Trent.—At the last meeting of the Council the chairman of the Gas and Electricity Committee (Ald. Lowe) said the increased demands for electric current during the past two or three years showed that the public had realised that electricity for power purposes had great advantages over almost all other sources of power.

He said there were so many demands that they must apply to the L.G. Board for a substantial loan in order to make their plant adequate for the requirements of the not far distant future. The present plant would not by next winter give sufficient margin of power to prevent the possibility of breakdowns, and it was proposed to put in a 3,000 kw. set and also further boilers, &c. He was doubtful if the Board would grant their request, but they were bound to prove to the public that they had done their best to provide the electricity required.

Islington (London)—Last week the Council was recommended by the Lighting Committee to increase the salary of the deputy electrical engineer, Mr. A. P. MacAlister, from £350 to £400 per annum.

The Council, however, adopted the report of the Finance Committee which recommended that the salary be increased to £375. The salary of the constructional and repairs engineer (Mr. C. S. A. Munro) was increased from £3. 9s. per week to £4.

Preston.—A report on the present position of electricity supply in the borough, which was prepared by the electrical engineer and tramways manager (Mr. J. F. Simpson) was adopted by the Council last week.

The Council was reminded that the supply of electricity for lighting and power was given by the National Electric Supply Co., which operated under a Provisional Order granted in 1891, and expired in 1933. It was suggested that a scheme should be prepared whereby the Corporation shall supply electric current for lighting and power on the same principle as that of other municipal "monopoly" undertakings. The report continued,

"The existing company supplies only a comparatively small amount of energy for power, having confined their operations principally to lighting, and that as any scheme to deal with the question on a sufficiently broad basis involves the erection of a new power station, which should be situated near an ample supply of water for condensing purposes, and with railway facilities for dealing with the large quantities of coal required, the company can hardly be expected to sink the necessary capital in view of the fact that their powers lapse in 17 years. Preston should have such a plant in readiness to meet the growing industrial demand and the expected expansion of trade on the conclusion of hostilities, and the Corporation land along the Ribble offered an ideal site for a new generating station."

TRACTION NOTES.

Bexley.—The Council have abolished halfpenny fares on the local tramways.

Blackpool.—The Tramways Committee has commenced the training of women tramcar drivers.

Croydon.—The Council have decided to purchase an Edison electric motor tower wagon for the tramways department at £921, the amount to be defrayed out of the reserve and sinking fund.

East Ham.—Although 51·392 per cent. of the passengers carried on the Council's tramway system are ½d. fares, the income derived therefrom is only 32·35 per cent. of the total. The Tramways Committee has, therefore, decided to abolish the issue of ½d. tickets to adults.

Electric Traction in U.S.A.—The electrification of the Chicago, Milwaukee & St. Paul Railway, which has already been completed through the Rocky and Belt Mountains, and is nearly finished through the Bitter Route Mountains, is to be extended to the Pacific.

The electrification of the original 440 miles of track will be completed shortly, and the "Electrical World" announces that surveys are being made of 400 miles of additional trackage so as to extend the electric system from Avery (Idaho) to the western terminus.

Lancaster.—At last week's Council meeting it was decided to purchase two more motor omnibuses of English make.

The Chairman of the Tramways Committee said he believed the time was coming when it would pay the Corporation to scrap the electric tramways and to go in for electric motor 'buses.

L.C.C. Tramways.—The Highways Committee reported to the Council on Tuesday that they had been considering the question of the suitability of the designation of the chief officer, and they recommended that in future the head of the department should be called general manager.

The committee also made recommendations in regard to the other appointments under the new scheme of re-organisation. With regard to the traffic branch they were of opinion that, in addition to filling the positions of traffic manager and operation superintendent, the position of development superintendent should be filled without delay. The question of making appointments to the new subordinate positions in the development and publicity sections would be taken into consideration as soon as possible. For the position of traffic manager they advised that Mr. J. K. Bruce should be selected, at a commencing salary of £1,250, rising to £1,500 a year. As a consequence of this transfer, his position of deputy chief officer of tramways would be abolished. For the positions of electrical engineer, development superintendent and operation superintendent it is proposed to issue advertisements inviting applications.

An amendment by Mr. Cotton, instructing the committee to invite applications by advertisement for the office of traffic manager, was negatived, and the committee's report and recommendations were agreed to.

Northampton.—All fares other than the ordinary 1d. ticket, the ½d. early morning ticket and children's tickets have been abolished. The increased revenue from this and a revision of the parcels rate is estimated at £2,000 per annum.

Post Office Tube Railway.—On the tube railway which the Post Office is constructing beneath London to facilitate the dispatch of mails, a sum of £355,496 had been expended up to March 31 last. Of the authorised issue £744,503 is unexpended.

Surbiton.—The Council recently decided to purchase two electric dust collecting vans.

As the L.G. Board refused to sanction a loan for the purchase, it was decided to purchase one vehicle this year and to hire the second vehicle for a year, at the end of which it will be purchased. The Council state that they have no alternative but to secure the electric dust vans as they have no other way of getting over the dust removal difficulty.

LIGHTING & POWER NOTES.

Electric Cooking in Canteens.—On Saturday Princess Victoria of Schleswig-Holstein opened the Y.M.C.A. canteen at the munition works of the British Thomson-Houston Co. near London.

Provision is made for about a thousand workers at the institution, and all the cooking is to be done electrically.

At Newport (Mon) there is a day and night canteen, which is run by the Alexandra (Newport and South Wales) Docks and Railway Co., and caters for some 250 workers. The kitchen equipment has been mainly provided by the Falkirk Iron Co., of Falkirk, N.B., and consists of four electric cooking ovens and two electric grills, steam boiler and boiling pans, steam-heated hot closets, a coal-fired range, &c.

Electric Stacking Machine.—At last week's meeting of the Mersey Docks and Harbour Board it was stated that the Traffic Committee were making a further experiment in electrical stacking machines. This machine was being effectively worked in Manchester, and they had made arrangements with Messrs. Furness, Withy & Co. to give it a good trial.

Street Lighting.—Deptford (London) Council is recommended to suggest to the responsible authorities that considering the brief period of darkness in May, June, July and August which will result from the introduction of the Summer Time Act, it is desirable to dispense with street lighting during those months, except at dangerous street crossings.

TELEGRAPH AND TELEPHONE NOTES.

Anglo-Canadian Cable Rates.—In the fifth interim report of the Dominions Royal Commission attention is called to the anomalies in cable rates between Canada and the United Kingdom and other Dominions, and it is suggested that there might be a decrease in the minimum number of words and corresponding charge for week-end messages. "Atlantic cable companies should (it is stated) adhere to the International Telegraph Convention, and measures should be taken to secure to the Canadian Government control over the landing of cables." The system of Press news is also said to be unsatisfactory and dangerous. There should be a combined news service from the United Kingdom for Canada, Australia and New Zealand.

Wireless Telegraphy on British Ships.—By an Order in Council, issued on July 28 last, every British ship of 3,000 tons gross or upwards is required to have a wireless installation.

Negotiations were opened with the Marconi International Marine Communication Co. and ship-owners in regard to the general conditions for supplying installations, but the details of the agreement are being left to individual ship-owners to settle. Subsequently modifications of the agreement were found to be desirable and are now being discussed. Licences are only issued by the Post Office (under the direction of the Admiralty) as and when it is found possible to obtain the apparatus and operators.

EMPIRE NOTES.

Australasia.—Christchurch (N.Z.) ratepayers have approved a proposal to expend £60,000 upon extensions of the municipal electric supply undertaking.

The following (amongst other amounts) will be expended on the Victorian railways during 1917: Electrical equipment of sub-station (Spencer-street), £16,244 (against £4,756 in 1916); installation of power signalling, £50,500 (£44,706); electric lighting of stations, £1,000 (nil); St. Kilda–Brighton street railway, construction and equipment of Elwood sub-station, £4,299 (£14,701). It is also expected to spend £330,000 during 1917 on rolling-stock, equipment and machinery, and, £775,000 upon the electrification of the Melbourne and suburban lines, excluding the construction and structural alterations of rolling-stock. For the construction of new lines (including rolling-stock) £230,000 has been set aside.

H.M. Trade Commissioner in New Zealand (Mr. R. W. Dalton) is arranging for a display of goods of United Kingdom manufacture at the South Taranaki Winter Show in July. Free space will be provided for United Kingdom exhibits, and the cost to each firm participating will be only a share of the expenses of erecting a suitable stand. Communications to H.M. Trade Commissioner, P.O. Box 369, Wellington, N.Z.

India.—The power station of the United Provinces Electric Supply Co. at Lucknow was formally opened on Jan. 17, the Lieutenant-Governor, Sir James Meston, attending.

Messrs. Martin & Co., managing agents, floated the company, for Messrs. Crompton & Co., who obtained the necessary licences for the supply of electrical energy in Allahabad, Lucknow and Bareilly and who equipped the works, Mr. T. E. Raven superintending the work on their behalf. Two second-hand 200-kw. sets are being used, pending the delivery of the engines for which contracts have been placed.

The report of the Punjab Public Works Dept. for 1915-16 states that the electrical division spent Rs. 1,19,828 (£7,989) on original works during the year. In Lahore electric lights and fans were installed in the medical, veterinary and Government colleges and in the lunatic asylum, and the Government Press was also supplied with electric motors, the lighting of the roads in the Lawrence Gardens was carried out, and additions and alterations were made to the electric lighting at Government House. In Lahore the division has charge of 1,952 fans, 3,693 lamps and 21 motors, which represent a capital value of about Rs. 3,66,000 (£24,400).

FOREIGN NOTES.

Chili.—The acting British Consul at Iquique has a list of firms who could deal satisfactorily in machinery, electrical material and ironmongery.

Coal Supply in Spain.—Owing to the shortage of coal caused by the German interference with neutral shipping, several gas and electricity supply works, including those at Cadiz, will be closed down.

Hydro-Electric Works in France.—An arrangement has been made whereby the *Société* d'Energie Electrique du Littoral Méditerranean will undertake the development of the water power in the valley of Tinée.

The company holds a concession in respect of the Var, but it is proposed to supply electricity for various lighting schemes, the electrification of the Sud France Railway and also for industrial works, &c.

In Auvergne, at Laroquebrou, the Société des Aciéries de Firminy proposes to construct hydro-electric works by utilising the waters of the Cère. More than 10,000 H.P. will be available.

Hydro-electric Works in Italy.—Sir Vincent Caillard and Mr. F. Barker, directors of Messrs. Vickers Limited, have been elected directors of the Società per le Imprese Idrauliche ed Elettriche del Tirso and of the Società per le Forze Idrauliche della Sila.

These two companies, to whom special concessions have been given by the Italian Government, have for their object the development of hydro-electric power for industrial purposes, and also for agricultural irrigation in Sardinia and the southern provinces of Italy. Hydro-electric works will be erected on the River Tirso in Sardinia and Sila in Calabria.

Italy.—The Government has granted to the Società per le Forze Idrauliche della Sila a concession for the construction of water power works in the upper valleys of the rivers Neto, Arno and Ampollino, the construction of channels to conduct the water to electric power works and the production of electric current.

The concession is for [illegible] years, at the end of which period the undertaking will revert to the State. The Company contracts to supply, within a year from the opening of the first power works, the electric current required for working the Calabro Lucana Railway. The total cost of the works is estimated at 70,000,000 lire (£2,800,000 at [illegible]), and they must be completed within 15 years. The company is required to construct two reservoirs, with electrical works producing 25,000 H.P. [illegible].

Spain.—A new company, entitled the Federacion Patronal de Industrias Electricas has recently been formed in Barcelona, with a capital of £10,000, to develop electric lighting and power installations in Spain.

Water Power in Norway.—The Norwegian Government has been requested by a committee of the Storting not to allow foreigners or foreign companies to acquire waterfalls in Norway except in special circumstances.

MISCELLANEOUS NOTES.

Cornish Wolfram.—The authorities of the Duchy of Cornwall have prepared a scheme for the recovery of wolfram in certain areas.

Among the works of development are the mine and ore-dressing works at Gunnislake Clitters, situated on a steep bank beside the River Tamar, about a mile from the Hingston Down mines. Work will be resumed on the mine in due course, but at present attention is being paid to the remodelling of the mill, which stopped work in 1909. A gas engine of 180 H.P., driven by producer gas, has been substituted for the steam engine originally installed for the generation of electric current. There are 25 Californian stamps, of which 10 are now at work, and preparations are being made to provide the washing tables required for the remaining 15. The process of treating the ore consists roughly in breaking it in stone crushers, passing it through the stamps and separating the valuable minerals from the sand by means of washing tables and other devices. As the specific gravity of wolfram and cassiterite is practically the same, the two cannot be separated by these means, and therefore recourse is had to a magnetic separator, consisting of four electromagnets of successively increasing power.

Enemy Firms Wound Up.—The Board of Trade has ordered the winding-up of 419 businesses controlled by alien enemies.

The latest list includes the Mea Magneto Co. (Ltd.), Gresse-buildings, 3, Stephen-street, London, W. (controller, Mr. C. R. Beeby, 66, Basinghall-street, E.C.).

The controller of R. Dolberg, 119-125, Finsbury-pavement, London, E.C., supplier of portable railway materials, has applied for a release. Objections to the Board of Trade by March 10.

The Controller of Ship Carbons (Ltd.) has applied for a release. Objections to the Board of Trade by March 14.

Export Licences.—Attention is called to Sect. 4 of the Customs (War Powers) Act, 1915, which requires that where a licence to export any goods subject to prohibition or restriction authorises exportation to a particular person or place, the name of the person or place (or both) shall be inserted in all invoices, the penalty for default being £100.

The requirements of the Section as regards bills of lading will be regarded as being met if the bills are made out to a bank for the account of the person named in the Privy Council licence, or to the order of the shippers for the account of the consignee named in the licence. A bill of lading in which the name of the consignee is only inserted in the margin is not regarded as complying with the requirements of the Section.

The Director of the War Trade Department points out that all communications for export licences should be addressed to the Secretary, War Trade Department, 4, Central Buildings, Westminster, S.W.

Fire.—A fire broke out at the Castleford depot of the Yorkshire (West Riding) Electric Tramways Co. on Monday morning and nine tramcars were destroyed. The damage is estimated at over £10,000.

Registration of Business Names.—A useful guide to the Registration of Business Names Act, 1916 (written by Kenneth Brown, Solicitor), will be published immediately by Sir Isaac Pitman & Sons, Ltd. The price is 1s. net.

An interesting lecture, recently delivered by Mr. Herbert W. Jordan, on The Registration of Business Names Act, has been issued by Messrs. Jordan & Sons, at 6d. net.

Restricted Imports.—*Wire.*—The Department of Import Restrictions announces that the general licence permitting the importation of all manufactures of wire is revoked and that a general licence is substituted permitting the importation only of wire hooks, wire nails, wire pins, wire screws and wire staples. Goods in transit before March 1 fall under the general licence now withdrawn.

Tribunal Case.—At Newmarket last week, Mr. F. Simpson, manager of the Newmarket Electric Light Co., appealed for Robert Claydon, a stoker at the electricity works.

It was said that the man was in a certified occupation and as a stoker he was indispensable. The company, which was supplying electric current to a military establishment, was very short handed.

Major D'Albani: Electricity is a convenience and not a necessity and the question is whether we should have this A1 man fighting in the Army or helping a convenience. We don't use electric light in the trenches.

Mr. Simpson: It wants a good man to do the work.

Temporary exemption was granted for three months, to be final.

TENDERS INVITED.

Turbo-alternators, Transformers and Condensing Plant.

GLASGOW.—The Corporation of Glasgow invites tenders returnable April 5 for Turbo-alternators (15,000 kw.), transformers and condensing plant for their new generating station at Dalmarnock. Particulars from W. W. Lackie, Chief Engineer and Manager, 75, Waterloo-street, Glasgow.

Electrical and Tramway Stores.

The Tramways and Electricity Committee of BELFAST Corporation invite tenders for the supply of stores and materials, including mill furnishings, packings and asbestos goods, lubricating oils and petrol, trolley wire, overhead line material and galvanised wires, v. b. insulated cable, v. i. r. cables and wires, electrical accessories, lamps, arc lamp carbons and carbon brushes; bitumen, tapes, joint box compound, fuse wires, meters, indicators, time switches and house service cut-outs, &c. Forms of tender, from Mr. T. W. Bloxam, city electrical engineer, and tenders to the town clerk by 10 a.m. Wednesday, March 14,

LONDONDERRY Corporation want tenders by noon March 17 for supply of Carbons, Meters, Cables, Fuse Boxes, Engine-room Stores, &c., for their electricity department. Specifications from the Borough Electrical Engineer.

Tenders are required by first post March 14 for supply of Electrical goods for one year to the Cheshire County Asylum, MACCLESFIELD. Forms of tender, &c., from the Clerk.

STOCKTON-ON-TEES Corporation require tenders by March 12 for six months' supply of Stores to the electricity department.

DUNDEE Corporation require tenders by 9 a.m. March 28 for 12 months' supply of Meters and Electrical and General Stores to their electricity department. Specifications from the Electricity Dept. Offices, Dudhope, Crescent-road, Dundee.

BOLTON Tramways Committee require tenders by noon March 19 for one year's supply of overhead materials, lamps, carbons, insulating materials, gear and pinion wheels, castings, &c. Specifications from the General Manager.

WEST HAM Guardians require tenders by 10 a.m. March 15 for three months' supply of Electrical Fittings, &c. Forms of tender from the Clerk, Union-road, Leytonstone, London, N.E.

Motors.

MANCHESTER Electricity Committee require tenders by 10 a.m. March 14 for the supply of nine 40 H.P. Three-phase Slip-ring Motors. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Arc Lamp Carbons.

ST. PANCRAS (London) Borough Council invite tenders for the supply of arc lamp carbons, delivery to be made as required. Specification, conditions of contract and form of tenders from the Electricity Department, Offices 57, Pratt-street, Camden Town, N.W. Tenders to the town clerk, Mr. C. H. F. Barrett, by noon of Thursday, April 12. *See an advertisement.*

BUENOS AYRES Municipality invite tenders for the supply of Electric Carbons during 1917. Conditions of tender may be consulted at the Oficina de Licitaciones, Avenida de Mayo 525, Buenos Ayres, when tenders will be received until March 30.

Synchronous Condensers.

The TORONTO ELECTRIC COMMISSIONERS invite tenders for Synchronous Condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28.

Meters.

RHONDDA Urban Council require tenders by noon March 21 for one year's supply of House Service Meters. Specification from the Electrical Engineer, Electricity Works, Porth, Glam.

TENDERS RECEIVED AND ACCEPTED

MARYLEBONE (LONDON).—The Council has accepted the offer of the Pritchett & Gold and E.P.S. Co. for the maintenance of the storage batteries at Aybrook-street and Rathbone-place substation for £88.

SALFORD.—The Council has accepted the tender of the British Westinghouse Electric & Mfg. Co. for the supply and erection at Frederick-road station of a 1,250 kw. rotary converter set for £3,660.

WOOLWICH.—The Council has accepted the tender of W. T. Henley's Telegraph Works Co. for the supply of cable, at £1,444. 7s. 11d.

CHELTENHAM.—The Corporation have accepted the tender of the Edison Swan Electric Co. for 12 months' supply of electric light fittings, at schedule rates.

BERMONDSEY (LONDON).—The Guardians have accepted the tender of Pryke & Palmer for the supply of Mazda and Ediswan electric lamps, ironmongery, &c.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Westminster Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on the 28th ult., under the presidency of Mr. J. BROWNE MARTIN, the chairman of the corporation.

The SECRETARY (Mr. W. A. Pearman) having read the notice calling the meeting and the auditors' certificate.

The CHAIRMAN said: Gentlemen, I am glad to say that during the past year the receipts have shown an upward tendency; they are larger by some £15,000 than those for 1915. This is due to the increased charge to consumers and to the large expansion in current sold for power and heating. The latter has been in great demand. Radiators and electric fires are now used in a large number of houses, flats and offices, and their use is constantly increasing, so that with the realisation by the public of its great and many advantages we may look forward with confidence to a greatly extended use in this direction. During the past year we have sold 187,000 units less for lighting than in the previous year; but this loss would have been considerably more had we not experienced the fogs and dark weather at the latter end of the year. The units sold for power and heating have increased by some 1,200,000, and the total sold for this purpose very nearly approached that sold for lighting. A few years ago we could hardly have supposed that a company like ours, whose area is mainly in the residential and shopping district of London, would sell as many units for power as for lighting; but the result has justified our policy in advocating a cheap supply for this purpose. I think we may take some credit for this, as we were the pioneers of power and heating at 1d. per unit in the West End. Some of the costs of generation have risen appreciably. Coal at our own stations and Grove-road has cost on an average 1s. 6d. per ton more than for 1915. Repairs and distribution, which are varying amounts, have also increased; but, although they amount to more than last year, they are less than for 1914. When addressing you last year we anticipated that the cost of public lighting would be larger this year by £1,000, owing to the increase in the cost of carbons and in wages; the actual increase works out at £927. For the first time in the history of the company we have to record a material reduction in the amount paid for rates. Last year, you may remember, I said that, "As we had failed to obtain any substantial relief from the Assessment Committee, we had decided to appeal to Quarter Sessions"; but before the case came on for hearing the Committee approached us, and we were able to arrive at a settlement. We, have, in accordance with the recommendation of our engineer-in-chief, Sir Alexander Kennedy, set aside the same amount as last year for depreciation and sinking fund. Insurance has increased, as the present account includes a full year's premium for insurance against damage by aircraft. War bonus to employés is larger. The loss on investments realised has been charged against the reserve fund. The enormous burden thrown on this country to finance the war has necessitated the raising of huge sums by the Government at a high rate of interest. This has had the effect of depreciating the value of all first-class securities: but, fortunately, we are under no necessity for realising. We have lent to the Treasury securities to the amount of over £70,000, and we also hold £90,000 of War Loan Exchequer Bonds and Treasury Bills. In addition, we have subscribed for £25,000 of the new Loan. Through the medium of our employés' deposit fund, our staff during 1915 subscribed for nearly £4,000 of the 4½ per cent. Loan. Besides converting their old Loan they found over £2,000 for investment in the new Loan. We have also initiated a war savings' association among our staff, and already over 1,000 of the 15s. 6d. War Savings' Certificates have been fully paid for. I regret we have lost seven of our staff in France, and of these six were killed during the past year, whilst three others have been wounded, and 10 have been in hospital through sickness. It has, owing to the shortage of labour, been very difficult to carry on the work of the company, but owing to the devotion of those of the old staff remaining with us, as well as that of the new staff, including female employés, only a very few of our consumers have had cause of complaint, and the interests of the company have not suffered. The directors desire publicly to express their appreciation of the work which has been done by the officials, the staff and the employés. The dependents of those serving with the forces have been, and are being, cared for. As regards the future, I should mention that the Daylight Saving Bill of last year, which met with such a favourable reception, very appreciably reduced our receipts for electrical energy supplied for lighting purposes. We anticipate a renewal of that Bill this year, so that we can hardly expect much, if any, increase in revenue from that source during the present year. We are making no further increase in the charge for electricity for lighting purposes beyond the 10 per cent. which came into force in October, 1915; but we are slightly raising the price for that supplied for power and heating. One of the chief factors in a business of this character is of course, the price of coal and, in these times, its delivery at our works. I now beg to move the adoption of the report and accounts.

Capt. EDMUND I. BAX seconded the resolution, which was carried unanimously. A dividend at the rate of 9 per cent. was declared for the half year ended Dec. 31, 1916 (making 7 per cent. for the year), less tax. The retiring directors, Mr. Browne Martin and Lieut.-Col. J. F. Remnant, M.P., were re-elected, and Messrs. Jackson, Pixley & Co. were re-appointed auditors. A vote of thanks was passed to the special constables for the care and protection of the company's premises during the past year, and a vote of thanks to the chairman terminated the proceedings.

Notting Hill Electric Lighting Co. (Ltd.)

The 30th ordinary general meeting was held on Tuesday, Sir WILLIAM CROOKES, O.M. (chairman of the company), presiding.

The MANAGER AND SECRETARY (Mr. R. G. Rawkins) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, the amount of share capital remains unaltered, and the only difference in the loan capital statement is that we have issued £6,000 further debenture stock as collateral security for a loan from the bankers. This further capital has been required to meet the repayment of loans falling due in connection with the Wood lane works. On the debit side of the capital account £994. 15s. has been spent. Nearly the whole of this has been spent for mains and meters, and is the smallest amount of capital expended for many years. The revenue receipts increased by £868, but this has been more than nullified by the heavy rise in the price of coal and other materials. These increases in the generating costs are included in the item "electricity purchased from Wood lane works," the amount being £10,399, against £8,611 for the previous year. In addition an extra bonus has been granted to the employés, owing to the enormous rise in the cost of living, rates have increased to the extent of £350, due to an increased valuation at the last quinquennial assessment, but in view of our reduced profit the question of appealing against the assessment is under serious consideration. The net result is that a profit of £23,306 is shown, against £25,270 for the previous year, or a drop of £1,964. The balance available for dividends is £10,213, or £3,115 below the figure for 1915. This reduction is mainly due to the heavy payment for income tax, which is increased to the extent of £1,871, and to the reduction of in the profits already referred to. A further £3,000 has been credited to depreciation, renewals and contingencies fund, making a total of £51,355. The Kensington & Knightsbridge and Notting Hill joint debenture stock sinking fund [illegible] to show the increased proportion of the company's contribution to the fund, which are estimated to be sufficient to redeem the joint debenture stock in 1931. The total amount of the sinking fund for the redemption of the Wood lane joint debenture stock now reaches a total of £79,563. The [illegible] staff are to be congratulated on the fact that the efficiency [illegible] distribution shews an improvement of 2 per cent. From the usual tables it will be seen that the number of consumers is 1,400 compared with 1,368 in 1915, the equivalent 8 c.p. lamps connected is 241,8[illegible], against 238,981, the units sold were 2,1[illegible], against 2,130,[illegible]. The revenue was £46,769, against £45,[illegible]21, the expenses were £23,[illegible], against £23,301, the net profit being £23,306, against £22,617 and the dividend 3[illegible], compared with 8s. [illegible] the ordinary share.

As might be expected, the number of new consumers and of additional lamps connected during the last year was the lowest in the company's history, and it is impossible to look forward to any improvement in this direction until the close of the war, especially as the Government have recently issued a regulation to the effect that no new meters must be purchased except for consumers who require current for Government work and for renewals. The war is solely responsible for the reduction in the dividend, but I feel sure it is only temporary. I am quite optimistic as to the future, and the output during the current year already shows an encouraging increase over 1916. We are hoping that the prices of coal, &c., may be kept within reasonable limits, in which case we may be able to show a better result during the present year. The increase of 10 per cent. in the charge to consumers was only in force for three months, but we hope the Kensington Borough Council will consent to the increase being continued until after the war. On the subject of coal I may say that we all had a very anxious time during the year, and on one occasion our stock fell so low that we were within a few days of having to shut down, but on strong representations in the proper quarter we managed to get a further supply. We are safe in this respect at present, as we have a stock sufficient for some weeks. One of the results of the reduced profit is that the bonus due to the staff under the co-partnership scheme works out considerably below the amount they received in former years, but the directors felt it was due to the employés that, having worked so loyally and well during the year they should receive a bonus on the scale of previous distributions. The Chairman concluded by moving the adoption of the report and accounts. The resolution was seconded by Mr. ARTHUR E. FRANKLIN, and carried unanimously. The retiring directors, Mr. Arthur E. Franklin and Mr. Alfred Hoare, were unanimously re-elected, and Messrs. Kennedy, Fox, Oldfield & Co. were re-appointed auditors, a vote of thanks to the chairman terminating the proceedings.

Telegraph Construction & Maintenance Co. (Ltd.)

The fifty-third ordinary general meeting was held on March 1, Right Hon. the EARL OF SELBORNE, K.G., chairman of the company, presiding.

The SECRETARY (Mr. C. W. Clarke) having read the notice convening the meeting, the minutes of the last meeting and auditors' report,

The CHAIRMAN said: Gentlemen, the accounts show a net profit of £111,915 after charging the interest on the debentures, and we brought forward £110,474, so that we have a total of £222,389; and after deducting the 5 per cent. dividend paid in July last, amounting to £22,410, there is a total of £199,979 to be dealt with. We have had to meet some depreciation in the market value of our securities for several years past, but in the year under review the depreciation is, as you are all quite aware, exceptional and very heavy, and the fund which was inaugurated a few years ago for the purpose of meeting such depreciation was not sufficient in amount to deal with the depreciation which we had to meet. We have, therefore, taken £50,000 from the statutory reserve fund against depreciation of securities in order to be able to write down our investments to their market value on Dec. 31 last, which has been done. After deducting this, we propose to pay the same dividend and bonus as we paid last year, and again to build up the reserve fund by £20,000, and this will leave £112,749 to be carried forward. Our regular work of making and laying submarine cables has necessarily been restricted, as you can image, during the war; but whatever the current year has in store for us, if we are still able to obtain remunerative work for our factories, the substantial amount we are carrying forward should be a great help to us in bridging over this difficult time. The past year has been an anxious period. All the staff and hands have been doing their utmost, and our output has been constantly pressed on the limit of the copper and steel that we have been able to get supplied to us. That has been a constant difficulty with which the management has had to cope, and, if I may say so in their presence, you owe a great debt of gratitude to them for the ingenuity with which they have surmounted all the difficulties one after another which the war has put in their path. On the whole, we have been able to keep to our engagements, and all our work has been satisfactory. The financial result of the year has again been much helped by the good rate of interest we have been getting for our money; but the main feature of our profit has been the charter of our ships. They have been constantly in request throughout the year, and one trading voyage alone of 7,300 tons of cargo from the Argentine brought us in just the amount we now propose to distribute to you by way of bonus. With regard to the War Loan, we have lent to the Government altogether £500,000—that is, £400,000 in the 5 per cent. War Loan and £100,000 in 6 per cent. Exchequer Bonds. Besides this we have advanced our employés £8,118 without interest to be invested in the War Loan, the advances being repaid by instalments. The number of men who have left us to serve with the Colours now amounts to 272, and we have replaced them by taking into our works 302 women. Our factories are principally employed in very urgent war work. The war found this company, as you know, in a strong position—not only strong in the usual sense of that term, but strong in the experience of your managing directors, in the efficiency of your staff and in the equipment of your factories. It has all, it is true to say, in one form or another, been utilised in the nation's service during this time or in the service of our Allies; and it is also, I think, a matter of congratulation that we cannot be reckoned as one of those companies who have made abnormal profits out of the war and because of the war. If it had not been for the fact that we have been able to build up your business so that your securities bring in an excellent interest, and the fact that your ships have been in constant employment, and that we had had the great stroke of luck that after one of our ships had fulfilled one of her war tasks she was able to load up a valuable cargo for the Argentine, and became for the moment a tramp—if it had not been for these facts, we should not have been able to present you with the results we have submitted to you to-day. It would not be right, and you would not wish me to describe to you in detail how our ships have been employed, but it must be clear to you that they have run great dangers constantly. It is with no spirit of boastfulness that I record the fact that so far as we have come through the war without mishap, and that that is so is due to the ceaseless vigilance with which the Navy has guarded our ships, to the efficiency of our captains, officers and crews, and to the complete understanding that there is between them and the naval officers with whom they have to co-operate. This is the second report and the second balance-sheet of a complete year's war. Will it be my fate, if I am alive next year, to make a report with another complete year of war ? We cannot tell. I do not think the signs are at all in favour of an early peace. We can make no greater mistake, in my judgment, than that of underrating the power of our foes in this war, and therefore I think that all sensible and patriotic women and men ought to take the attitude of preparing themselves for a prolonged state of war, of supporting the Government in all measures of precaution and prescience which are taken, and of saying as little about it as they can. I move that the report and accounts to December 31, 1916, be received and adopted.

Sir JAMES PENDER, Bart., seconded the motion, which, after some remarks by Mr. H. H. S. CROFT, welcoming the return of Lord Selborne to his position as chairman of the company, was carried unanimously.

The retiring directors, Mr. Colin F. Campbell and Mr. Paget V. Luke, were re-elected, and Messrs. Gane, Jackson, Jefferys & Freeman and Messrs. Welton, Jones & Co. were re-appointed auditors.

CASTNER-KELLNER ALKALI CO. (LTD.)—The profit for the year ended Sept. 30 last (after allowing for amount expended in keeping up the works, plant and machinery, and after making provision for the estimated liability for excess profits duty) was £262,208, against £260,805. Deducting debenture interest (£7,705) and estimated liability for excess profits duty for year 1915 (£45,000), and including £61,152 brought forward, the balance is £270,654. The dividend of 22 per cent. for the year (against 20 per cent.) required £181,250, and it is proposed to carry to depreciation reserve account £50,000, leaving £39,404. Owing to an outlay on extensions of plant it will be necessary that increased borrowing powers be given to the directors.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.).—The capital expended during 1916 on account of the Company's London districts amounted to £31,409 8s. 9d. and the net total expenditure in respect of these districts up to Dec. 31 last was £2,189,064 4s. 5d. The balance from revenue account, after deducting generation and distribution costs, repairs, rents, rates, taxes, wages, directors' fees, general establishment and other charges and proportion of salaries, is £156,894 9s. 10d., and with £14,499 3s. 2d. brought forward, the available total is £171,393 13s. Deducting interest on the first and second debenture stock and interest on temporary loans to Dec. 31, 1916, less tax (£42 528 3s. 9d.), and amount carried to reserve for depreciation, &c. (£45 000), the balance is £83,865 9s. 3d. Interim dividends have been paid (less tax) on the six per cent. fully-paid preference shares, and on the ordinary shares for the half-year ended June 30, 1916, at the rate of 5 per cent. per annum. These interim dividends absorbed £28,600 and leave for further distribution £55,265 9s. 3d. The directors recommend a further dividend on the 6 per cent. preference shares and a further dividend on the ordinary shares for the half-year ended Dec. 31, 1916, at rate of 9 per cent. per annum (less tax), which will absorb £36,887 10s., and leave £18,377 19s. 3d. to be carried forward.

The applications received during the past year amounted to the equivalent of 4,516 kw., making the total at Dec. 31 last 64,581 kw. The total units sold were 35,029,862, against 30,562,045 for 1915, an increase of 4,467,817 units. The number of consumers increased from 25,913 to 26,994. The directors feel that these results, in spite of the continued abnormal conditions, must be regarded as satisfactory. The cost of coal and other materials has further increased during the year, the lighting restrictions have been more vigorously enforced and additional members of the staff have been released for war purposes. The directors of the Bournemouth and Poole Electricity Supply Co. have declared a final dividend on the ordinary shares at the rate of 7 per cent. per annum making 6 per cent. for the year. The Coatbridge and Airdrie Electric Supply Co. has again made excellent progress during the past year, the units sold having increased from 6,134,986 units in 1915 to 8,414,823 units in 1916.

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.).—The profit for 1916 was £144 less than for 1915, but in view of the lighting restrictions, the increased cost of coal and material and other difficulties caused by the war, the directors considered the results satisfactory. The disposable balance was £4,400 (against £4,239) and a dividend at the rate of 6 per cent. per annum was declared. The chairman (Mr. R. W. Wickham) referred to the applications to the Board of Trade for orders for certain districts in the West Riding and said that in several cases the consent of the local authority had been obtained. Opposition was being threatened by some of the neighbouring boroughs who were desirous of incorporating those districts within their area at some future date. In view of the right that local authorities had to purchase the electric lighting undertaking at a period and on terms mentioned in the Electric Lighting Acts (or the orders issued thereunder) the directors considered that the opposition was unreasonable.

HARROW ELECTRIC LIGHT & POWER CO (LTD.).—As was reported at the recent annual meeting that during the past year 18 new installations, representing 17 kw. of additional demand, had been connected to the mains. The number of consumers was 1,812 and their aggregate requirements amounted to 1,879 kw. The output was 517,911 units. The balance to the credit of net revenue account, after deducting debenture interest and interim dividend on the preference shares, was £1,966. The directors recommended payment of the final dividend on the preference shares and a dividend on the ordinary shares at the rate of 4 per cent. per annum (against 5 per cent.), leaving £258 to be carried forward.

The Chairman (Mr. J. N. Stuart) stated that, owing to the Daylight Saving Act and increased restrictions on lighting, the total number of units sold showed a drop of 12,196, not a very large reduction under the circumstances, for though there was 13 per cent. reduction in consumption for lighting, that was almost made up by the increase in heating and cooking, a brisk demand for which at the present time promises a still further increase this year. When people learnt to appreciate the cleanliness, efficiency and saving in labour which resulted from the use of electrical heaters and ovens, there would undoubtedly be a great future for that method of cooking and heating. Their engineer (Mr. Horsley), though over military age, patriotically resigned his post to take a commission in H.M. Navy, and 10 other men had joined the Army. By the courtesy of the Reading Electric Supply Co., Mr. Whitie was allowed at short notice to take up the post of electrical engineer in Mr. Horsley's place. Mr. Spencer Hawes had consented to become managing director in addition to being deputy-chairman. Mr. Bishop, on Mr. Horsley's retirement, was appointed manager as well as secretary, and to him, as well as to the other leading members of the staff, they offered their hearty thanks for carrying on the work amid exceptional difficulties.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—During 1916 the number of houses and shops connected with the system increased by 59 (from 5,011 to 5,070) and the energy consuming devices, calculated as represented by lamps of 30 watts' consumption, by 11,390 from 510,785 (15,320 kw.) to 522,175 (15,665 kw.). The lighting restrictions during the year were more stringent than during 1915, and the Smner Time Act caused a further reduction of 8 per cent. in the units sold during the period it was in operation. The net profit available for dividends is £11,573. 17s. 11d., and with £431. 12s. 8d. brought forward, the total is £12,005. 10s. 7d. Deducting the interim dividends paid during the year (at rate of 5 per cent. per annum on the ordinary shares 6 per cent. per annum on the first preference shares to June 30, and 5 per cent. per annum on the second preference shares to Sept. 30), amounting to £6,000, the balance is £6,005. 10s. 7d., out of which must be deducted the second half-year's dividend on the first preference shares (£1,500), and provision for the dividend on the second preference shares (£625), and the board recommend payment of a dividend at the rate of 7 per cent. per annum for the last half-year, which will absorb £3,675, and making with the interim dividend already paid, 6 per cent. for the year on the ordinary shares. A sum of £205. 10s. 7d. is carried forward.

MATHER & PLATT (LTD.).—At the annual meeting last week a letter was read from Sir William Mather explaining that he had resigned the office of chairman for "reasons of health and on account of advancing years." Sir William added : "After the war, concluding with victory for the righteous cause of the Allies, there will dawn a new era in the relations between employers and employed. I foresee that the marvellous manifestation of patriotism displayed under the tremendous stress of a gigantic war will have enlightened all classes as to the vital importance of mutual goodwill and co-operation in order to repair our losses and secure long years of prosperity in which all our workpeople will share. United as we have been in war to save our country from destruction by the enemy, we must be united in peace in order to reconstruct our country on foundations that no internal conflicts can shake. I hope our company will ever maintain a high place among the pioneer employers who feel it to be their paramount duty to provide for the training and education of their young workers and the general welfare of their adult employés, also to provide the spirit of hearty goodwill and co-operation between themselves and their employés, so that the fruits of their combined industry and intelligence may become of mutual benefit."

Capt. L. E. Mather, who has succeeded his father as chairman, moved the adoption of the report. He said the turnover of the year was the largest on record, and the work was practically all in connection with the war. The dividend on the ordinary shares had been increased to 17½ per cent. for the year, although an addition had been made to the reserve, and the "carry forward" was larger. One of the most hopeful signs due to the war was the closer union between engineering firms who were competitors in their ordinary business. This better understanding should bear good fruit in years to come and help the country to be better organised against foreign competition. The signs were not unpropitious that before another 12 months passed we should have secured a decisive and lasting victory, but it must be borne in mind that 1917 might not be so prosperous a year as 1916. The cost of materials had risen enormously, wages were increasing owing to the greater cost of living, and many other things pointed to difficult times ahead. The directors considered it desirable that £5,000 should be added to the employés' benefit fund, in order to provide for cases of hardship which might arise on the termination of hostilities and during the progress of demobilisation.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.).—The directors' report states that the capital expenditure, which at the end of 1915 amounted to £2,258,600 16s. 6d., has now reached a total of £2,293,093 13s. 10d., an increase during 1916 of £34,492 17s. 4d. The gross revenue for the year amounted to £277,909 2s. 11d., compared with £229,200 15s. 6d., in 1915, an increase of £48,708 6s. 7d. The working expenses amounted to £161,008 13s. 10d. against £127,149 12s. 8d., an increase of £33,859 1s. 2d. The balance at credit of revenue account, before providing for depreciation, is £116,900 8s. 3d. The directors have set aside £10,000 as an addition to the depreciation and reserve fund, which now amounts to £377,358 15s. 3d., carrying to credit of net revenue account £76,900 8s. 3d. This sum, with the balance brought forward from last account, interest and dividends on investments and other receipts, makes a total of £90,195 10s. 11d. After deducting interest on debenture stocks and loans, dividend on preference shares and sundry items written off, there remains £34,756 19s. 7d. An interim dividend of 1s. per share (being at rate of 2 per cent. per annum) on the ordinary share capital, amounting to £10,000, was paid in August, 1916, and the directors recommend that a further dividend of 2s. per share (being at rate of 4 per cent. per annum) on such shares be now paid, making a total distribution for the year of 3s. per share, or 3 per cent. This will absorb a further sum of £20,000 and leave £4,756 19s. 7d. to be carried forward. During the year new connections representing the equivalent of 119,880 25-c.p. lamps (equal to 3,600 kw.) were added to the company's system, making a total connection at the end of the year of 1,317,643 lamps.

OXFORD ELECTRIC CO. (LTD.).—The annual general meeting was held on Tuesday, when the directors reported that the past year's profit (including £968 brought forward) was £11,682 8s. 1d. After providing £2,000 for debenture interest and writing off £639 on account of hire-purchase installations, the balance available was £9,043 4s. The directors proposed to pay a dividend at rate of 5 per cent. per annum on the preference share capital and a dividend at rate of 5 per cent. per annum (less tax) on the ordinary share capital (whereof 2½ per cent. was paid in September last), a sum of £649 is placed to credit of reserve and renewal of plant account and £643 carried forward. Reserve and renewal of plant account has been charged with the plant replaced. The mains were extended in Stockmore-street and for the supply of the military hospital.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. H. St. J. Winkworth, who presided over the meeting last week, said that during the past year 204 new consumers were connected, representing 2,002 H.P., equal to 43,102 35-watt lamps. A loss of revenue arose from the restricted lighting and the introduction of the Summer Time Act, but new business and extension orders and additional bulk supply had increased the revenue by £15,130, the largest increase the company had had. The total units sold were 13,004,670, against 9,185,742 in 1915, an increase over 1915 of 41 per cent. The sales for heating and domestic power were 356,758 units, against 212,154 in 1915 and 154,783 in 1914. The sales in the showrooms and the wiring and installation work represented £12,800, the number of transactions being 4,804, against 4,479 in 1915 and 3,759 in 1914. The total receipts were £95,882 against £80,576. Coal cost £26,673, or about £12,420 more, chiefly owing to the increased price and much higher freights. Other increases in expenses were over £1,600. The total expenditure, £45,373, represented approximately 48 per cent. of the gross receipts, compared with 39 per cent. in 1915 and 36 per cent. in 1914. The net revenue was £50,509, and with £6,601 brought forward and £1,001 dividend of 10 per cent. on the shares in the West Kent Electric Co., the total was £58,116. They were placing to the credit of depreciation fund £17,600, and, after payment of the dividends recommended, £7,248 was being carried forward. During the last four years the company had set aside out of the profits over £67,000, which had been profitably employed in the business. The prospects as to output in the current year were good, the increased output for many weeks past having been 35 per cent. to 45 per cent. over that of 1916.

TRAMWAYS, LIGHT & POWER CO. (LTD.)—The chairman (Viscount Chilston) reported at the meeting last week that progress had been made during the past year notwithstanding the very difficult conditions under which all power, lighting and tramway undertakings had been working. They took over the Ilkeston Corporation electric lighting and tramway undertaking on Oct. 1 last. The income received from the various undertakings was £35,272, against £30,492 for 1915. Administration expenses were approximately the same, but debenture and loan interest absorbed £2,000 more. The share capital remained the same as in the previous account, but £100,000 of 5 per cent. debenture stock was issued during the year. All their properties showed an improvement except the purely electric lighting portion of the undertaking of the Leamington & Warwick Electrical Co. and the electric lighting undertaking in Leamington. In Warwick the gross receipts showed a considerable improvement, but that was more than absorbed by increased expenses. In Leamington, which was almost entirely a lighting supply, the gross receipts were slightly behind the previous year, due entirely to the lighting restrictions. In both cases they were satisfied that the decline in profit was purely temporary, and it was satisfactory to know that, notwithstanding the slight decline in receipts from those two properties, they had received an income from the various properties of £1,780 in excess of the previous year and, in addition, left reserves to the various undertakings amounting to £1,700 in excess of the previous year. The real improvement during the year was £[illegible]. The company had made an agreement with Ilkeston Corporation to enable the Nottinghamshire & Derbyshire Tramways Co. to acquire the Ilkeston tramways and the Derbyshire & Nottinghamshire Electric Power Co. to acquire the Ilkeston electric lighting undertaking. The terms on which these companies had acquired the undertakings had been fixed so as to throw no undue strain on those companies or this company during the war. They would pay to Ilkeston Corporation at stated intervals a sum equal to the interest and sinking fund applicable to the outstanding debt on those undertakings, the sinking fund portion of such payment being reckoned as part payment of the principal sum due in respect of the properties. The arrangement would remain in force until two years after the conclusion of peace, at which time the balance of the principal sum then remaining unpaid would become payable to the Corporation. The total sum payable in respect of the two undertakings was £47,000 They took possession of the properties on Oct. 1 and the directors were satisfied with the results to date.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The directors' report for 1916 states that the net income from investments, &c., after deducting general expenses, and including balance from last account, was £664,665. 1s. 8d. The interest, plus tax, on the 4½ per cent. bonds due 1933 required £106,508. 5s., interest on the 4½ per cent. three-year secured notes, £31,500; the payment under the guarantee on Central London Railway assented stocks, £13,465. 14s. 4d.; and the interest on the 6 per cent. first cumulative income debentures stock required £76,380, leaving a surplus of £436,812. 2s. 4d. Interest at rate of 5 per cent. per annum plus tax on the 6 per cent. income bonds (3 per cent. for June half-year and 2 per cent. for December half-year) will require £168,801. 6s. 8d., leaving £30,633. 18s. 2d. The income from investments, &c., amounted to £653,360. 19s. 5d., as compared with £680,741. 7s. 1d. for 1915, a decrease of £27,380. 7s. 8d. (4·02 per cent.). Income tax on the interest on the 4½ per cent. bonds and on the 6 per cent. income bonds, together with the loss on foreign exchange in respect of coupons encashed abroad, amounted to £134,015, an increase over 1915 of £56,805 (73·57 per cent.). The aggregate gross revenue of the five companies parties to the Common Fund authorised by the Facilities Act of 1915 was £6,038,529. 5s. 11d., and the aggregate amount retained by them for "revenue liabilities" (including reserves) was £5,531,561. 13s. 10d., leaving £506,967. 12s. 1d. (increase of 12·32 per cent.), which was credited to the common fund This amount was apportioned amongst the five companies concerned.

Under the provisions of the London Electric Railway Act, 1912, authority was given for the through running of trains from the Bakerloo section of the railway to Watford on the electrified portion of the London & North-Western Railway. The North Western Co. had arranged to provide the joint rolling stock required for the services, but its manufacture has been delayed owing to the war. In order to give the public the benefit of this new service without further delay, arrangements have been made between the two railway companies whereby the London Electric Co. will, for the present, provide the necessary trains and work the train service. It is anticipated that this through running will commence early in April. In order to provide for a larger increase of output from the Associated Equipment Co.'s factory at Walthamstow, extensions of the premises have recently been carried out

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

R. BECKER & CO. (LTD.) (145,966.)—Private company. Reg. Feb. 9, capital £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in machinery, appliances, special tools, electric light and power plants, tools, &c. O. G. R. Becker is first director. Reg. office, 53, City-road, E.C.

LEHMANN, ARCHER & CO. (LTD.) (145,870)—Private company. Reg. Jan. 27, capital £20,000 in £1 shares, to take over business of manufacturers of engineers' tools carried on as Lehmann Bros., and the similar business carried on as Frederick R. Archer. First directors (to number not less than two nor more than five) are S. P. Lehmann and F. J. R. Archer (joint managing directors). Secretary: F. J. R. Archer. Reg. office: 5, Farringdon-road, E.C.

MORTGAGES AND CHARGES.

INTERNATIONAL ELECTRIC CO. (LTD.)—Mortgage on freehold property at Tottenham, dated Feb. 8, 1917, to secure all moneys due or to become due from company to London and South-Western Bank.

PHILLIPS MAGNETOS (LTD.)—Particulars of £3,000 debentures created Oct. 2, 1916, have been filed, whole amount being now issued. Property charged company's undertaking and property, present and future. No trustees.

CITY NOTES.

MEMORANDA—(March 6).—Consols, 53⅞xd. Consols Pay Day, April 4. Stocks and Shares Ticket Days, March 13 and 28. Pay Days, March 14 and 29. Price of Silver, $37\frac{5}{16}$d.

AUTOMATIC TELEPHONE MFG CO. (LTD.)—A dividend of 5 per cent. (less tax) has been declared for the past year on the ordinary shares. The directors state, that (after estimating for excess profits and contingencies) the profit for 1916 was £51,000. A sum of £16,000 has been written off and £14,774 carried forward.

BRITISH INSULATED & HELSBY CABLES (LTD.)—A final dividend of 10s. per share, making with interim dividend 15s. per share, has been declared for the year, together with a bonus of 5 per cent., making in all 20 per cent. for the past year.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The directors recommend that £73,259 of the reserve fund be capitalised, and that one new ordinary share be allotted to each similar share now held.

CLYDE VALLEY ELECTRICAL POWER CO.—The directors recommend a dividend of 1¼ per cent., tax free.

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NOTES.

The Standardisation of Control Gear.

In these days of collapse of time-honoured ideas and principles in the industrial world, to say nothing of the increasing attention that is being paid to requirements "after the war," we should like to direct the attention of the thoughtful to a particular branch of electrical engineering, which, in the past, has not received the attention it ought to have received. We refer to industrial control gear. Times without number our readers will have heard the remark, "O! he deserves all the trouble he gets for buying such shoddy gear." As a matter of fact the reputation of control gear generally is such that it gets the blame for almost any trouble arising in electric drives. Only too often this assumption proves to be correct. As soon as it is generally recognised that control gear is a very important link in the chain of electric driving, improvement will take care of itself. But as long as control gear is regarded as a sort of adjunct to a motor or to the driven machinery, the door remains wide open for so-called cheap and "good enough for the job" gear. The ignorance on all electrical matters of the buyer and user makes it a little difficult for him to recognise the importance of control gear. If in the future he knows as much about the part played by each item of an electric equipment as he does, or did, with regard to steam plants, he will, as a matter of course, protect himself, and the days of manufacturing and supplying unsatisfactory control gear will automatically end. In the meantime we shall have to rely on the conscientious manufacturer, contractor and consulting engineer to supply control gear, not on price, but on quality. This, however, is a slender safeguard, and, in the interests of electrical engineering, we would greatly welcome any step taken by the Engineering Standards Committee to lay down national rules. There is plenty of scope for improvement, both electrical and mechanical, and there is a large amount of control gear to be ruled out of court.

The Chemical Engineer.

To the general public little is known of the enormous work which is at present being carried on by the chemists of this country in providing for the needs of war. It is largely an industry which has been improvised under the stress of circumstances, and has been effected by the combination of the engineer and the chemist. The results which have been achieved show how important a rôle can be filled by the true chemical engineer—*i.e.*, by an engineer with an adequate amount of chemical knowledge. Equally it is important that the chemist who goes in for this class of work should have more than a nodding acquaintance with engineering. So far, the chemist has often been too much of a chemist. In making this remark we are leaving on one side the chemist who devotes himself to research, and whose whole energy should be thrown into chemical work pure and simple. Such men are a most valuable asset to the nation, but it is not every man who can carry on research, and there are many chemists—and, in fact, they are far more numerous—who should be trained to understand the point of view of the engineer.

It is undoubtedly the case that the chemist looks at things too much from the molecular point of view, whereas the engineer deals with masses. Consequently, the chemist fails to take his proper position in the works and the engineer is apt to look upon him as a hopeless sort of individual, who merely plays about with glass flasks and small samples. This state of affairs, as was pointed out in an interesting discussion on the subject last week before the Faraday Society, is largely due to lack of proper training. The laboratory is not the place in which the training should take place. In America steps are being taken to remedy this state of affairs in advance of what we are doing. Thus, the Massachusetts Institute of Technology has a five years' course in chemistry, and in the two last years the student is in close touch with manufacturing processes by being placed in works for a portion of his time. This must alter his general outlook and give him far greater breadth of view. It is clear that some such similar steps must be taken in this country if we are to obtain the best results. Further, it is desirable, as was pointed out by Prof. F. G. Donnan, that training institutions should have facilities at their disposal for carrying out experimental investigations on something like a works scale. These facilities need not be refined, but they should be ample to give results of technical value.

The Institution Building Commandeered.

The announcement made at the last meeting of the Institution of Electrical Engineers that the building had been commandeered by the Government will be received with some complacency on the one hand, and with a good deal of concern on the other. The view may be taken that accommodation is needed, and that so long as this is the case we must expect to put up with any inconvenience so long as such changes make for the more vigorous prosecution of the war; but we may nevertheless feel some misgiving as to whether so much accommodation is really essential, and whether the vastly increasing Government organisations are being carried on efficiently. We believe that the Council has done much to assist Government departments during the war, but such assistance cannot be rendered so efficiently if the present building is to be replaced by some small ill-equipped office. Apart from this, a good deal of concern will, we think, be felt at the library of the Institution being rendered inaccessible. The library of the Institution of Mechanical Engineers suffered a like fate long ago, and thus the present step means that two of the technical libraries in London will now be rendered useless. We fear this indicates that the importance of the engineer is not yet sufficiently realised in Government circles. It has frequently been stated that the present war is largely a war of engineers. Surely then it would be well to hamper the engineer as little as possible. With this end in view we suggest that if the accommodation of the Institution of Electrical Engineers is really essential to the Government, the authorities should at least make the library accessible to the members.

Electric Steel.

Striking figures on the development of the electric furnace were given by an engineering correspondent in a recent issue of the "Yorkshire Post." It is said that at the beginning of the year there were in the United States 136 such furnaces, in Great Britain 88, in Germany 52, in Sweden 40, in Italy, 29 in France 29, in Canada 19, in Austria-Hungary 18, in Russia 16, and a further 44 in other countries. Accepting the list as given, there are now at work no less than 471 electric furnaces producing steel of one kind or another. The output of special steels and castings melted up from cold charges will, it is estimated, shortly reach 1,000,000 tons per annum. In addition to this must be reckoned the extensive use that is being made of the electric furnace for the refining of steel which is charged in the molten state. Reference is made to the rapid development of electric furnaces in Sweden, owing to the utilisation of water power. This fact is said to have promoted in Sweden the use of electric furnaces for the production of pig-iron, no less than 17 furnaces, with capacities ranging from 3,000 H.P. to 6,000 H.P., being at work or under construction in Sweden for this purpose.

* * *

New Electric Department at Guy's Hospital. We learn from the "Hospital" that a new electrical department at Guy's Hospital, opened in September last, is now in full operation. Apparatus has been added for the electrical treatment of nervous and other disorders; also four X-ray outfits, a high frequency apparatus, static and diathermic machines, &c.

Control of Mines and Quarries. By an Order in Council, issued on Tuesday last, the Minister of Munitions is empowered, "if he considers it expedient" to apply Regulation 9G of the Defence of the Realm Regulation (which confers on the Board of Trade power to take possession of coal mines), "to any metalliferous mine, or to any mine of stratified iron-stone, shale, or fireclay, not being a coal mine, or to any quarries."

Charging Facilities for Electric Vehicles.—A list of charging stations has been prepared by the Electric Vehicle Committee and will be published in the forthcoming second edition of the Commercial Motor Users' Association Handbook of Approved Depots, and also as a supplement to the June issue of the "Electric Vehicle." The list gives a considerable amount of information, such as the maximum current, range of voltage, terms, hours of charging and whether the E.V.C. standard plug is provided, also certain details, such as the facilities for garaging. The list should be a great convenience to those having electric vehicles.

Single Strand Conductors of Small Section.—The following letter has been sent by the hon. secretary of the Incorporated Municipal Electrical Association (Mr. H. Faraday Proctor) to the Cable Makers' Association on this subject:—

With further reference to your letter of February 28th, I laid this matter before the Council of the I.M.E.A. at their meeting held last Friday, and have pleasure in informing you that such Council adopt the recommendation you set forth as below, and recommend their members to agree to the same. With a view to giving this matter publicity I am sending a copy of this communication to the technical press, and to the secretary of the Institution of Electrical Engineers. The recommendation above referred to is as follows: "That, in view of the demand by the Government for small stranded wires being so great, the restrictions as to the use of single-strand conductors of 18 S.W.G., 16 S.W.G. and 14 S.W.G. should be temporarily suspended during the war and that the use of such for installation wiring in place of 3/22 and 7/25 S.W.G., 3/20 and 7/23 S.W.G. and 7/22 and 7/21½ S.W.G. respectively be accepted."

Use of Waste Heat in the Electro-Chemical Industry.—In a recent Paper before the Newcastle Section of the Society of Chemical Industry, Mr. Henry Peile described the use of the waste heat at the Blaydon & Rowlands Coke Works for the production of electricity. For example, at Rowlands Gill Mine, Stirling, water-tube boilers were erected on the main flues, which carried the waste heat from the ovens to the chimney, and the steam generated is employed to drive four Westinghouse turbines coupled to three-phase alternators working at 6,000 volts. The current is transformed down and supplied to the Newcastle Alloy Co. at a voltage suitable for electric furnaces. Other transformers furnish power for pumping, hauling and lighting purposes. The power produced is largely used for the production of non-ferrous alloys, and in other cases the electric energy generated from waste heat is delivered to the mains of the Newcastle Electric Supply Co.

OBITUARY.

David Huntley.—We regret to record the death on the 6th inst. of Mr. David Huntley, A.M.I.E.E., for many years chief engineer and works manager of the Dowsing Radiant Heat Co.

Mr. Huntley was taken ill with a bad cold, which developed into pneumonia, and died after 14 days' illness. Mr. Huntley commenced his electrical career at the age of 17 as a pupil of Mr. H. J. Dowsing, M.I.E.E., in his private practice, and remained with him when the business developed into the Dowsing Radiant Heat Co. (Ltd.). He represented the firm in the electrical section of the B.E.A.M.A., of which he was chairman. He was a man of great energy and ability, and his experience and knowledge of electric heating was very considerable. During the war he had been carrying out special Government work in connection with electric heating appliances, and in other important directions, and his loss will be greatly felt. He was buried in the Ruislip Parish Churchyard on Saturday last.

H. Shelford Bidwell.—The death occurred suddenly on the 4th inst. of Mr. H. Shelford Bidwell, M.I.C.E., one of the engineering inspectors of the Local Government Board

A. E. White.—The death is announced of Mr. A. E. White, formerly city engineer of Hull. Mr. White was 61 years of age and was responsible for the construction of the permanent way of the tramways.

S. Charlesworth.—The death of Mr. Sheard Charlesworth, the well known electrical engineer and contractor of Oldham, occurred on the 24th ult.

Deaths on Active Service.—The following deaths on active service are reported:—

Lieut. Geo. K. Scott, R.E., 25 years of age, who has been killed, obtained a first class in engineering at Christ Church, Oxford. He was wounded in May, 1916, and only returned to the front last January.

Sec.-Lieut. R. G. Dyer, R.E., aged 23, who has been killed, was a student at the City and Guilds Engineering College for two years prior to the war.

Pte. H. Pixton, aged 44, who has died of pneumonia, was formerly an inspector on the Blackpool Corporation tramways.

Capt. H. J. Sutherland (Oxford and Bucks L.I.) was only 20 years of age when he died recently on active service. He obtained his first commission when 17 years of age and his captaincy at 19. He was an engineering student at Battersea Polytechnic prior to the war.

Pte. G. Payne (R.W.F.), killed in action, was formerly a conductor on the Birmingham tramways.

Lance-Corp. Edwin Plows (Warwickshire Regt.), who has died on active service, was also employed on the Birmingham tramways before the war. He had served in the Egyptian Campaign and the Boer War.

Rifleman J. A. Powell (K.R.R.), who has been killed, was employed by the General Electric Co., Witton, Birmingham, before enlisting. He was 20 years of age.

Lance-Corp. Edward Mee (L.N.L.), who was formerly engaged in the Bolton tramway offices, has been officially assumed to have been killed after being missing nine months.

Lieut. R. H. Handcock, A.M.I.E.E., A.M.I.M.E. (Inspector of Ordnance), was drowned in the Somme on Feb. 17.

We regret to learn that Sec. Lieut. Alan Percy Rosling, Worcestershire Regt., elder son of Mr. Percy Rosling, of Henley's Telegraph Works Co., was killed in action on the 4th inst.

PERSONAL.

The acting electrical engineer at Epsom (Mr. W. C. Browne) having obtained a commission in the Royal Flying Corps, the Council has granted him leave of absence and Mr. T. Young, waterworks engineer, will act in his place. This is the second official of the electricity department to get a commission, as Mr. A. C. Gilling, electrical engineer, joined the R.F.C. some months ago and is now a captain.

Mr. C. H. R. Thorn, manager in India for W. T. Henley's Works Co., has returned to England to take up his duties as a captain in the Royal Engineers (Territorials).

Mr. Thorn will again take up the position of manager for India for W. T. Henley's Telegraph Works Co. as soon as he is released from military duties. He held the rank of captain in the London Electrical Engineers when he went to India in 1911, and was seconded, being attached to the Calcutta Port Defence Volunteers. Mr. Thorn served in the South African War with the London Electrical Engineers, and received the Queen's medal with clasps.

APPOINTMENTS VACANT AND FILLED.

Junior engineers-in-charge are required for a large power station in Scotland (d.c. and e.h.t. three phase with rotaries); also junior engineer for mains department. *See advertisement.*

Assistant electrical engineers are required to work in eight-hour shifts and take charge of electrical equipment in a Government factory. *See advertisement.*

A switchboard attendant is required for a.c. and d.c. municipal electricity works in the Midlands.

A shift engineer is required for a small municipal station.

Mr. Archibald Page has been offered and has accepted the post of assistant general manager of the Clyde Valley Electric Power Co.

For the past 12 years Mr. Page has been deputy chief engineer and manager of the Glasgow Corporation electricity department, having been 18 years in the department's service altogether. During that period the Glasgow undertaking has increased its output from 3,000,000 units to 132,000,000 units per annum. Mr. Page's nomination as chairman of the Scottish Local Section of the Institution of Electrical Engineers for next session comes up for confirmation at the monthly meeting on Tuesday.

Mr. Reg. A. A. Graham has been appointed junior shift engineer to the Sheffield electric supply department.

Mr. B. C. Wilson has been appointed engineer of the La Plata (Argentina) station of the River Plate Electricity Co.

INSTITUTIONS AND SOCIETIES.

Institution of Civil Engineers.—Sir William Edmund Garstin, G.C.M.G., and Major-General Sir George Kenneth Scott-Moncrieff, K.C.B., C.I.E., R.E., have been elected honorary members of the institution.

Royal Society.—At the meeting of this Society held yesterday four Papers were read, among which was one by Prof. S. W. J. Smith, F.R.S., and Mr. H. Moss, on "Experiments with Mercury Jets." I.—"The Relation between the Jet-length and the Velocity of Efflux." II.—"A Comparison with Jets of other Liquids."

Physical Society.—On Friday, the 23rd inst., the third Guthrie Lecture will be delivered by Prof. P. Langevin, of Paris. The lecture will be delivered in English, and the subject will be "Molecular Orientation."

Association of Chemical Manufacturers.—A meeting of chemical manufacturers was held at the Chemical Society's rooms (London) on the 7th inst., Dr. Charles Carpenter presiding.

Dr. Carpenter said that in the interests of the British chemical industry it had been considered advisable to form an association of manufacturers. The object was to ensure that the industry should have the general importance already secured by other industries, and that could be attained best by means of the new association. Already they had done useful work in getting the Admiralty to withdraw the circular which called upon manufacturers to reveal trade secrets. Lord Moulton of Bank had consented to be the first honorary president.

Society of Glass Technology.—At the last meeting of the above Society on Feb. 15 Papers on the Annealing of Glass were read by F. Twyman and S. English, in the course of which it was mentioned that the mobility of glass is roughly doubled for each 8 C. rise in temperature. Optical and mechanical methods of determining annealing temperatures were described.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, March 17th.

Association of Mining Electrical Engineers.

4.30 p.m. At the Royal Technical College, Glasgow. Paper on "Maintenance of Underground Plant," by Mr. Matt. Baird, jun.

MONDAY, March 19th.

Institution of Post Office Electrical Engineers.

6 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Provision of a Telephone Exchange," by Mr. G. F. Greenham.

TUESDAY, March 20th.

The Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, S.W. Paper on "The New Electric Power House at Birchills, Walsall," by Mr. E. M. Lacey, M.Inst.C.E.

Scottish Local Section, Institution of Electrical Engineers.

7 p.m. At Princes-street Station Hotel, Edinburgh. Paper on "Voltage Regulation of Rotary Converters," by Mr. G. A. Juhlin.

WEDNESDAY, March 21st.

Manchester Local Section, Institution of Electrical Engineers.

7.30 p.m. At the Royal Institution, Liverpool. Joint meeting with the Liverpool Engineering Society at Liverpool. Paper on "Equipment of Hull Joint Docks," by Mr. L. Leighton.

Yorkshire Local Section, Institution of Electrical Engineers.

7 p.m. At the Philosophical Hall, Leeds. Paper on "The Voltage Regulation of Rotary Converters," by Mr. G. A. Juhlin.

Institute of Metals.

8 p.m. to *10 p.m.* At the Chemical Society, Burlington House, Piccadilly, W. Annual General Meeting, after which selection of Papers will be read.

THURSDAY, March 22nd.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "Modern Improvements in Telegraphy and Telephony: Telegraphy," by Prof. J. A. Fleming, F.R.S. (Lecture I.).

Institute of Metals.

4.30 p.m. to *6.30 p.m.* and *7.45 p.m.* to *10 p.m.* At the Chemical Society, Burlington House, Piccadilly, W. A selection of Papers will be read.

Greenock Electrical Society.

7.45 p.m. Masonic Rooms, 22, West Stewart-street, Greenock. Paper on "Electric Welding," by Mr. D. Angus.

Institution of Electrical Engineers.

8 p.m. At Victoria Embankment, W.C. Paper on "Machine Switching Telephone Gear," by Mr. F. R. McBerty.

FRIDAY, March 23rd.

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, S.W. Prof. P. Langevin will deliver (in English) the Third Guthrie Lecture, the subject being "Molecular Orientation."

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At Bolbec Hall, Newcastle-on-Tyne.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Colonel C. B. Clay, V.D., Commanding.

Officer for the Week.—Platoon Commander H. de P. Birkett.

Next for Duty.—Platoon Commander Hughes-Hallett.

Saturday, March 17.—The Parade for Route March will be 2.45, Golder's Green Station.

Monday, March 19.—Technical for Platoon No. 9 at Regency-street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.30 to 8.

Wednesday, March 21.—Instructional Class, 8.15. Platoon Drill, Platoon No. 1.

Thursday, March 22.—Platoon Drill, Platoon No. 7. Ambulance Class by M.O., 6.30.

Friday, March 23.—Technical for Platoon No. 10, Regency-street. Squad and Platoon Drill, No. 9. Signalling Class. Recruits' Drill, 6.30 to 8.30.

Saturday, March 24.—N.C.O.'s Instruction Class, Capt Castell bridging.

Sunday, March 25.—Special Work at Bombing School. Parade Clapham Common Station (City & S.L. Tube Railway) 9.45 a.m. Uniform, haversacks, water-bottles. Mid-day Rations to be carried.

Easter Training.—Will be at Esher. Names can still be sent in. Special Technical Instruction will be given for the first hour to all Platoons on their respective Drill Nights to prepare for this Training.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills will take place at Headquarters.

SELF-PROPELLED ELECTRIC VEHICLES AND THEIR APPLICATIONS.*

BY L. BROEKMAN.

The numerous purposes for which electric vehicles have been designed, and are particularly well adapted from every point of consideration that counts, render necessary the following classification under two principal heads:—

Utility Vehicle.
Industrial vans and wagons.
Public service conveyors and road appliances.
Road tractors, couple-gear and locomotives.
Workshop trucks and tractors

Passenger Vehicles.
Commercial and inspectors' runabouts.
Ambulances and motor chairs.
Omnibuses and taxicabs.
Pleasure cars.

Giving industrial vans and wagons first place, and making these, in fact, the main subject with which the present account is concerned, needs no justification.

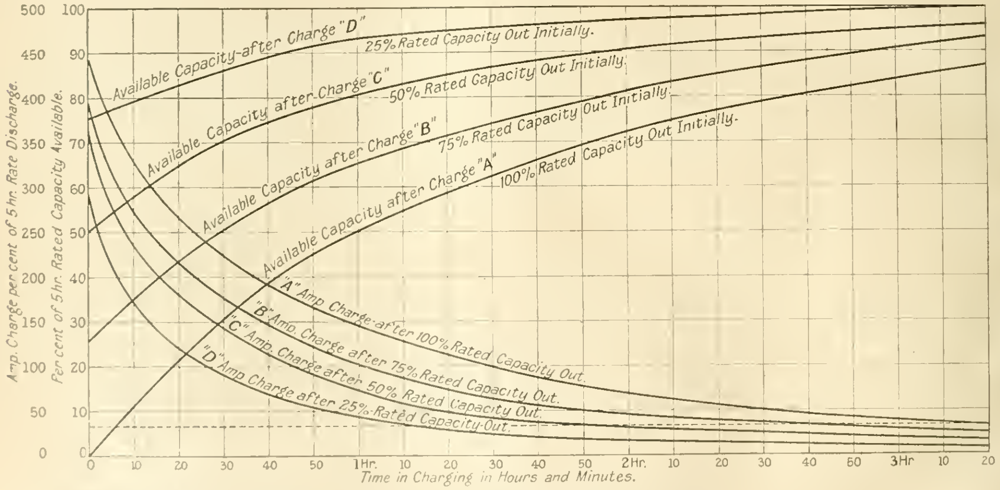
A sweeping reform in the means at our disposal for road transport of merchandise, and in the regulations governing these, has long been overdue. No move worth the name, however, is being made in that direction, and, with the continuous growth in the volume of commerce, dislocation and congestion of vehicular traffic in central areas have become chronic. The large number of petrol motors already in use has given greatly improved service to individual owners, especially for remote deliveries, obviating terminal delays, besides saving time and repeated handling of materials. But, for short distance work within restricted boundaries, entailing frequent stopping and restarting, petrol machines have proved to be neither suited nor economical; hence horse haulage has been affected to a very small extent only by their introduction.

Of all power vehicles, electrically-driven vans and lorries have proved themselves best suited in every respect to supersede horse traction in city and suburban service, and for these fundamental reasons: (1) The cost of energy is low, and no power is consumed while at rest; (2) the speed is double or treble that of horses with equal loads; (3) they are self-starting, and easily controlled by cheap labour; (4) they have a short wheel base, taking up a minimum space on streets and in garages; (5) they have a reliability equal to [illegible] per cent. of the working hours due to simple mechanism, consequently the upkeep charges are low; (6) they are clean, sanitary, and free from fire risk.

The coefficient of utilisation, i.e., the ratio of working days in comparison to total number of working days during any given period, comes out at the high average of [illegible] per cent. The relative figures for other haulage systems are:—Petrol lorries, 90 per cent.; steam lorries, [illegible] per cent.; and horses, according to severity of service, from [illegible] to [illegible] per cent.

The Massachusetts Institute of Technology has issued a report on road transport based on over 100,000 individual observations and owners' records during a period of four years, supplying full particulars as to the relative costs and performances when use was made of horse haulage and of motor traction with petrol and electric machines respectively. According to these statistics, electric vehicles come out easily first when operating within a radius up to 10 miles from a given centre. For conveying tonnage beyond that distance at high speed, petrol motors are best adapted—principally in competition with railways. Time saved, handling of consignments reduced, empties returned, and many other advantages, are all factors which must be taken into account in comparing motor expenses with freight charges, and setting the limit when costs outweigh benefits. Where tonnage and long distance are essentials, but more latitude can be given as regards speed of delivery, traction by steam motors, with or without trailers, making a strong bid for consideration in this country.

Certain shortcomings and disabilities of early attempts are held, in some quarters, to cling still to present-day models, restricting their use unduly, and, in general, making operation liable to a number of unknown factors. Such views are disproved by owners' records over long periods of years, which, if consistently unfavourable, could not have been explained away by makers; in fact, neither records nor the cars themselves would be in evidence now. Nevertheless, misgivings are sometimes entertained on the points mentioned below.



IRONCLAD EXIDE CELLS. QUICK BOOST CHARGES BY TAPERING CURRENT METHOD, IRRESPECTIVE OF THE SIZE OF BATTERY.
At Constant Potential—2·3 volts per cell.

Speed.—The reasonable speed insisted upon in commercial electric vehicles is adversely contrasted sometimes with the great pace at which petrol motors can be driven on top gear by making use of the excess engine power available. But petrol and steam motors compete in the main with railways; battery motors with horses. High speeds are expensive in repairs and maintenance costs, and in shortening the useful service period of the chassis. The fact that on an electric vehicle speed is not within the discretion of the driver beyond a sensible maximum rate on the level, suited to the carrying capacity of the truck, accounts largely for its long life and high coefficient of dependability.

Distance Limit.—The previous remarks, to some extent, indicate reasons why the travel range of an electric vehicle may be kept down without militating against its competence. Horses, used in heavy haulage, are good for from 15 to 20 miles per day at a travelling speed of about three miles per hour; taking into account times for rest, the average effective speed per nine-hour day is barely two miles per hour. On the other hand, electric vehicles as a general rule, are equipped for runs of 40 miles on a single battery charge, and move at from 8 to 12 miles per hour. The loading capacity is assumed to be the same in either case. On delivery service in town, 25 miles per day is rarely exceeded. During meal times at mid-day, or while loading, a "boost" or refreshing charge can be given to the battery, if necessary, replacing up to 50 per cent. of its total mileage range in one hour, in a manner similar to filling up a tank from a hose-pipe. Repeating this process when convenient 70 and 80 miles per day are practicable if the human element is willing.

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* Abstract of a Paper read before the Institution of Engineers and Shipbuilders in Scotland.

Weight.—This certainly operated against the battery vehicle in the early days of the industry. With modern principles of construction applied, however, such a handicap has been much reduced; in fact, if the petrol engine and flywheel, transmission, clutch, radiator, petrol, water, &c., were weighed against battery and motor the difference would be surprisingly small. Moreover, weight distribution on electric vehicles is excellent. The total frictional losses on electric vehicles account for only about 70 watt-hours per ton-mile. Their mean energy consumption on give-and-take roads with fair surface, and the track in good running order, is covered by an allowance of 120 watt-hours per ton mile gross (vehicle and load combined) reckoned over the whole day's performance. For a two-ton capacity wagon, running under an average load of $1\frac{1}{2}$ tons at adequate speed all day long, this works out, therefore, at less than 1 H.P. hour per vehicle-mile, which is clear proof that the tare weight is not a serious drawback.

Price.—The economic merit of battery vehicles is beginning to be recognised in this country, but until manufacturers are justified in building their various standard models on a large scale, production costs cannot be influenced favourably.

Assuming that the employment of motor vehicles is warranted in a given business, selection of type will be guided by: (*a*) Degree of suitability and scope for intensive use. (*b*) Effective service ratio (working days × reliability coefficient). (*c*) Grand total of annual charges. To give a concrete instance:—

Estimated cost of 5-ton capacity electric motor and Ironclad battery	£1,105
Estimated cost of 5-ton capacity petrol motor	875
Difference	£230

Service: Town Deliveries, 40 Miles per Day, 250 Days per Year.

Electric delivery, estimated total cost per year	£558
Petrol delivery, estimated total cost per year*	591
Difference	£33

Therefore, from the extra capital outlay on the electric vehicle a saving results of £33, or nearly 15 per cent. per annum on £230, as well as an additional 5 per cent. in service reliability.

Electrical Troubles.—Fears of being left stranded en route occasionally prejudice against electricity, as a motive power. Through want of technical knowledge drivers are assumed to be incapable of making adjustments, or of coaxing the mechanism into action. In any properly organised home depot all the required attention will have been given to motor, controller, battery and the running gear generally before turning out, so that drivers need never concern themselves with these. An account kept at a large general garage in New York some six years ago, mostly of pleasure cars of that time, showed tow-ins:—

Electric cars, one for every 8,500 miles;	average distance $= 1\frac{3}{10}$ miles.
Petrol cars, one for every 3,000 miles;	average distance $= 8$ miles.

The majority of the electric cars were on the home run, and within $1\frac{1}{5}$ miles, due to drivers cutting things too fine.

Recharging Facilities.—Sources from which batteries can be recharged grow in numbers week by week throughout industrial districts, as new users of electric vehicles equip their home depots with suitable plant, or have these connected up to the public supply mains.

The author then describes the Orwell vehicle, the chassis of the General Vehicle Co., the trucks and vans of the Electromobile Co., and passes on to special batteries

High rates of charge which apply to the every-day working of Ironclad Exide cells are shown in the accompanying diagram. There is virtually no limit to the rate at which current can be drawn from the battery without detriment to it. As regards facilities for recharging, or boosting, batteries at a quick pace, there, again, the user has almost an entirely free hand. So long as the cells do not gas, and the temperature of the electrolyte is kept below 110° F., the current rate employed may be anything up to the number of ampere-hours previously discharged from the battery, as indicated by the meter, irrespective of the size of cell.

Next in importance to the battery comes the motor, although it is difficult to differentiate where perfect combination is so essential. The usual rating is full load for continuous operation, and $2\frac{1}{2}$ times this value for one hour. Low saturation and high torque per ampere is desirable, entailing a battery discharge equal to approximately $2\frac{1}{2}$ times the normal load current for accelerating, and on a 7 per cent. grade. It pays better to take a short hill at a high speed with fields in series-parallel and a heavy burst of discharge from the battery, than to toil up on, say, second speed with fields in series and a lower, but longer battery discharge.

Controllers of every kind have been developed to a high state of efficiency for meeting all service conditions. Both the drum and the flat types are so designed that transitions of field and battery connections are made by bridging and, therefore, without interruption of motor torque; this gives freedom from jolts while moving the controller arm over the contacts, and materially reduces strain on the rear axle. Controller fingers with removable tips are pivoted and pressed into contact with the drum cylinder by helical compression springs. Rheostats of the supported grid construction—*i.e.*, reinforced by insulated clips to eliminate vibration—are supplied either attached to the controller, or separately.

The rubber tyre question deserves to be treated in much fuller detail than can be attempted in this survey. In respect of trucks and delivery wagons, solid tyres only have to be considered. Excessive speed is one of the principal enemies to lengthy tyre life. It results in damage not only through the loaded wheels striking violently against obstructions on the road, but further, through the heat generated by the successively rapid compression and expansion of the rubber particles. Wheels out of alignment put a diagonal grinding strain on the treads. Overloading, unequal loading, and leaving rubber tyres standing under heavy loads, at nights, for instance, are causes responsible for prolific waste of money and material. As the load weight increases, the rubber in the tyre becomes displaced both to right and left. Up to a certain point it will spring back into normal shape, but if distorted beyond its power of recovery it snaps, figuratively speaking, like a rubber band overstretched. A single instant is sufficient to cause this permanent damage. With its structure broken down and elasticity sapped, the rubber becomes mere pulp at that spot, and the trouble spreads rapidly throughout the tyre, which is then easily cut by rough objects along the road. Excess energy consumption then proceeds apace. Considering that frictional, bearing, and motor losses on a truck are fractions only of the power absorbed by the tyres, their efficiency is of great consequence. It has been demonstrated that a truck in good condition requires about 70 watt-hours per ton mile average to overcome total frictional losses. Of this energy expenditure from 40 to 50 watt-hours are absorbed in tyres alone. Progressive methods of manufacture, and the scientific compounding of rubbers, are doing wonders in steadily increasing mileage per battery charge, and in extending the normal tyre life. The makers' usual guarantee of 10,000 miles' run per annum is habitually and considerably exceeded in electric vehicles.

(*To be concluded.*)

INTERLINKING OF LANCASHIRE AND CHESHIRE ELECTRICITY SUPPLY SYSTEMS.

As announced briefly in our last issue, a conference was held on the 2nd inst. at Manchester, presided over by Mr. G. H. Roberts, M.P., Parliamentary Secretary to the Board of Trade. Representatives (125 in number) of the following undertakings were present:—

Group A: Altrincham, Eccles, Lancashire & Yorkshire Railway, Manchester, Middleton, Sale, Salford, Stockport, Stretford, Trafford Power & Light Supply Ltd.

Group B: Bolton, Bury, Heywood, Lancashire Electric Power Co. Leigh, Radcliffe, South Lancashire Tramways Co., Wigan, Rochdale, Farnworth, Swinton.

Group C: Ashton, Glossop, Oldham, Stalybridge.

Group D: Accrington, Blackburn, Burnley, Colne, Darwen, Nelson Rawtenstall, Preston Corporation Tramways, Preston Electric Light Co.

Group E: Birkdale & District Elec. Supply Co., Birkenhead, Bootle, Liverpool, Liverpool District Lighting Co., Ltd., Liverpool Overhead Railway Co., Mersey Power Co., Mersey Railway Co., Prescot & District Lighting Co., St. Helens, Southport, Wallasey, Warrington.

The Chair was first taken by the Lord Mayor of Manchester, who welcomed Mr. Roberts to the conference.

Mr. ROBERTS, in reply to the Lord Mayor, remarked that the report which had been drawn up by the Interconnection Committee (THE ELECTRICIAN, Vol. LXXVIII, p. 53, 1916) was, in his opinion, a very valuable one, but it had been his duty to point out that the circumstances of the war were not for the moment very favourable to large projects. There was no reason, however, to rest on their oars and they should be deciding how to be prepared for the problems of peace. He was of opinion that the policy pursued in the past had not been the right one. They had been too parochial in their views. It might well happen that whenever undertakings of this character were to be embarked upon in the future it would not be by a small local authority, but by groups of local authorities having common purposes and seeking to serve the common interest. Legislation in the past had placed some slight restriction on developments. One of the objects of that conference was to consider how far legislation was necessary to carry out the projects they had in view.

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* Normal price of motor spirit taken at 1s. 6d. per gallon.

The Lord Mayor then vacated the Chair in favour of Mr. Roberts, who proceeded to call upon various speakers to express their views.

Mr. S. L. PEARCE, Chairman of the Interconnection Committee, dealt in general terms with the report, which had been submitted. The advantages of interlinking were to be found in the reduction to an absolute minimum of fuel costs, labour costs and capital charges. On the basis of coal at 17s. 6d. per ton and on an entailed capital expenditure of some £281,000 for interlinking mains and transforming plant there would be an annual saving of coal alone, in respect of the first four groups of undertakings considered, of some £82,000. That result arose simply and solely from the more efficient use of existing plant and would be materially increased, possibly three-fold, if the present-day export value of coal were taken. Powers were already in existence by which combinations of local authorities were possible. There was a difficulty in combining with companies; therefore, it was suggested in the report that working arrangements with power companies should be permitted. It was desirable that the scheme should be voluntary and that the control of the electricity supply in the several undertakings should be in the hands of those closely connected with them, but it would be necessary to control the extent to which the plant at the various stations was run if the most beneficial results were to be obtained. Meetings had been held of the groups of undertakings for the purpose of considering the report, also a joint meeting of the first four groups, and the principle of interconnection set forth in the report had been approved practically unanimously.

Councillor DAGNALL (Chairman of the Manchester Corporation Electricity Committee) agreed that the present was not the time to promote parochial aspirations. Manchester would probably gain very little by interlinking, but the Electricity Committee were willing to do all they possibly could to justify the recommendations the engineers had placed before it.

Mr. L. C. EVANS (Town Clerk of Salford) said that in Salford they desired to preserve local autonomy for those subjects which were properly the subjects for local administration, but they desired co-operation outside their own frontiers with other local authorities in matters which ought not to regard municipal frontiers. There was great difficulty in fusing a number of municipal undertakings into one; thus a much more modest proposal was put forward. It was one for co-operation, and on that basis Salford was quite prepared to join hands with all the other authorities.

Councillor ROBINSON (Stretford) agreed with what had been said about parochial boundaries. The principle they were to settle that day was that municipal boundaries should not be a bar to electricity development. If the proposal had been made 12 years ago a number of plants would not have come into existence. Those plants might be a hindrance. He was himself considering a particular case, whether it was desirable to put down plant of 1,500 kw. for a mill or to purchase the power. If collective production of electrical energy put such private plants out of court the saving of capital outlay to the industries of the country would be enormous.

Dr. H. F. PARSHALL (Chairman, Lancashire Electric Power Co.) agreed that the whole matter should be dealt with most broadly by the Board of Trade. There was always a desire on the part of each person responsible for an existing undertaking to see it live and grow. As far as his company was concerned he thought it should persist, but he was quite prepared to abide by the decision of a properly constituted body. His company had already carried out most of the interlinking proposals suggested.

Councillor [illegible] (Bury) hoped that there would be no interfering with those [illegible] having statutory powers. He thought much good [illegible] interlinking. At Bury they had applications from a good many [illegible] industries which they were unable to supply for lack of [illegible].

[illegible] (Stalybridge) referred to the good results obtained [illegible] Hyde, Stalybridge, Dukinfield and Mossley. They [illegible] 2,50 [illegible] per head of population, and if they [illegible] they could raise that consumption to [illegible]. A [illegible] of that kind could be obtained for a large [illegible] population.

[illegible] (Accrington Corporation Electricity Committee) [illegible] should be provided whereby small [illegible] the Joint Board with a view to obtaining a [illegible] that [illegible] could not possibly provide for them [illegible].

Mr. [illegible] (Chairman of the Liverpool Corporation [illegible] Committee) [illegible] the movement, although Liverpool was one of those undertakings which could not very well participate, owing to its geographical position. He thought municipalities should pay a little more attention to the scientist and the chemist and see what could be done in the [illegible] of fuel.

Mr. [illegible] (Town Clerk of Blackburn) emphasised the desirability of general co-operation.

Alderman F. SMITH (Liverpool) spoke in favour of the scheme.

Mr. W. H. TYRER (Town Clerk, Wigan) stated that they were already linked up to the Lancashire Electrical Power Co. He asked for further details as to representation on the Joint Board and what the next step would be.

Councillor J. W. COLLIN (Birkenhead) suggested that the Committee should consider the probability of large curtailment of tram services in the country in the near future.

Mr. ROBERTS, in closing the proceedings, expressed his gratification at the unanimity that had been shown. With regard to the next step, that must rest with the Committee. They should work out the details of the scheme and submit them to the Board of Trade. Any proposals that were submitted would be most thoroughly investigated in a sympathetic spirit.

PRESSURE HARMONICS IN POLYPHASE SYSTEMS AND WINDINGS.

BY B. HAGUE, B.SC., D.I.C.

Summary.—In this article the properties of pressure harmonics in a polyphase system are first discussed by the use of the well-known theory; after which the effect of the distribution of the armature winding of the alternator (from which the system is derived) on the magnitude of the harmonics is considered. Tables of distribution factors are given for single-layer windings and for double-layer lap windings, forming an extension to similar tables published by Dr. S. P. Smith and Mr. R. S. H. Boulding.

Introductory.

PART I.—POLYPHASE SYSTEMS AND WINDINGS.

- I. Symmetrical polyphase systems.
- II. Hemi-symmetrical polyphase systems.
- III. Power in polyphase systems.
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- IV. Interlinked polyphase systems.
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  - (*a*) The effect of interlinking on harmonics.
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PART II.—THE EFFECT OF WINDING FACTORS ON THE PRESSURES IN SYMMETRICAL POLYPHASE WINDINGS.

- I. Single-layer windings.
  - (*a*) Whole number of slots per pole, Q.
    - (i.) Full-pitch coils.
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- II. Double-layer windings.
  - (*a*) Lap windings.
    - (i.) Diametral loading.
    - (ii.) Three-phase polygon loading.
  - (*b*) Wave windings.
    - (i.) Diametral loading.
    - (ii.) Three-phase polygon loading

Conclusion.

LIST OF SYMBOLS.

B Amplitude of nth harmonic in flux density curve.
C Total number of coils in a winding.
E R.M.S. value of electromotive force.
I R.M.S. value of current.
N Number of phases.
P Power.
Q Number of slot pitches per pole-pitch $= S/2p$.
S Total number of slots.
S' Number of slots in a symmetrical polyphase system $= S/a$.
T_c Number of turns per coil.
T Total number of turns in a circuit $= qmT_c$.
a Number of identical parts in a winding.
e Instantaneous value of electromotive force.
$\bar{e}$ Maximum value of electromotive force.

f=Frequency.
$f_{\epsilon,n}$=Coil-span factor of the nth harmonic$=\cos n\frac{\varepsilon}{2}$.
$f_{m,n}$=Distribution factor of the nth harmonic$=\dfrac{\sin n\frac{m\psi}{2}}{m\sin\frac{n\psi}{2}}$.
$f_{g,n}$=Group factor of the nth harmonic$=\dfrac{\sin n\frac{g\psi}{2}}{g\sin\frac{n\psi}{2}}$.
f_n=Winding factor of the nth harmonic$=f_{\epsilon,n}\times f_{m,n}\times f_{g,n}$
g=Number of groups of m coils in a circuit.
i=Instantaneous value of current.
$\bar{\imath}$=Maximum value of current.
m=Number of coils in a group of a circuit.
n=Order of harmonic.
p=Instantaneous power.
=Total number of pole-pairs in an alternator.
q_0=Wound slots per pole and phase.
t=Time.
β=Angular phase-pitch in radians.
γ=Angular slot-pitch in radians.
ε=Angular deviation of coil-span from π radians.
σ=Angular phase-spread in radians.
ψ=Angular phase displacement between successive coils in the winding.
φ=Phase angle between current and electromotive force.
$\omega=2\pi f$.

Introductory.

An accurate understanding of the properties of harmonics in a polyphase circuit is absolutely essential in many technical problems, and the author hopes that the present communication will assist students and designers who need such knowledge in the consideration of certain technical matters.

In the present Paper an attempt is made to collect together the various properties of harmonics in practical polyphase systems, the subject being considered under the following heads. In sections I., II., III. and IV. of Part I. the usual theory of polyphase systems is laid down along the well-known lines,[*] whilst in section V. the less familiar properties of harmonics in such systems are worked out. All this theory is perfectly general, and quite independent of the way in which the polyphase system is procured. In practice, however, polyphase systems of pressures are derived from the armature winding of a synchronous machine, and so in Part II. attention is given to the effect on harmonics of such a winding.

In this latter connection this article forms a sequel to a Paper by Dr. S. P. Smith and Mr. R. S. H. Boulding,[†] in which tables were published of the distribution factors of the harmonics for three-phase windings having an integral number of slots per pole. The tables given in the present communication deal in addition with other practical cases, and, therefore, extend the usefulness of the results published by these writers. The reader is referred to their Paper (particularly to Part II. on windings and their vector diagrams) for points in connection with the theory of aramture windings into which we cannot enter here, and the author advises that the present Paper be read as a corollary to their arguments rather than as a complete theory in itself. At the same time it is hoped that nothing has been omitted from the following discussion that will in any way limit the application of the results to actual windings without further reference.

Part I.—Polyphase Systems and Windings.

A system of pressures of the same frequency differing in phase from one another is called a polyphase system of pressures. The N pressures of such an N-phase system can be represented by the equations :—

$$\begin{aligned} e_I&=\bar{e}_I\sin(\omega t-\beta_I),\\ e_{II}&=\bar{e}_{II}\sin(\omega t-\beta_{II}), \qquad \ldots\ldots \quad \text{(I)}\\ e_N&=\bar{e}_N\sin(\omega t-\beta_N),\end{aligned}$$

wherein $e_I, e_{II}, e_{III},\ldots e_N$ denote the instantaneous values of the N pressures, $\bar{e}_I, \bar{e}_{II}, \bar{e}_{III},\ldots\bar{e}_N$ their amplitudes, $\beta_I, \beta_{II}, \beta_{III},\ldots\beta_N$, the phase displacements of the respective pressures from the instant of time $t=0$; $\omega=2\pi f$, where f stands for the frequency. The vector diagram for a general N-phase system is shown in Fig. 1.

A polyphase system of pressures is usually derived in practice from the armature winding of an alternator arranged so as to give the required number of phases, and although it is not usual for the amplitudes of the pressures and their phase displacements from one another to differ in practice, yet cases of this dissymmetry are by no means rare. This happens sometimes, for example, when an N-phase system is tapped off a closed commutator winding.

If all the phases are similarly loaded—*i.e.*, if the load is balanced —as will be assumed throughout this Paper, then the vector diagram for the currents will be displaced from that of the pressures by an angle φ. When φ is positive, the currents lead on the pressures, and φ is called the angle of lead ; whereas when φ is negative, it is called an angle of lag, and the currents lag behind the pressures. It must be understood that the present section deals only with the fundamental of the pressures and currents, leaving the consideration of harmonics until section V. of this part of the Paper.

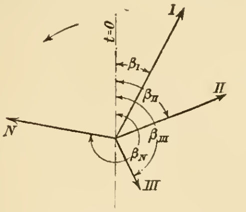

Fig. 1.—Vector Diagram of Pressures in General N-phase System.

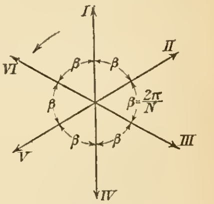

Fig. 2.—Vector Diagram of Pressures in Symmetrical N-phase System.
Example, $N=6$, $\beta=2\pi/N=2\pi/6$.

In practice, therefore, the only polyphase systems that call for general treatment are those in which all the pressures have the same amplitude $\bar{e}$, and the successive phases are displaced from one another by a constant angle, β. Then we have :—

$$\bar{e}_I=\bar{e}_{II}=\bar{e}_{III}=\ldots\ldots=\bar{e}_N=\bar{e},$$

and $$\beta_{II}-\beta_I=\beta_{III}-\beta_{II}=\ldots\ldots=\beta_N-\beta_{N-1}=\beta.$$

Taking $\beta_I=0$, we get $\beta_{II}=\beta$, $\beta_{III}=2\beta$, and so on, so that $\beta_N=\overline{N-1}\beta$. Equation (I) can now be written :—

$$\begin{aligned} e_I&=\bar{e}\,.\sin\omega t,\\ e_{II}&=\bar{e}\,.\sin(\omega t-\beta),\\ e_{III}&=\bar{e}\,.\sin(\omega t-2\beta), \qquad \ldots\ldots\ldots \quad (2)\\ e_N&=\bar{e}\,.\sin(\omega t-\overline{N-1}\beta).\end{aligned}$$

The angle β is called the angular phase-pitch. Further simplification can be introduced into this equation due to the practical limitations in the value of β, for in all practical systems the angular phase-pitch is either equal to $2\pi/N$ or to π/N.

I. Symmetrical Polyphase Systems.—When $\beta=2\pi/N$, the successive phases are displaced from each other by $1/N$th of a period or cycle. Such a polyphase system is called symmetrical. The equations for the pressures in a symmetrical polyphase system then follow by inserting $\beta=2\pi/N$ in equation (2), viz :—

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[*] *See* Steinmetz, "Alternating-current Phenomena," 1908, pp. 634-698. Russell, "Alternating Currents," second edition, Vol. II., Chap. XVIII., p. 493. Bragstad and La Cour, "Theory and Calculation of Electric Currents," 1913, pp. 236-291. Fraenckel, "Theorie der Wechselström," 1914, Chap. VIII., p. 103.

[†] "Journ." I.E.E., Vol. LIII., p. 205, 1915.

$$\begin{aligned} e_I &= \bar{e} \,.\, \sin \omega t, \\ e_{II} &= \bar{e} \,.\, \sin (\omega t - 2\pi/N), \\ e_{III} &= \bar{e} \,.\, \sin (\omega t - 2 \cdot 2\pi/N), \quad . \; . \; . \; . \quad (3) \\ e_N &= \bar{e} \,.\, \sin (\omega t - \overline{N-1} \cdot 2\pi/N), \\ &= \bar{e} \,.\, \sin (\omega t + 2\pi/N). \end{aligned}$$

The vector diagram in Fig. 2 is drawn for a symmetrical polyphase system, when $N=6$, and consequently $\beta=2\pi/6$—*i.e.*, 60 deg. It is obvious that the vectors of the pressures in a symmetrical polyphase system are equally spaced round a circle like the spokes of a wheel. N can, of course, be any odd or even integer, its commonest value in practice being 3, the symmetrical three-phase system, in which $\beta=2\pi/3=120$ deg.

II. Hemi-symmetrical Polyphase Systems.—When $\beta=\pi/N$ the successive phases are displaced from each other by $1/N$th of a half-period or cycle. Such a system is called hemi-symmetrical by Steinmetz, because it constitutes one-half of a symmetrical polyphase system. For example, the hemi-symmetrical three-phase system is one-half of the symmetrical six-phase system.

The equations for the pressures in a hemi-symmetrical polyphase system then follow, by substituting $\beta=\pi/N$ in equation (2) :—

$$\begin{aligned} e_I &= \bar{e} \,.\, \sin \omega t, \\ e_{II} &= \bar{e} \,.\, \sin (\omega t - \pi/N), \\ e_{III} &= \bar{e} \,.\, \sin (\omega t - 2 \,.\, \pi/N), \quad . \; . \; . \; . \; . \quad (4) \\ e_N &= \bar{e} \,.\, \sin (\omega t - \overline{N-1} \,.\, \pi/N), \\ &= -\bar{e} \,.\, \sin (\omega t + \pi/N). \end{aligned}$$

The vector diagram in Fig. 3A is drawn for a hemi-symmetrical three-phase system, with $N=3$, and consequently $\beta=\pi/3$—*i.e.*, 60 deg.

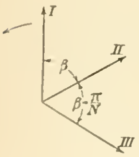

FIG. 3A.—VECTOR DIAGRAM OF PRESSURES IN HEMI-SYMMETRICAL N PHASE SYSTEM.

Example: $N=3$, $\beta=\pi/N=\pi/3$.

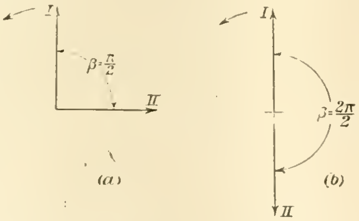

FIG. 3B.—VECTOR DIAGRAM OF PRESSURES IN TWO-PHASE SYSTEMS.

(*a*) Hemi-symmetrical system, $N=2$, $\beta=\pi/N=\pi/2$.

(*b*) Symmetrical system, $N=2$, $\beta=2\pi/N=2\pi/2=\pi$.

The commonest of the hemi-symmetrical systems is the two phase or quarter phase system, in which $\beta=\pi/2=90$ deg. The term "quarter-phase" describes this system much better than "two phase." "Hemi-symmetrical two-phase," although clumsy, is preferable to the latter term, which is indefinite, and might mean two phases displaced from each other by 180 deg. in a symmetrical two phase system (*see* Fig. 3B).

III. Power in Polyphase Systems.—Let us now consider the expression for the power in one phase of a polyphase system, the voltage equations for which are given in equation (2). Taking, for example, the rth phase, the pressure is

$$e_r = \bar{e} \sin (\omega t - \overline{r-1} \,.\, \beta),$$

and the current is

$$i_r = \bar{i} \sin (\omega t - \overline{r-1} \,.\, \beta - \varphi),$$

where φ denotes the angle of lag of the current behind the pressure.

The instantaneous power is then given by

$$p_r = \bar{e}\bar{i} \sin (\omega t - \overline{r-1} \,.\, \beta) \sin (\omega t - \overline{r-1} \,.\, \beta - \varphi),$$

$$= \frac{\bar{e}\bar{i}}{2} [\cos \varphi - \cos (2\omega t - \overline{r-1} \,.\, 2\beta - \varphi)].$$

If I_p and E_p be the R.M.S. values of the current and pressure in any phase of the system, we can write for the instantaneous power in the phase r,

$$p_r = E_p I_p \cos \varphi - E_p I_p \cos (2\omega t - \overline{r-1} \,.\, 2\beta - \varphi). \quad (5)$$

Hence, the power in a single-phase pulsates at double frequency about the mean value $E_p I_p \cos \varphi$.

(*a*) *Symmetrical Systems.*—In a symmetrical polyphase system $\beta=2\pi/N$. Substituting for β in equation (5) we have

$$p_r = E_p I_p \cos \varphi - E_p I_p \cos \left(2\omega t - \overline{r-1} \,.\, \frac{4\pi}{N} - \varphi\right).$$

The total power in the whole system at any instant, $\sum_{r=1}^{r=N} p_r$, is the sum of the separate powers in the all phases—*i.e.*,

$$\sum_{r=1}^{r=N} p_r = N E_p I_p \cos \varphi - E_p I_p \sum_{r=1}^{r=N} \cos \left(2\omega t - \varphi - \overline{r-1} \,.\, \frac{4\pi}{N}\right),$$

$$= N E_p I_p \cos \varphi - E_p I_p \cos \left(2\omega t - \varphi - \frac{N-1}{2} \,.\, \frac{4\pi}{N}\right) \frac{\sin \frac{N}{2} \,.\, \frac{4\pi}{N}}{\sin \frac{1}{2} \,.\, \frac{4\pi}{N}}$$

$$= N E_p I_p \cos \varphi - E_p I_p \cos \left(2\omega t - \varphi + \frac{2\pi}{N}\right) \frac{\sin 2\pi}{\sin 2\pi/N}.$$

Now, the second term is always zero when N is greater than 2. Hence, for $N > 2$, we get for the instantaneous power,

$$\sum_{r=1}^{r=N} p_r = N E_p I_p \cos \varphi = P = a \text{ constant}. \quad . \; . \; . \; . \; . \; . \; . \quad (6)$$

Thus, the power in a symmetrical polyphase system is constant.

When N is 1, we have a single-phase system. When N is 2, we get a symmetrical two-phase system with its two phases at 180 deg., and the second term becomes $-2E_p I_p \cos (2\omega t - \varphi)$, showing that the power pulsates therein. This is what we should expect, for with two phases at 180 deg. the powers simply combine to form that of a single phase.

(*b*) *Hemi-symmetrical Systems.*—Applying equation (5) to the hemi-symmetrical system, where $\beta=\pi/N$, we get

$$p_r = E_p I_p \cos \varphi - E_p I_p \cos \left(2\omega t - \varphi - \overline{r-1} \,.\, \frac{2\pi}{N}\right).$$

Hence, the total power of the whole system, $\sum_{r=1}^{r=N} p_r$, is equal to

$$\sum_{r=1}^{r=N} p_r = N E_p I_p \cos \varphi - \sum_{r=1}^{r=N} E_p I_p \cos \left(2\omega t - \varphi - \overline{r-1} \,.\, \frac{2\pi}{N}\right)$$

$$= N E_p I_p \cos \varphi - E_p I_p \cos \left(2\omega t - \varphi - \frac{N-1}{2} \,.\, \frac{2\pi}{N}\right) \frac{\sin \frac{N}{2} \,.\, \frac{2\pi}{N}}{\sin \frac{1}{2} \,.\, \frac{2\pi}{N}}$$

$$= N E_p I_p \cos \varphi - E_p I_p \cos \left(2\omega t - \varphi + \frac{\pi}{N}\right) \frac{\sin \pi}{\sin \pi/N}.$$

Now, the second term is always zero, except when $N=1$; hence we have

$$\sum_{r=1}^{r=N} p_r = N E_p I_p \cos \varphi = P = \text{a constant}. \quad . \; . \; . \; . \; . \quad (7)$$

Thus, the power in a hemi-symmetrical system is constant, as in the symmetrical system.

(*To be continued.*)

VOLTAGE REGULATION OF ROTARY CONVERTERS.*

BY G. A. JUHLIN.

(*Concluded from page 695.*)

BOOSTER CONTROL.

In this method the voltage variation is obtained by the use of a synchronous booster mounted on the shaft of the converter. With the booster field unexcited and the converter operating on unity power factor, the E.M.F. of the converter is not affected by the current passing through the booster, except to a very small extent, due to the impedance drop. The armature reaction is, of course, purely distortive, and has, therefore, practically no influence on the voltage.

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* Abstract of a Paper read before the Institution of Electrical Engineers on March 8, 1917.

When the power factor varies from unity the conditions are quite different, as the booster armature reactance is then either magnetising or demagnetising, and the booster armature M.M.F. must, therefore, be balanced by an equal number of ampere-turns on the booster field. The booster field may, therefore, require a certain amount of excitation, although no change in the converter E.M.F. is required. Conversely, it is possible to obtain boost, positive or negative, without exciting the field of the booster, by producing wattless currents in the converter which will produce the excitation of the booster.

From the above it is clear that the power factor is under complete control in a booster type of converter, as the influence of the wattless current on the E.M.F. can be counterbalanced by the excitation of the booster field. It should be noted, however, that it is essential not to operate a booster converter at a lagging power factor, as this will overload the booster field when raising the voltage, and may account for the booster not giving its full range in voltage.

The fact that the power factor can be kept at unity, or leading, if desired, is undoubtedly the chief reason why the booster type of converter has found such an extensive use. Some doubt may be expressed, however, as to whether this extensive use is altogether justified, as in many cases the reactance control could be employed with equally good results.

The advantages of the booster converter are fully appreciated whereas its disadvantages are not so apparent.

It is from the point of view of the designer that the booster converter presents difficulties, and it may be of interest to study the influence of the booster on the commutation. As this point is of practical importance in the interpole type of converter, only this type will be dealt with.

In the simple converter the total armature reaction is only produced by the losses in the converter, but the distribution over the pole-pitch is not uniform, with the result that a certain part is acting in the interpolar space. This must be compensated for by a certain number of ampere-turns on the interpole. The armature M.M.F. is a simple function of the load, and can, therefore, be taken care of by the ordinary commutating pole winding.

When the booster is used the effect of the converter armature is complicated, due to the fact that a part of the electrical energy supplied to the converter is transformed into mechanical power and transmitted through the shaft to or from the booster, the direction depending on whether the boost is positive or negative. In the case of positive boost—*i.e.*, when the E.M.F. of the converter is increased—it acts partly as a motor supplying mechanical power to the booster, which then acts as a generator in raising the E.M.F. On the other hand, when the converter E.M.F. is reduced by means of the booster the converter acts partly as a generator receiving energy from the booster, which is then operating as a motor delivering its energy through the shaft to the converter. Under these conditions, the effect of the armature on the interpoles is no longer dependent only on the load of the converter, but also on the E.M.F. of the booster. This is due to the fact that the alternating and continuous currents are not balanced, as in the simple converter, and the converter armature, therefore, develops a motor reaction when the boost is positive, and a generator reaction when the boost is negative.

The value of this armature M.M.F. is directly proportional to the output of the booster, and this means that a variation of the flux is required to obtain correct commutation. When it is considered that the interpole ampere-turns necessary to produce this flux, as well as compensate for the normal armature reaction at zero boost, only amount to about 35 per cent. of the armature ampere-turns, it will be seen that a reduction of 10 per cent. means a big change in the strength of the interpole flux. In order, therefore, to keep the intepoles at their correct strength at any load and voltage it will be necessary to provide some means whereby the interpoles are automatically adjusted with the load. It is, of course, also necessary to vary the excitation on the interpoles with varying boost.

Unfortunately, it is not possible to compensate the armature reaction completely, as it is not constant for all positions of the armature. The fluctuations also exist in the simple converter, but are accentuated in the booster converter.

Several methods have been adopted in order to obtain the necessary compensation, all of which involve an auxiliary winding on the interpole, and in some cases special apparatus for varying the excitation of this winding. In most schemes the variation in the excitation is obtained by variation of the resistance in the circuit of the auxiliary winding, and the accuracy of the compensation depends therefore on the number of steps in which the resistance is changed. The question of rapidity in adjusting the excitation is of importance in cases where sudden load fluctuations occur, and the time lag must, therefore, be reduced to the smallest possible amount.

The problem of accurate compensation of booster converters is, therefore, not an easy one, especially in cases where large voltage variations are required.

A certain limited amount of boost can be obtained without any adjustment of the interpole excitation, and as the conditions of commutation cannot be made uniform for all voltages, it is clear that full advantage cannot be taken of the material if good commutation is to be obtained at all loads and voltages. In other words, a given machine would reach its commutation limit at a lower load, if fitted with a booster for voltage regulation, than would be the case if arranged for reactance control.

When inverted running is required and voltage variation is necessary, a booster is essential, if the converter is not running in parallel with any other alternating-current plant, as reactance control cannot be used in such cases. This will be clear when it is considered that, with a given condition of load to keep the speed, and therefore the frequency, constant it is essential to keep constant field current, assuming a fixed continuous voltage. In order to vary the E.M.F. delivered by the converter, it would be necessary, however, to vary the excitation, so that the two conditions are opposed. If the converter is running in parallel with an alternating-current system, it is possible to regulate the alternating voltage by means of reactance control, as in this case the speed of the converter cannot increase, due to the fact that it is held in synchronism with the system to which it is connected. Inverted running should however, be considered as an emergency condition, as the rotary converter is primarily a machine for transforming alternating current into continuous current, and not *vice versa*.

COMPARISON.

A study of a particular case may help to bring out the advantages and disadvantages of the respective types.

When dealing with the reactance control, a case was considered where two ranges of voltages were required—*i.e.*, 400 to 440 volts for lighting and power, and 500 to 550 volts for traction. These requirements are fairly common, and may serve as a basis for comparison.

Cost.—For this voltage variation the booster would require a range of ±75 volts, which means that the output would be 15·8 per cent. of the converter output. Assuming a unit of 1,000 kw. output, the cost of the booster would be in the neighbourhood of 20 per cent of the cost of the converter alone.

In the case of reactance control the cost of the converter would be practically the same as for the booster control. Owing to the reactance and the tappings required in the transformer, the cost of this would be increased by approximately 5 per cent. of the converter cost. A three-pole double-throw switch would be required, the cost of which would be about 2 per cent. of the converter cost.

From the point of view of first cost, therefore, the advantage would be with the reactance control. The size of the booster would, of course, be materially reduced by arranging the transformers with tappings giving 420 and 525 volts respectively on the continuous-current side, and providing a change-over switch, as in the case of the reactance control. The advantage of this arrangement would be not only reduced cost, but also improved conditions from a point of view of commutation, on account of the reduced boost. This advantage is more marked in large units than in smaller ones, owing to the increasing difficulties in commutation.

Power factor.—As regards the power factor, the booster type of converter has the advantage, as its power factor can be varied at will under all conditions of load and voltage, and, in cases where wattless currents are required for power-factor improvement independent of the voltage conditions, it is the only type suitable.

When no leading currents are desired, however, there appears little or no reason why the reactance type should not be used, and it is doubtful whether better results would be obtained with the booster type.

With the reactance type of control, it is only necessary to operate the field rheostat in changing the voltage, and the fact that the power factor is fixed definitely for each voltage is not altogether a disadvantage.

Commutation.—In this respect the reactance control has the advantage. Satisfactory commutation is obtained with the booster type of machine, but much finer adjustments as regards interpoles and brush gear are necessary with this type of machine.

The object of the comparison is to bring out, if possible, the fact that in many cases sacrifice is made in the most vital feature of the machine—*i.e.*, the commutation—in order to obtain the advantage of unity power factor, which may, or may not, be realised in actual operation.

The following summary of the two systems may be considered as generally applicable :—

	Reactance Type.	Booster Type.
Cost	Cheaper	—
Power factor	Cannot be controlled at will for each voltage and load	Can be controlled at will for any load and voltage
Commutation	Good commutation more readily obtained	—
Range of voltage	Limited (±7½ per cent. may be considered as the limit)	Great range can be obtained (± 15 per cent. or more)
Efficiency	Slightly higher	—
Starting	No difference	No difference
Space	Less space required	—
Maintenance	—	More parts to keep in order

From the foregoing it will be seen that the question of voltage regulation of rotary converters is one which requires close consideration from every point of view in order to obtain the best results as regards first cost and operation. The simplicity of the reactance control, coupled with its low cost and advantages in operation, are factors which recommend it very strongly wherever the range of voltages required permits its adoption, even at a sacrifice in way of power factor.

DISCUSSION.

Mr. A. M. **Taylor** said the Paper appeared to have for its object the showing up of the advantages of the reactance-controlled rotary when used in the ordinary way ; but a question that was exercising the minds of many station engineers was whether the rotary could not be satisfactorily used "inverted" to a much greater extent than had up to now been done. The use of batteries in alternating-current sub-stations had enormously increased during the past few years and there were many sub-stations, especially towards the outskirts of large systems, where a large alternating-current load was transmitted through the sub-station to regions beyond, and where, if it were possible to feed into the alternating-current network from the sub-station battery and at the same time to boost up not only the alternating-current voltage *but also its power factor*, engineers would not hesitate to pay, perhaps, 25 to 30 per cent. more than they at present paid for rotaries, in view of the considerable saving in copper which would be effected in the mains, and of the (in some cases) really serious difficulty of being tied up, on the one hand, to direct-current mains fed from adjacent sub-stations of higher pressure, and, on the other hand, to its own alternating-current mains which were considerably below the normal. The speaker endeavoured to show some years ago that it was financially a safe proposition to put in batteries in the more distant sub-stations, even on the basis of unity power factor in the alternating-current load ; much more so when the power factor was poor. He believed that it was possible to obtain a large leading current from the rotary, both when it was delivering direct current to the sub-station 'bus bars and also when it was running inverted off these 'bus bars—*i.e.*, over the whole 24 hours, in fact—and this desirable result could, he believed, be obtained in either of two ways : (1) A rotary with a large external reactance could be used on the "charge" and the rotary designed to give the correct direct and alternating current volts only when heavily over-excited (*i.e.*, with a large leading current) ; the reactance in this case acting to give a heavy positive boost from the alternating current mains to the direct-current mains. The same rotary, with the reactance cut out by a switch and with the addition of an alternating-current booster (or induction regulator) giving a large counter boost, could again be run at a high excitation, and with a large leading current this time "inverted" and feeding into the alternating-current mains. (2) The alternative would be to have only the alternating-current booster (*i.e.*, without the reactance) and to have the rotary and transformer with as little reactance in them as possible. In this case the rotary would be run over-excited on the "charge" as well as on the "discharge" (*i.e.*, when running inverted), and would take a big leading current in *each* case. The booster would be used to give a counter boost on the discharge only, or, if found more desirable, it might give a forward boost on the "charge" and a counter boost on the "discharge." He (Mr. Taylor) would be much interested to know whether the sparking limitation would prevent such machines being built at reasonable cost. No doubt the booster would have to be bigger than was usually supplied ; but he believed engineers would willingly face the cost for the sake of the improved power factor. It was, of course, not necessary that the required boost should be furnished by a rotating booster. It could equally be provided by, for instance, the new type of static regulator described at the meeting by Mr. [illegible] which also had the advantage that it could be added to [illegible] rotary.

Mr. H. **Brazil** said he endorsed the author's commendation of the reactance control. For most lighting supplies where the regulation was only from 3 to 4 per cent.—i.e., 3 or 4 per cent. above or below normal, but 7 or 8 per cent. total—reactance control was undoubtedly the best thing, but sometimes it was necessary to get much larger variation of voltage. He had done this by a combination of the reactance control rotary and the booster control. He used a direct current booster. This had worked admirably. He thought this was really the same as the author mentioned in the case of the booster. Part of the energy put in on the alternating current side of the rotary was used to convert into mechanical power to drive the direct-current booster. This had many advantages, as one had the reactance controlled rotary and the advantages of that for ordinary variations of supply, and larger variations could be got by the boosters. He had one at each end of the shaft. The original idea was to keep these boosters on to charge and discharge batteries. The efficiency with ordinary motor-driven boosters, where the current was converted to direct current, re-converted to mechanical energy and then re-converted to electrical energy, was very poor. By putting the booster on the end of the rotary shaft he thought a lot of those losses could be done away with. Where the batteries charge and discharge by reversing the booster a battery was available at a moment's notice. In case of a breakdown on the extra-high-tension system the rotary remained running, and in five seconds the change over to a discharge could be made by exciting the field of the booster. That was the original idea, but they could be used for other purposes. For getting a voltage of 400 or 440 to 550 he had a 500 kw. rotary with a booster at each end, and had taken as much as 15 per cent. of the output of the rotary from the booster, and he got perfect commutation. If that 15 per cent. were added on to the 7½ per cent. that the reactance rotary would give, a much larger regulation was obtained than could be got by any other method. The booster could also be used in the ordinary way for testing purposes. It could be made distinct from the rotary, and used for testing switches, which could not be done with the alternating-current booster. As regarded the effect on the power factor, this would be similar to that of the alternating-current booster, though in that case one did not get the reversibility. He had taken 15 per cent. of the output of the rotary from the direct-current booster and increased the total amount on the rotary to 25 per cent. over-load without any appreciable sparking. Did the author see any disadvantage in this method of obtaining a large range of voltage ?

Mr. R. A. **Chattock** asked whether a leading power factor could not be obtained by over-exciting the machine if the tappings from the transformers were arranged suitably to give a low voltage, and then over-exciting the machine to get the voltage necessary on the line. He thought that could be done in most sub-stations where it was necessary to correct the power factor on the system, and where it could be done with the reactance type of control in place of the booster. The booster type was a very nice machine to run, but was more complicated. He thought they would go back to the reactance type on that account.

Mr. W. B. **Woodhouse** said they found it necessary to connect a constant direct-current voltage with a variable alternating-current voltage and variable power factor. Some engineers had hoped the reactance regulated rotary would be useful for correcting power factor, but their experience went to show that it was not commercially possible. The booster control had to be used if the control was wanted to help to correct the power factor. His experience of the booster had been as favourable as his experience of the reactance control. The author pointed out the dangers of that type of machine, but he (Mr. Woodhouse) thought that for the lower voltages and the usual lighting supply they need have no fear about commutation. With a 2,500-volt traction rotary voltage regulation was not so important, and he supposed one might adopt the reactance. The author compared the cost of booster and rotary control. He gave the cost of a booster giving a smooth range ± 75 volts, which he pointed out later was not really necessary. With the booster control the change over was made just as it was with the reactance regulator. What was the author's estimate of the cost of the booster with a very small range of voltage and tappings with a change-over switch to change by steps from 440 and 550 volts ?

Mr. H. **Burge** asked whether the curve showing copper losses of the converter applied to six-phase machines or three phase ? Also, what did "reactance iron in transformers" mean ? He supposed it was some leakage path provided in the transformer. With a direct-current booster it meant adding another commutator equal in size to the rotary commutator. Perhaps it would be feasible to have a separately driven booster run at a higher speed and driven by a synchronous motor connecting the booster with the slip-rings when desired.

Dr. S. P. **Smith** remarked that the difficulty of commutation prevented a designer using the material to the best advantage unless rather intricate methods of obtaining good commutation were introduced, and it was questionable whether these would always be satisfactory. The author spoke of straight-line reactance. He would like to know how the author would get 300 per cent. overload. He could not see how a transformer giving straight-line reactance up to 300 per cent. overload could be designed, unless it was a very abnormal design. He did not think it could have any reactance iron in it, and he would not like to say what the losses would be. If the author was able to keep the saturated iron so that saturation was not reached before full load there might not be very serious trouble, but he believed the saturation would occur much before that point. With the saturated iron a sinusoidal voltage was not added to the sinusoidal supply. The reactance voltage was no longer proportional to the current, and therefore it was no longer a sine wave, and the effect on the rotary might be disastrous. It was not only the booster control that caused an unbalanced magnetomotive force inside the rotor, but if non-sinusoidal E.M.F. were applied to the slip rings of the rotary wattless currents were caused to flow through the converter, and it spoilt commutation. However much one might dislike booster control, it was only fair to emphasise the disadvantages of reactance control when saturated iron was used. With saturated iron in the control sparking trouble was caused.

Mr. F. P. **Whittaker** said most designers agreed with the author's view that the reactance type was the best where the range of voltage was moderate and where the power factor could be changed over a moderate amount. He (Mr. Whittaker) had advocated that type, especially where there was one range of voltage for lighting and another for traction. But where a moderate range of voltage could not be got the author had not left them much of a choice. He said in effect that if more than a moderate range was wanted one had to put up with a machine which had a limited boost, or allow it to spark, or put on commutating pole adjustment devices, or put in a complicated tap switching arrangement with auto-transformers. He (Mr. Whittaker) did not think the landscape was so black. The booster machine was satisfactory if liberally designed; but the booster itself caused discrepancies of commutation which became greater as machines were rated up. However, with the introduction of commutating poles on rotaries, and a better understanding of reactances, the instability of motor-pole armatures and self-inductance, improvements had been made in economising material. Reactance-control machines could be built to-day at a cost out of the question with booster machines, except booster machines with special forms of windings. Though the booster machine was satisfactory if liberally designed, the induction regulator type was cheaper and more efficient. It had not in the past found favour in England because it required external connections, and it often required separate ventilating arrangements; but there were induction regulating machines built to-day where the induction regulator was mounted on the base plate, which were self-ventilating, and which had no external connections, and the regulator did not affect the commutation of the machines. They could be built for a range of 30 per cent. or more without having any effect on the commutation. He was installing 12 sets for operating on a 24-hour day, seven days a week, on full load, and the sets had to take from full-load current over a range of over 30 per cent. He did not think anything but an induction regulator type of machine would meet such conditions so economically or efficiently.

Mr. TAYLOR said (in reference to Mr. Brazil's remarks) he worked out the case of a rotary converter with a direct-current booster mounted on the shaft, and he came to the conclusion that one could not get a leading power factor under both conditions—charge and discharge—using it as an inverted rotary.

Mr. JUHLIN said, in reply to the discussion, Mr. Taylor had rather misunderstood the diagrams in Fig. 1. They were not intended to be representative of voltage, but simply to be typical. The change of the direct-current voltage was effected by the reactance, which was, of course, the usual way. They were rather on difficult ground, so far as power factor correction was concerned, with the inverted rotary. It was clear that leading currents could not be supplied to the line from the rotary, as it was operating purely as a generator. To get regulation when the machine was running it would be necessary to shift the power factor from one machine to the other. He had not considered the inverted rotary so much as the ordinary machine, as it was originally intended for converting from alternating to direct current, and not vice-versa. The advantages for the rotary converter were not as good when running inverted as when running in its ordinary way. Booster rotaries had operated satisfactorily. It was not impossible to make good commutating machines of the booster type, but in that way the material could not be used to the same extent or to the same advantage as in the reactance type, or in a type where some other form of regulation was used. Mr. Brazil described the direct-current booster. The operating conditions of a machine were the same whether the booster was direct current or otherwise, as power was still transmitted to the shaft to or from the booster. No doubt Mr. Brazil had had the advantage of what Mr. Whittaker described as a "liberal" machine, and probably that accounted for the fact that they could get a very large range without ill effects from the booster. Whether the booster was alternating or direct current had no influence on the power factor, which could be changed in the same manner in either case. As Mr. Chattock suggested, leading power factor could be obtained if the tappings were changed. If the rotary were designed always to carry a certain amount of leading current the advantages Mr. Chattock mentioned could be obtained; but changing the tappings on a transformer took time, and was cumbersome. Mr. Woodhouse also raised the question as to the commutation advantages of the booster type. He (the author) had no intention of creating the impression that booster-type rotaries could not be built, but it seemed to him a waste of material if the machine had to be made much more liberal to do a given duty simply because one wished to have a certain form of voltage control, when there were alternatives quite as good and without the difficulties of the booster type. With regard to the booster-type of control with tappings on the transformer, if the intervening gap between 440 and 500 volts was cut out (practically 12½ per cent.—6¼ per cent. on either side), and instead of that a change-over switch provided, the cost would be materially reduced; probably 6-7 per cent. of the cost would be saved. Mr. Burge asked a question about the reactance iron. This was provided in the transformer to form a leakage path, and where a large reactance was required it was almost a necessity. The large leakage flux would cause heavy losses in the copper if it were not controlled within the reactance iron. Separately-driven boosters could be used, but it meant the addition of a driving motor, and probably the cost would not be reduced. It certainly had the advantage of doing away with the interference with the commutating qualities of the machine. The drawback of the direct-current booster was that the full current of the rotary converter had to be carried on the booster commutator. Dr. Smith raised the question as to the straight-line reactance, and referred to 300 per cent. overload. He must have misunderstood. It was 300 per cent. load, or 200 per cent. overload. Up to those loads a straight-line reactance could be obtained. If there was any deviation from the straight line it was so small that it could have no influence. The saturation point of the reactance iron could be controlled by introducing a number of small air-gaps, which he believed was done in transformer design. He also believed reactance iron was used, and that the point of saturation could still be controlled, depending on the amount of overload required from the rotary, so as to have straight-line reactance up to the maximum overload required from the machine. The question of the influence of the saturated reactance on commutation was raised by Dr. Smith. To deal with that interesting question he (the author) would require more time than he had been able to devote to the Paper. He admitted that he had made the picture appear black, as Mr. Whittaker said. He had had in mind that he was only dealing with the two more general types. He agreed that the possibilities of the induction-type regulator had not been finished with; but he suggested that it would probably be more profitable to investigate the possibilities of the booster-transformer type. The cost of stationary transformers, as was well known, was much lower than rotating machinery. The induction regulator was not, strictly speaking, rotating, but it was of the type. The cost of that was, of course, much higher than the transformer type. The efficiency of the transformer would be considerably greater than that of the induction regulator—at least, on the higher loads; but no doubt the induction regulator was exceedingly useful, and required to be taken into consideration.

THE TRAINING AND WORK OF THE CHEMICAL ENGINEER.

At a meeting of the Faraday Society on the 6th inst. an interesting general discussion was held on the training and work of the chemical engineer. Several short Papers were contributed, and these were followed by an animated discussion. The President, Sir Robert Hadfield, F.R.S., who occupied the Chair, opened the proceedings by indicating how wide a field of work was covered by the industrial chemist. Owing to this breadth of field the chemist should begin to branch off early into the line of work with which he intended afterwards to be associated. After giving some amusing personal incidents illustrating the kind of early training which he himself had received, Sir Robert made reference to what was now being done in this country by the Government to aid industrial research. Finally, he outlined the scheme recently proposed in connection with the Ramsay Memorial Fund for promoting chemical training, which included the establishing of a Ramsay Memorial Laboratory for dealing with the very subject they were discussing that evening, namely, engineering chemistry.

A Paper was then read on

"THE TRAINING AND WORK OF THE CHEMICAL ENGINEER."

BY SIR GEORGE BEILBY, LLD., F.R.S.

The author remarked on the very real danger under present war conditions of encouraging the development of unbalanced proposals for the training of future leaders and workers of industry. The chemical engineer would undoubtedly have to play a very important part in industry after the war, but he would only cover one part of the field occupied by chemistry in its industrial application. Chemical engineering had for its function the design and construction of apparatus required for the carrying out of chemical processes on a manufacturing scale. The centre of all chemical activity was the laboratory, and in considering the activities in the laboratory it was evident that there were two types of men. For the first of these the qualities required were wide scientific knowledge, originality and resourcefulness; for the second, sound chemical training, method, quickness and organising power. The remaining portion of the field to be covered in the factory was the process control. As a corrective to a narrow individualism the author was strongly in favour of some engineering training. He outlined a course consisting of three years' training in chemistry and chemical physics, at the end of which time the student would be advised to specialise. No degree would be given until after four years, and chemical engineers, research chemists and specialists in other branches would devote one or two years to higher post-graduate study. Chemical engineers should have a great deal of knowledge and experience quite outside the range of the ordinary engineer, particularly in reference to materials. The points of view of the chemist and the engineer were very different, though both dealt with matter and energy; but they approached the fundamental realities from opposite sides, the engineer dealing with masses, the chemist with molecules. In a certain sense the training of chemists had been intellectual rather than practical. Thus it was that the point of view of the engineer was not so far removed from that of the ordinary intelligent person, but the thoughts and aims of the chemist were for the most part quite inscrutable to the vast majority of his fellow men. It was necessary to have students who had acquired both points of view, and from these the true chemical engineers would be recruited.

The next Paper was on

"THE TRAINING OF CHEMICAL STUDENTS TO WORK IN FACTORIES."

BY F. G. DONNAN, F.R.S.

The author classified chemists into three classes:—(1) chemists research chemists), (2) engineer-chemists, and (3) chemical engineers. Our general practice had been to keep the chemist and engineer apart, but this practice had resulted in enormous damage to progress and efficiency of our chemical and allied industries. The chemist in works held merely a secondary position, because his training had been too narrow and specialised. He could calculate the results of an analysis, but he could not calculate anything else. He lacked the engineering sense. The research chemist was essential, but must be able to co-operate intelligently with the other two classes. Men in class 2 were required in great numbers and they should receive a very considerable amount of engineering training in various subjects, such as the properties of materials, testing of materials, motion of liquids and gases, thermophysics, principles of design, generation of power, fuel economy, calculation of costs and use of engineering tools. In chemical engineering there lay the greatest and most lucrative field of engineering science. The culmination of the training of the engineer chemist should certainly be research, but it should be research on processes. For this purpose educational institutions should have cheap, rough buildings, well supplied with water, power, steam, gas, draught, and drainage. The work of the engineer chemist was essentially applied physical chemistry. The engineer chemist was a chemist not an engineer, but he should be a chemist with a wide knowledge of physical chemistry imbued with the spirit and method of the best type of engineer. He would gain much if he could spend some of his long vacations in chemical or allied factories.

"A PLEA FOR THE FORGOTTEN FACTOR IN CHEMICAL TRAINING."

BY W. R. COOPER, M.A., B.SC.

The author emphasised the fact that although in everyday life the working of a process at a profit was all important, this factor of £. s. d. was completely neglected in technical training. The training generally consisted of purely technical and theoretical matters. The idea of introducing the factor of cost was often distasteful to the teacher, but it was a mistake to imagine that a commercial problem was on a lower plane than one that was purely scientific. Actually the introduction of the factor of cost made the problem all the more difficult of solution. By some it was urged that the question of profit and cost should receive no attention in our educational courses and that the would-be chemical engineer would soon pick up this commercial question when he entered the works, assuming that the need arose for such knowledge. In the case of large works that view might be good enough. The young chemist if he came across the commercial side under these conditions would find himself in good hands, but in small works and in other lines of activity this was often not the case, and the young chemist would find himself called upon to decide on processes along broad commercial lines. It, therefore, seemed a mistake to leave the profit side of chemical operations entirely untouched. The author suggested that a ground work of sound principles might be laid down in a course of three months at the conclusion of the technical course.

"THE TRAINING OF THE WORKS CHEMIST IN PHYSICS."

BY C. R. DARLING, F.I.C.

The author described the training that is given at the City and Guilds Technical College, Finsbury. No college could turn out a finished works chemist, but it could produce a type of man possessing the requisite kind of information and the right outlook and a degree of manipulative skill. It was unwise to give a too great preponderance to the purely technical side, as this led to restricted outlook. The author found, however, that a study of practical applications was the best method of impressing principles. At the Finsbury Technical College such subjects as electrochemistry, osmotic pressure, &c., were dealt with in the Chemical Department, either following or in parallel with the instruction in sound, light, heat and electricity by the applied physics staff. A large portion of the syllabus was devoted to heat, as this was extremely important, and one set of lectures was devoted to fuels and their uses. Special attention was given to refractory materials and to pyrometry. There was also a course of lectures on the principles of electricity and practical applications. Harm had resulted from the scientific men holding aloof from research of a commercial character. This had led to the common belief that science was something apart from daily activities, and hence the low esteem in which science students were held, and the generally low remuneration they received.

The concluding Paper was on

"THE WORK OF THE IMPERIAL COLLEGE IN THE TRAINING OF ENGINEERS."

BY J. W. HINCHLEY.

The principles on which the work of the Department of Chemical Technology had been inaugurated was that the studies should be post-graduate in character, that only principles should be taught, and that mechanical drawing, workshop practice, factory organisation and economics should form an integral part of the course. The author did not agree with Prof. Armstrong's recent declaration that the study of chemistry and engineering were antagonistic in character, and that there should be merely co-operation between those branches. His experience was otherwise. One of the principles upon which the practical work of the course had developed was that it must involve self-teaching by the student himself. The student was required to compile a reference book of information. He was taught to use the most efficient methods of calculation, to make himself familiar with methods of handling technical problems, to determine coefficients used in designing, to make drawings of plant, to study plant experimentally, to prepare specifications and estimates, to determine the cost of production and to devise a system of factory records and plans for a factory. The training could not take the place of the factory, but it planted the necessary seed.

DISCUSSION

Sir **ARTHUR DUCKHAM**, in opening the discussion, remarked that in addition to the pure chemist there was the chemist who was something of an engineer. The latter should not go too far in engineering, but should be able to think as an engineer, and the chemical engineer as distinct from the engineering chemist should have a good idea of chemistry. The workshop should be brought into the college and lectures should be given by men carrying on various processes. He was sorry that the subject of fuel had not been emphasised in the papers, as almost every problem seemed to come ultimately to the fuel question.

Prof. A. K. **HUNTINGTON** thought that the question of whether a process paid went to the root of everything, and no apology was needed for the introduction of this principle into the discussion. The student should consider all problems in this way. On the other hand, what did not pay to-day might pay to-morrow. He felt that the terms "works engineer" might be a better term than "chemical engineer." Inferior secondary education of this country was responsible for much and if it were better a five years' course would not be necessary. The practical man had largely been responsible for the antagonism between science and practice.

Mr. A. P. M. **FLEMING** expressed the view that some of the engineering training should be gained in the works. The student there learned to understand men. He thought that courses similar to those adopted by the Massachusetts Institute of Technology might be followed in this country. He was not well acquainted with research in the United States as regards chemistry, but in other industries we might still feel apprehensive as to how we should stand in the future in competition with the U.S.A. He had not found the young chemist who came to the works of very much use, but he was now putting chemical graduates through a two years' course in the works to get them fully acquainted with the processes and at home with the men. The latter was important. Works investigations carried out by graduates in conjunction with professors were an advantage and gave the chemist an idea of cost. There was no question that they wanted the best brains, but sufficient monetary attraction must be offered.

Dr. W. **ROSENHAIN** was of opinion that breadth of view was important and this was best obtained by having a double course. In fact he had found that the best men were those who had followed one course to a considerable extent and then changed their minds and gone in for another course. This led to breadth of view. It was essential not to be hide-bound.

Mr. **ROBERTSON** thought that the meeting would prove a landmark, specifying a new class of chemist. The need for the engineer-chemist would increase largely in the future and he thought that a course of engineering should be introduced into every chemical course. This would enable the professor to decide what students to select for specialisation. Contact with the works was also most important. The student should go through every part of a process in the works and thus learn something of works management.

Mr. W. **MCNAB** said that the country had never had such an opportunity for branching out in chemical engineering as at present. There was, however, a sad lack of engineering chemists.

Prof. E. G. **COKER** thought that engineering courses for chemists should be permissive. The chemist with an engineering mind was what was wanted. There was nothing worse than to teach men engineering who did not wish to know anything about it. Engineering courses should be specialised to suit the chemist. As to American programmes he hoped that the specialised courses there in vogue would not be adopted in this country. There should not be too many subjects.

Lieut. **GREENWOOD** was of opinion that the chemist played second fiddle in the works on account of wrong training.

Mr. C. S. **GARLAND** said that students should rub shoulders with other men in works and thus get to know their own value. Proper monetary inducement was a most important thing.

Dr. E. F. **ARMSTRONG** was of opinion that the human factor must be taken into account. Many students had a liking for engineering and should be encouraged in this direction as they would make ideal plant-chemists. The research chemist was a man in a thousand. What was wanted was chemists. They could not know too much chemistry, but the engineer could not work in with the research chemist, though he could with the engineer-chemist. The manufacturer should be introduced into the university and should have a place on the board as an adviser.

Mr. W. Gathorne Young thought the meeting would prove to be epoch making and that courses would be worked out on the lines indicated by Prof. Donnan. If a student showed no aptitude after three years he should not proceed to chemical engineering. If suitable, he should follow the post-graduate course of work with manufacturers.

Mr. P. G. Elliott emphasised the importance of secondary education.

LIFTING MAGNETS.

Several well-known makes of lifting magnets were described in these columns some time ago.* From information recently to hand it appears that a great many magnets made by the Electric Controller & Mfg. Co., of Cleveland, Ohio, are giving satisfactory service. This company has been engaged in the development and manufacture of lifting magnets for over 19 years, and up to November, 1915, no less than 1,163 lifting magnets had been sold, divided approximately as follows:—

Steel works and blast furnace service	586
Iron and steel foundry service	123
Railway service	146
Miscellaneous manufacturing service	308

Amongst the principal users may be mentioned the Carnegie Steel Co. (56), the Illinois Steel Co. (47), the American Steel & Wire Co. (44), and the Bethlehem Steel Co. (24).

It is estimated that these 1,163 lifting magnets are now making a direct saving of about half a million sterling annually in labour costs alone, and it is said to be no uncommon thing for a single magnet to effect a saving of from £2 to £8 per day.

In addition to the direct saving in labour, the following indirect economies may be mentioned:—

(*a*) Ability to pile stock to any height, limited only by the clearance of the crane. This augments the capacity and value of a given stock yard over one served by hand labour, where a stock pile of any considerable height becomes prohibitive owing to the cost of handling material. The introduction of one or more lifting magnets frequently makes it possible largely to increase the capacity of a given plant without increasing the size of the stock yard or the number of cranes in service.

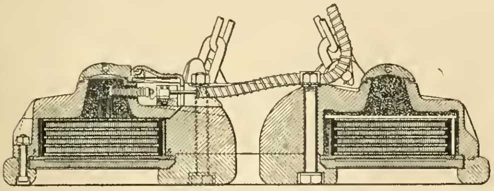

Fig. 1.—Cross-section of Lifting Magnet.

(*b*) Ability to "make up heats" promptly in an open-hearth or foundry stock yard, thus increasing the output of the furnaces, decreasing the consumption of fuel in keeping empty furnaces hot, and decreasing the labour and fuel cost per ton of output.

(*c*) Saving in demurrage on railway wagons. It is not at all uncommon for a single operator to handle a 50-ton truck of pig-iron in 15 minutes.

(*d*) Delays in unloading or rehandling stock under inclement weather conditions are avoided.

In the design and manufacture of lifting magnets it has been the aim of the Controller & Mfg. Co. to produce a tool which would most satisfactorily meet operating conditions.

The latest type, which was introduced about six years ago, is depicted in Fig. 1. The magnet is permanently waterproof and fireproof. It is provided with a renewable bottom plate of manganese steel, which may be easily removed and replaced without exposing or disturbing the coil in any way. The coil cannot move in any direction in the case, and is cushioned against the effect of hammer blows by the double bottom-plate construction. Ribs on the top and sides of the case serve not only to stiffen the case and to decrease the magnetic resistance, but also largely to increase the cooling surface. The large cored hole in the centre pole acts as a very effective ventilating duct.

The magnet coil is strap wound, and is heavily insulated with mica and asbestos and thoroughly impregnated. It is wound directly upon a flanged aluminium or metal spool, the flange forming the inner waterproof bottom plate being screwed to the magnet case, so as to prevent rotary or lateral movement of the coil. Four radial clamps are used to prevent vertical movement of the coil. The spool construction makes the coil a rigid unit that may be handled without danger of mechanical injury. The coil terminals are spread 120 deg. apart, and are moulded into heavy high-voltage insulators babbitted into the case. Terminal cavities are large, allowing for expansion and contraction of the insulating compound, and a third reservoir is provided, insuring about 2 in. of compound between terminals and case. This construction gives 4 in. of insulating compound between terminals as a protection against short circuits.

The terminal cavities are cast integral with the magnet case, and are heavy enough not to be broken by catching under truck bodies or knocking against heavy pieces, such as ingots. The heavy cast-steel terminal covers are attached by four bolts, which pull down against a gasket. A cast-steel hinged lid protects the external parts of the terminal. The inner and outer pole shoes are of massive design, and are recessed into the magnet case to prevent shearing strains coming on the bolts. Large clearance spaces are provided at both these shoes so as to prevent the possibility of the outside bottom plate being riveted in.

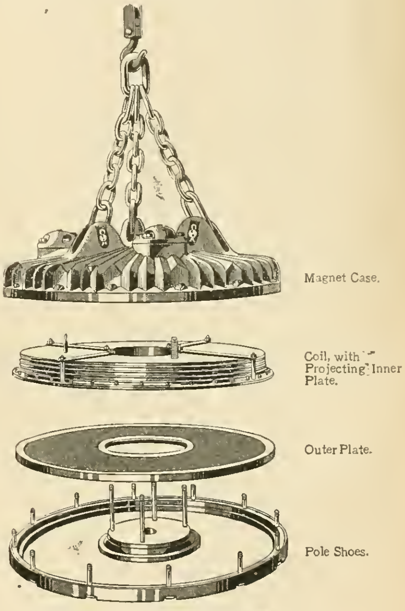

Fig. 2.—Assembly View of Lifting Magnet.

A good idea as to the arrangement of the several parts will be obtained from the assembly view shown in Fig. 2, and the ratings of four of the magnets are set out in the accompanying table:

Diameter of magnet, inches	36	45¼	55½	65
Head room required, inches	40	43	48	48
Weight, complete, pounds	1,300	3,500	5,600	7,600
Average current at 220 volts	11 amp.	27 amp.	49 amp.	61 amp.
Material.	Lifting capacity, in lbs.			
Billets and slabs	20,000	32,000	42,000	50,000
Skull-cracker balls	12,000	15,000	20,000	30,000
Single ingot	6,000	6,000	8,400	16,000
Pig iron	550	1,200	2,000	2,500
Heavy melting stock	750	1,250	1,900	2,500
Boiler-plate scrap	600	1,100	1,650	2,300
Scrap tubing	200	500	750	1,000
Loose iron or lamination scrap	200	500	750	1,000

The control equipment consists of a master controller, provided with three points marked "lift," "drop" and "off"; a double-pole magnet switch for handling the main current, this switch being specially designed to break the highly inductive arc; and a resistor for limiting the reverse current in releasing the load.

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* The Electrician, Vol. LXXVII, p. 623.

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FOREIGN TRADE AND FOREIGN INVESTMENT.

The Council of the Institution of Civil Engineers have recently adopted the policy of giving lectures on certain subjects which would otherwise be outside the scope of the Institution. The subjects selected are important at the present time, when all of us should pay attention to matters concerning the welfare of the country apart from our individual professions, and we are glad to see that the Institution is adopting this policy. The first lecture of this kind was delivered by Mr. HAROLD COX, and dealt with the relations between Capital and Labour. Last Tuesday the second lecture was delivered by Mr. EDGAR CRAMMOND, his subject being "Foreign Trade and its Relation to the Investment of Capital Abroad."

Those who attended Mr. CRAMMOND's lecture must have been struck by the stupendous figures which he put before them. It was shown that at the end of 1913 our colonial and foreign investments amounted to £3,554,000,000, exclusive of capital privately invested, which probably amounted to another £350,000,000, making an aggregate of £3,904,000,000. The £3,554,000,000 was made up of £1,770,000,000 in British dominions and £1,784,000,000 in the rest of the world. These investments were spread over various parts of the world, and we may certainly congratulate ourselves that the main part of them was invested in countries remote from Europe. The amount invested from 1897 to 1913 inclusive was £1,659,000,000, the annual amount varying from £38,000,000 in 1897 to £185,000,000 in 1912. To those who are not engaged in finance it may be difficult to arrive at the exact method of investment. Mr. CRAMMOND states that the true source of these investments is the income from investments abroad, the earnings of our shipping industry and our great banking and mercantile houses engaged in international finance—not the transmission of gold. Whatever the source may be, the figures show in a striking way the enormous wealth of the country, and explain the financial stability of the Empire. The fact that British capital invested abroad was over £1,000,000,000 before the war, whereas corresponding German investments were £1,000,000,000, showed the difference between the two countries in this respect.

One of the points particularly emphasised in the lecture was the extreme importance of our shipping industry. Mr. CRAMMOND expressed the hope that every influence would be used to ensure that the men who built up our mercantile marine to the enormous proportions it attained before the war would be given every facility to restore the marine fleet to its former pre-eminence. This point of view is evidently thoroughly appreciated by Germany at the present time. It remains to be seen whether the Government will adopt a policy helpful to the shipping industry, or whether there will be some absurd attempt to minimise the profits and increase the difficulties of private enterprise.

Mr. CRAMMOND expressed the view that scientific direction was necessary in regard to the investment of capital abroad. It was desirable that such investments should be made from the point of view of the Empire, but not from that point of view solely. At the present time if our foreign investments had all been in the Empire our position in relation to neutral powers would not be so strong as it is, with which opinions we agree. Possibly the establishment of a British trade bank, as recommended by Lord FARRINGDON, would be a step in this direction, but so far nothing has been done, and the fact that it is now some months since the recommendation was made does not augur well for this important suggestion. As Mr. CRAMMOND states, investments abroad should be directed to the economic development of the Empire, to increasing our exports and manufactures and to increasing our supplies of foodstuffs and raw materials.

The question is often asked: Is it desirable to invest capital abroad? As often as not, the reply is in the negative, the suggestion being that investment of capital abroad is equivalent more or less to starving our home industries. Obviously if our home manufacturers do not obtain a fair share of capital, the state of affairs is unsatisfactory. It means that expansion in this country is not what it should be. On the other hand, it is practically impossible to have artificial direction of capital. It cannot be forced, and inevitably flows to those countries where the best return can be obtained for a given risk. If the manufacturers of this country are unable to obtain sufficient capital it shows that the return they offer is not sufficiently good, and behind this lies the suggestion that their working is not efficient. Of course, for this statement to be true our manufacturers must work under conditions equivalent to those of their competitors abroad, taking everything into consideration, but the fact remains that no tariff, however large, can permanently take the place of efficiency.

In the discussion that followed the reading of Mr. CRAMMOND's Paper various views were discussed, and these our readers will find recorded in another column. In conclusion, however, we feel we must refer to what we consider the fallacious views put forward by Mr. HAROLD COX. Mr. COX stated that the desirability of a country being self-supporting had been shown to be fallacious by the present state of Germany. In Germany they had attempted to be self-supporting as regards food, but they were now in a worse condition than we in this country, notwithstanding the fact that we had never sought to be self-supporting in this respect. This argument is surely a fallacy in itself. If Germany were less self-supporting than she is, the lack of food would certainly be felt to be greater than it is. On the other hand, if we in this country were more self-supporting as regards food, the immediate future in this respect would not be so serious for us as is being constantly pointed out by the Food Controller. The fact is that the conditions of the two countries are due solely to the power of the British Fleet. We may congratulate ourselves upon the position we have been able to attain on this account. That, however, is no reason why we should not be self-supporting in commodities that are essential. It is sufficient to state that if Germany had been as little self-supporting in the matter of materials for explosives as we were ourselves, the war would have been over long ago. The scientific development of the Haber and similar processes has enabled Germany to do without imported nitrates, and so has saved the situation so far as Germany is concerned. We cannot, however, argue on that account that we should take no similar precautions. Do not let us attempt to be entirely self-supporting, but let us be reasonably so in the commodities that are essential for national safety.

THE APPLICATION OF RADIO-TELEGRAPHIC METHODS OF RECEIVING FOR CABLE TELEGRAPHY.

BY LOUIS W. AUSTIN AND LOUIS COHEN.

The problems arising in the development of suitable instruments for the reception of signals in cable telegraphy and radiotelegraphy are very closely related. In either case the, currents available at the receiving end are of very small magnitude, and in both cases sensitiveness and reliability of operation of the receiver are essential.

In the case of cable telegraphy direct currents or alternating currents of very low frequency, as in the Squier system, are used, while in radiotelegraphy currents of high frequencies are employed. It does not follow, however, that because currents of different character are employed in the two systems of telegraphy that the same types of receiving instruments may not be used.

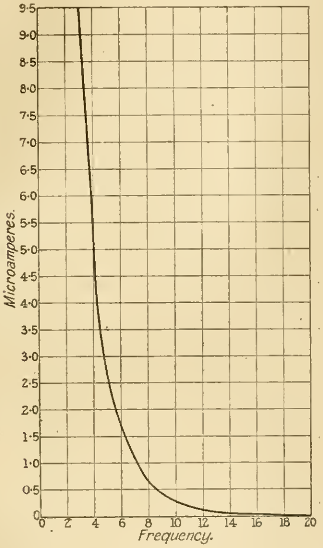

FIG. 1.—SHOWING DEPENDENCE OF RECEIVED CURRENT ON FREQUENCY.

It is well known that the receiving instruments in radiotelegraphy, particularly the Audion and Ticker types, are of a far higher order of sensitiveness than those used in cabling, and it occurred to the writers that the same detectors may be also employed to great advantage in cable work. Experiments carried on in our laboratory demonstrated that the Audion or Ticker will make a suitable and by far more efficient receiver than those employed now in cable telegraphy. With these receivers we can make use of either of audible reception or recording. We have found that the Audion operates as an oscillator for any frequency even below the range of audibility, and by associating with it an oscillating circuit of suitable electrical constants, it can be made to oscillate with an audible frequency, the note of which is heard in telephones connected to it in the usual way. The received signal modifies the oscillatory current, and the variation thus produced is heard in the telephones. Or the Audion may be adjusted for the critical point just short of oscillations, and the effect of the received signal is to start momentary oscillations in the Audion. In such an arrangement a current of 1 microampere is more than ample to give a readable signal, and even less than 1 microampere will suffice.

In case of the Ticker method the operation is somewhat different, the function of the Ticker is merely to interrupt the incoming current, rendering it audible, and thus make it possible to use telephones for the reception of signals. We have employed the slipping contact Ticker which was used by one of the writers * a good many years ago for rendering direct current audible in telephones, and later for receiving radio signals. In the use of the Ticker we also found that less than 1 microampere will suffice to give a good readable signal.

In either of the above methods audible reception is not essential. Good results may be also obtained by using recording devices in place of the telephones, the recording device being preferably connected through a transformer to the detecting instrument. Further increase in sensitiveness may be obtained by using an Audion amplifier with either of the detectors mentioned above.

It is obvious, of course, that higher sensitiveness of receiver is desirable in any system of telegraphy, but it is particularly valuable in connection with the Squier system. In the latter system the speed of signalling is directly proportional to the frequency of the current employed, but for the same transmitting voltage the current at the receiving end decreases very rapidly as the frequency is increased. In Fig. 1 a curve is given, showing the decrease in received current for a Transatlantic cable for increasing frequency. For a frequency of 20 the current at the receiving end is about 0·3 microampere for 100 volts at the transmitting end, and, therefore, it is only with highly sensitive detectors that any such frequency could be employed for cable work.

The combination of the use of alternating currents and highly-sensitive detectors offers the additional great advantage that the solution to the problem of multiplexing can be realised. It must be remembered that in direct-current cabling all improvements in regard to increase in sensitiveness and speed are controlled by the accuracy with which the duplex bridge may be balanced. The opening and closing of the circuit in signalling introduces transient effects which are difficult to balance accurately. This was recognised by Col. Squier, and he brought it out very clearly in his Paper in the following statement † : "In the last analysis it was always the opening and closing of the transmitter circuit which produced the final kick or 'jar' in the balance. This is not surprising when we remember that, from an electrical standpoint, few things can be done to a circuit more severe than suddenly to introduce an infinite resistance into it. . . . It was only after many variations of the simple alternating current had been tried in the course of experiments to perfect the duplex balance of the bridge that the fundamental principle of never breaking the transmitter circuit became impressed." The use of an unbroken alternating current eliminates many of the difficulties in balancing which were considered heretofore as inherent in duplex cabling, and also simplifies the problem of multiplexing.

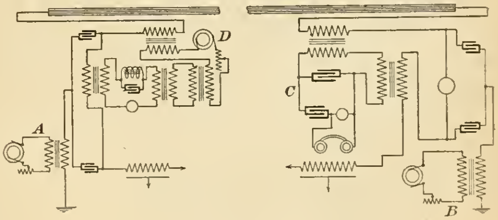

FIG. 2.—ARRANGEMENT OF CIRCUITS.

In conjunction with Col. G. O. Squier the writers developed a method in which an extra simplex system is superimposed on a Squier duplex cable. The arrangement of circuits used is shown in Fig. 2. As is seen, we have at the two ends of the cable stations A and B equipped for duplexing, and in addition we have stations D and C, where one acts solely as the transmitter and the other as the receiver, constituting the super-

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* L. W. Austin, "Physical Review," Vol. XI., p. 117, 1900; "Physical Review," Vol. XXIV., p. 509, 1907; "Journal" Wash. Acad., Vol. I., p. 8, 1911.

† G. O. Squier, "On an Unbroken Alternating Current for Cable Telegraphy," "Proc." Phys. Soc. of London, Vol. XXVII., p. 541.

imposed simplex system. In the simplex system, which we designate by D C, audible reception is used. The frequency of the current may be either within the range of audition or below audition, and rendered audible at the receiving end by a Ticker or an Audion, the frequency of the current being comparatively high, say, 15 or more. The current used in the duplex system is of low frequency. The two receiving circuits at B and C are tuned for the corresponding frequencies of the signals which are to be received at the respective stations, and since the frequencies used in the two cases are considerably different, the tuning of the circuits will insure responsiveness of each receiver only to the current of the signal, which is to be received at each station.

To eliminate the effect of transmitter B in receiver C, the receiving circuit is coupled to the bridge arm of the artificial cable as well as to cable, and the secondaries so connected as to induce equal and opposite E.M.F.s in the receiving circuit, thus neutralising the effect of transmitter B on receiver C. A little different arrangement is employed to eliminate effect of transmitter D on receiver of station A. In addition to double transformers, which neutralise each other's effects, a loop circuit tuned to the frequency of transmitter D is also introduced in receiving circuit of station A, thus rendering it opaque to currents of frequency produced by station A. In this way it becomes perfectly feasible to superimpose an extra simplex circuit on a duplex cable. By suitable modifications of transformers and tuned circuits, and also making use of different frequencies, it is possible to develop a system in which a number of simplex systems are superimposed on a duplex cable.

We have only given a general sketch of the work being carried on in making use of these new types of detectors and multiplexing for cable telegraphy. Various arrangements and modifications are being developed, but cannot be discussed at present in detail. It was thought, however, that it would be of interest to engineers to bring to their attention this new development work in cable telegraphy, and we hope at another time to discuss the subject more fully.

In all this work we had the valuable co-operation of Col. G. O. Squier.

CORRESPONDENCE.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

In your issue of the 2nd inst., a correspondent states that for several years he has kept his accounts on a decimal basis, taking the florin as the unit. Because of that fact he ridicules the picture of a grocer trying to explain to customers that 3s. 6d. is 1 florin 75. Thus is the issue confused for which we are fighting. We are not concerned with the difficulties of expert accountants, possessing the advantages of education, pens, ink and paper. But we have to reckon with coins in the hands of the masses and the capacity of those masses for mental arithmetic. Those are the people who are going to spell success or failure for the decimal movement.

The reason for the ease with which British and French coins can be used indiscriminately in the Channel Islands is obvious. The coins are made arbitrarily interchangeable on the basis that one sou equal one penny and one franc ten pence. To save the situation there is a premium of two sous payable on every shilling if the change is given in French money on the basis named.

If we must have new measures of value such as the florin would it not be better for us to be sensible and go the whole hog, by entering the Latin Monetary Union. Our new silver and gold coins would then be interchangeable with France, Belgium, Italy, Switzerland, &c. During the transition period, for home use, we could work on the system that now applies in the Channel Islands, but for the sake of progress get rid of the absurd fallacy that there is anything sacred about the British sovereign. The world's basis of value is gold. Gold of 21 carats. Turning gold into sovereigns does not increase its value. On the contrary, in our case it becomes a piece of gold of 22 carats only. When stamped it is hall marked by the British nation as to its weight and fineness. When it is shipped abroad its value as a coin has gone, for it is weighed and priced as metal.

London, March 6. G. O. PARSONS.

THE ENGINEERS' CLUB, MANCHESTER.

TO THE EDITORS OF THE ELECTRICIAN.

From your report of Mr. Hill's recent lecture before the Engineers' Club, Manchester, it appears he gave a quite erroneous impression of the initiation of that Institution. This is to be regretted, since the means so successfully adopted would most likely yield as good results in the other centres mentioned as contemplating the founding of similar clubs, and therefore deserves publicity.

The starting of an Engineers' Club was a favourite theme of conversation for engineers in Manchester for many years, and one or two abortive attempts to float one were made.

The successful scheme was initiated by the local committee of the Institution of Electrical Engineers, who instructed their Honorary Secretary to communicate with the committees of the other technical societies in the district and ask them each to appoint four of their members to meet and discuss the question with a similar number of their members. This was done and the gentlemen so nominated formed what was known as the "Preliminary Committee," who not only carried out the work involved in bringing the Club into existence but (with the aid of one or two other gentlemen) also advanced the necessary money for the purpose.

Mr. Green, the Assistant Secretary to the Local Section of the I.E.E., acted as Secretary to this "Preliminary Committee."

Manchester, March 6. ORIGINAL MEMBER.

FOREIGN TRADE IN RELATION TO THE INVESTMENT OF CAPITAL ABROAD.

Mr. Edgar Crammond, in the course of his lecture on this subject at the Institution of Civil Engineers on Monday, said the early command we obtained of the carrying trade, and the enormous profits therefrom, enabled us to accumulate a fund of loanable capital and make use of the most profitable field for its employment. From about 1830 or 1840 our foreign and colonial investments rapidly increased. The Commissioners of Inland Revenue earmarked as the income of this country in the year ended April, 1914, from colonial and foreign investments £118,113,703. This did not include concerns (other than railways) having their seat of direction in this country, concerns worked jointly abroad and in this country, mortgages of property, &c., abroad belonging to concerns in this country, or profits on business done abroad by firms in this country, which were estimated to amount to at least £95,000,000. At the end of 1913 our colonial and foreign investments amounted to £3,554,000,000, exclusive of capital privately invested, which probably amounted to another £350,000,000, making an aggregate of £3,904,000,000. The £3,554,000,000 was made up of £1,770,000,000 in British dominions and £1,784,000,000 in the rest of the world, including upwards of £600,000,000 in the U.S.A. Great Britain had no reason to regret having invested her savings in countries in the main remote from Europe. From 1896 to 1911 the value of our investments abroad increased by £1,162,000,000, and the income from abroad identified by the Commissioners of Inland Revenue was £54,901,000 and £118,113,000 for those years respectively. Assuming similar increase in the income not earmarked, the total increase in income between 1896 and 1913 was £126,000,000, which, capitalised on the basis of 5 per cent., was equivalent to a capital sum of £2,520,000,000. It was a fairly accurate estimate to say the amount of British capital invested abroad from 1897 to 1913 inclusive was £1,659,000,000, the annual amount varying from £38,000,000 in 1897 to £185,000,000 in 1912. The official returns did not support the conclusion that these investments abroad were made by means of the export of gold and silver. Imports of treasure from 1902 to 1911 exceeded exports by £29,918,000. During the same years the amount of capital invested abroad was £1,161,000,000, while imports of commodities exceeded exports by £1,542,323,000. The true source of these investments was the income from interest on investments abroad, the earnings of our shipping industry, and our great banking and mercantile houses engaged in international finance. The Board of Trade returns did not reveal these "invisible" exports and imports. The earnings of our shipping industry in 1913 were estimated at £162,000,000, of which £100,000,000 must have reached the United Kingdom. Our enormous share of the carrying trade was intimately bound up with the position London enjoyed as the monetary centre of the world. There were 46 great Anglo-colonial and Anglo-foreign banks engaged in financing the trade of the Empire and of the world. Their aggregate capital and reserves amounted in 1916 to £107,000,000, the property of British subjects, and there were other houses employing many millions of capital in financing international trade. These activities would not be possible without the facilities afforded by British shipping. The Right Hon. F. H. Jackson said our carrying trade was one of the forces which created the demand for the draft on London in every country of the world. Underwriting also brought a great income to this country. The revenue of our marine insurance companies and Lloyd's from underwriting ships and cargoes was over £20,000,000 a year. Shipping and allied trades employed 830,000 persons, and the capital employed in those trades was £990,000,000. Our trade balance for 1912 showed credits £1,004,143,000 and debits £1,026,208,000, but this did not take into account the value of fish landed at British ports (£13,234,000), imports and exports of precious stones (net imports about £4,000,000), nor pensions paid in England by the Indian Government (over £2,000,000). The Board of Trade returns for the past 30 years, with the data available as to the investment of capital abroad, established clearly the dependence of our exports upon the amount of capital lent to foreign and colonial debtors. The contraction of credit due to crises in the colonies and foreign countries caused a decrease in our exports from £263,000,000 in 1890 to £216,000,000 in 1894. From 1904, when the South African war ended, capital was poured out by this country at an unprecedented rate. Statistics for 1900 to 1913 showed that in years when we invested capital abroad on a large scale the excess of imports over exports was comparatively small, while the excess was appreciably greater when smaller amounts of capital were invested abroad. In 1900 the amount of capital so invested was £45,000,000; excess of imports over exports, £168,790,000. In 1912 the amount invested was £185,000,000, and the excess of imports over exports £145,678,000.

Of course other factors, such as increase of population and increase of index prices also affected the position. As regarded the influence of investment of capital abroad upon the growth of our national wealth, Sir Robert Giffen, in 1885, estimated our national wealth at £10,000,000,000, including £1,300,000,000 invested abroad, and he (Mr. Crammond) estimated on similar lines that the respective figures at the end of 1911 were £16,000,000,000 and £3,800,000,000, which showed that out of a total growth of wealth of £6,000,000,000 no less than £1,500,000,000 was due to increased value of investments abroad. As the proportion of our wealth abroad increased the peoples of these islands would become more and more dependent upon these investments for the maintenance of their well-being. The investment of capital abroad had provided a magnificent field for the employment of the sons of our middle class as engineers, managers, &c., and it also exerted a stimulating influence upon our shipping and shipbuilding industries.

Investments abroad should be directed to the economic development of the Empire, to increasing our exports of manufactures, and to increasing our supplies of foodstuffs and raw materials. These conditions had not been strictly observed. Before the war emigration from this country was proceeding at the rate of 300,000 per annum, and it was to be feared that after the war it would be greater. The countries to which we were exporting capital were, as a whole, increasing their manufacturing production more rapidly than their agricultural production. New conditions created by the war had made our adoption of a new economic policy essential. We had opened our money markets to the whole world, thrown down all barriers to free trade, and become dependent upon foreign supplies of foodstuffs and raw materials to the extent of three-fifths of our requirements, and we became dependent upon Germany for commodities vital to our greatest industries. The total amount of our foreign investments was approximately the same as before the war, though there had been a heavy depreciation in some of them. He hoped his hearers would use their powerful influence to ensure that the men who built up the mercantile marine to the enormous proportions it attained before the war would be given every facility to restore the merchant fleet to its former pre-eminence. It appeared to be an indispensable feature of our post-war policy to divert to the United Kingdom as much as possible of the raw material formerly exported to Germany and Austria-Hungary, but we could not rely solely upon the overseas dominions for all our raw material, at least for many years to come. The Master of Balliol recently referred to our being "at the very edge between two periods, one of blind growth and the other to which we should apply systematic study, scientific method, statistical tests, and even experiment and verification by results, when progress would begin to march." Scientific direction was necessary in regard to investment of capital abroad. There were few purely British issuing houses in the City of London. It was of urgent importance that the British Trade Bank, recommended by Lord Faringdon's Committee, should be established quickly. The world-wide character of our trade relations before the war had been of enormous advantage during the past two and a half years, and he thought if our foreign investments had all been in the Empire our position in relation to neutral Powers would not be so strong as it was at present. He advocated a moderate import tariff, and the adoption of an Imperial economic policy, with due regard to our obligations to our Allies and safeguards against German competition. He believed a Channel Tunnel would be very damaging to British shipping, and that Continental ports would benefit at the expense of British ports. He thought we should still have large amounts available for investment abroad, and that there would be a tremendous demand for them in all parts of the world after the war; but the capital should not be allowed to be used to develop foreign manufactures at the expense of British manufactures. For this reason it was desirable that the British Trade Bank should be placed upon a working basis at the earliest possible moment.

DISCUSSION.

Dr. **Dugald Clerk** said it was difficult to follow Mr. Crammond's figures without a table of them, but he had studied the subject to some extent and had come substantially to the same conclusion—that our exports of capital had been perhaps the most beneficial circumstance in our favour at the beginning of the war, at which time British capital invested in foreign countries was over £4,000,000,000, while the German investments abroad were £1,000,000,000. This enabled the exchange to be kept in a relatively favourable position and enabled us to find money and goods for other countries. When one considered that our population in Britain was 46 millions and its food to the extent of three-fifths came from abroad he thought we had been very successful in feeding that population. Germany and Austria were probably more self-supporting, but when the war came upon them they soon got into difficulties, which showed that it was necessary even for a country with a large area of land to keep up communication with outside. In an address to the Victorian Chamber of Manufacturers last year Mr. Herbert Brooks said the ideal of Australian manufacturers was a self-contained Commonwealth in a self-contained Empire, but that had not been the object of the British Empire, which would not have been fed at all if it had followed that policy. He thought the future of the country depended more on the engineers, who were stationed all over the world, than upon our soldiers. He did not approve of limiting our efforts to the Empire. The creditable way in which this country had come out of a terrible ordeal was largely due to the work of financiers and engineers abroad, and another element in obtaining our favourable position was the ocean going tramp. Mr. Crammond was right in saying that before everything we must get hold of the shipping industry. It was not possible to plan everything in advance. The Germans attempted it and failed. A certain amount of co-ordination was necessary, but if the co-ordination was too great there might be a stupid person at the top of the co-ordinated things who would ruin the scheme.

Mr. **Harold Cox** said he agreed that our extraordinary progress had resulted from the unco-ordinated efforts of manufacturers. The Germans were in greater difficulties than ourselves as regarded food because they had tried to make themselves self-supporting. France was also suffering more than ourselves from a similar cause. He agreed with Dr. Dugald Clerk that we were better without too much State control. Our ability to bring increased wealth to this little island was due to our having exported brain power, but not the brain power bred in Government offices. He agreed that we should not adopt a policy which would be detrimental to our allies and we must not use the force of our arms to deprive our enemies of a chance of selling their goods where they could sell at a profit. He would rather trust the blind growth of the Empire—or rather the instinct of the people—than growth directed by politicians.

Mr. W. H. **Ellis** (Master Cutler of Sheffield) said it was important to have substantial representatives in foreign countries to keep us well advised of the requirements of those countries and to keep those countries *au fait* with our possibilities as manufacturers and engineers. Much of the talk about limiting the powers of our enemies to supply other countries was premature. We might dictate terms as regarded some portions of the world, but it would force Germany to trade in certain other countries to such an extent as to make our position as competitors very difficult. Even after obtaining reliable information regarding requirements abroad there was a scramble and the order was often secured by an English firm at a price not worth having. We should take our competitors into our confidence. No shipping should be allowed to enter British ports on terms more advantageous than those applying to British ships. Before a new National Bank for Foreign Trade was established we should satisfy ourselves that the present banks were not sufficient. They had a greater knowledge of the conditions than a new bank would have.

The Hon. Sir **John McCall** (Agent-General for Tasmania) said he was satisfied that the prosperity of this country had been brought about by the sale of its assets, such as coal. He did not think sufficient had been said with regard to industrial organisation. During the 10 years he had been here he had not seen sufficient effort to make this an industrial country like Germany. Home industries should be supported. His Government gave orders to British manufacturers at prices higher than Krupps quoted, but he found Corporations in England were sending orders to Germany. He approved of a tariff on imports. It did not stop trading. We had traded with Germany and with America where there was a high tariff.

The Hon. F. W. **Young** (Agent-General for South Australia) said he had somewhat free trade instincts but he had had to adjust his ideas. He was inclined to differ from Mr. Harold Cox as to trusting the individual instinct of traders without control. How would we have fared if Germany had postponed the war 15 or 20 years? He did not think the idea that food could easily be got abroad absolved any country from the duty of providing its own food. The question of emigration must not be lost sight of. For some time after the war the available ships would be carrying home the men who had been fighting for us and there would be more space available in ships for emigrants to foreign countries than for the colonies. Precautions should be taken against that. The double income tax would have to be removed if this were to remain the great monetary centre of the world.

Sir **Robert Hadfield** said we had nothing to fear from Germany if we put our shoulders to the wheel. He invited the Agents-General to go to Sheffield where they would see we could beat anything the Germans had. The Federation of British Industries which had now 350 members was going to do its best to improve the consular service. The Germans had pulled together more than our manufacturers in obtaining contracts. There was much work for engineers to attend to in connection with this country, such as the Channel Tunnel, improvement of canals, construction of better motor roads.

Mr. **Hamilton Wickes** (H.M. Trade Commissioner for Canada) expressed the opinion that organisation and control was very necessary. If Germany had not declared war when she did she would have swallowed us up in 10 years. She was getting at the sources of the raw material and securing them. He referred to a case where Germans obtained a contract in Canada at a lower figure than those quoted by others, but they got all the renewal and repair work and the Canadians were under an agreement to pay penalties if they obtained any of it from America.

LEGAL INTELLIGENCE.

British Thomson-Houston Co. (Ltd.) v. Duram (Ltd.)

This case came before the Court of Appeal (the Master of the Rolls and Lords Justices Warrington and Scrutton) last week, upon the appeal of plaintiffs from a judgment of Mr. Justice Astbury in favour of defendants.

Plaintiffs brought the action for an injunction and ancillary relief to restrain defendants from infringing plaintiffs' patent No. 21,513 of 1906 and also patent No. 17,722 of 1911, which was granted to John Thos. Hy. Dempster. It was alleged that defendants had manufactured wire in accordance with these inventions and sold three spools of pladuram made according to the same to the Central Electric Co. Defendants pleaded that plaintiffs' patents were invalid, and denied infringement, and said that the processes and manufacture had since the patent of 1906 been carried on mainly outside the United Kingdom—viz., by companies in America, Germany and Holland.

Mr. A. J. Walter, K.C., Mr. Colefax, K.C., and Mr. J. H. Gray appeared in support of the appeal; and Mr. T. Terrell, K.C., Mr. Kerly, K.C., and Mr. Courtney Terrell for respondents.

Mr. **Walter** said the action was originally for the infringement by defendants of two patents, but the appeal only related to the patent of 1906. Mr. Justice Astbury had dismissed the action on the ground that the plaintiffs' patent was bad for want of subject matter. Plaintiffs' patent related to the preparation in manufactured form of the metal tungsten for the purpose of drawn wires for use as filaments in electric lamps. Plaintiffs' invention was not confined to drawn wires for incandescent electric lamps, but it was for the preparation in manufactured form of the metal tungsten. Having outlined the history of the developments in electric lamp filaments, he said the whole problem was how to get greater efficiency—in other words, how to get more and more light per watt. Several metals had been suggested for lamp making. Tungsten was first suggested in 1880, but the difficulty with all the metals suggested was of getting anything in the form of a thread. Most of them were in the form of refractory powder with which you could do nothing at all. In 1898 Dr. Welsbach suggested that a filament should be made of osmium, but was not very successful. From 1896 to 1904, although the Patent Office during the intervening period was full of specifications, nothing practically happened until 1904 when there appeared the patent of Just and Hanaman, where finely divided tungsten was mixed with organic powder carbonised and then the carbon was removed by the action of steel in the presence of hydrogen. Then there was a metal called tantalum, and there had been a lamp made with that metal for many years. The melting point of tantalum was not so high as tungsten. Many inventors had been at work on tungsten, and tried to solve the problem of drawing tungsten wire by some means. It had been suggested that if tungsten could be drawn into the form of wire it would be of great value, but until plaintiffs' patent nobody knew how to do it. Plaintiffs' patent solved the question how mechanically to work tungsten, and really it was a very beautiful idea when one came to think of it. He submitted that Mr. Justice Astbury should have given judgment for plaintiffs, as defendants had practically admitted infringement. Mr. Walter, having dealt exhaustively with the evidence given in the Court below and the alleged anticipation upon which defendants relied, contended that nobody but the present patentee had ever solved the problem which he had successfully solved, and which had proved of the greatest importance and utility in the engineering and manufacturing industries. Plaintiffs' patent was worth hundreds of thousands of pounds, and had contributed valuable information as to the metallurgy of tungsten.

Mr. **Colefax**, K.C., having followed on the same side,

Mr. **Terrell**, K.C., on behalf of respondents, said that plaintiffs' patent had been propounded before the Court as being a patent of considerable merit, and one which had founded a new industry. The view that respondents wished to put before the Court was that plaintiffs' patent never did anything at all, and that the present action was brought for the purpose of trying to see whether the persons owning the patent could not reap the reward due to other inventors. He had gone through the notes of the evidenee and he assumed that if the Court was against him on the question of whether there was subject matter on the face of plaintiffs' specification or whether there was subject matter on the face of the specifications of Moissan and Siemens, there was nothing in the evidence which would make their lordships vary that opinion. His learned friends on the other side had been floundering for a long time in that case, and at last had crystallised down to one or two things, one of which was that nobody had ever made tungsten in the form of a rod before. But the patentee claimed a vast amount more than that. The patentee had put in two claims, one of which was "electrically heated," and the other was "general." He did not limit himself to a rod, but a piece of solid metal capable of being heated and when heated hammered.

Lord Justice **Warrington**: What is the meaning of the claim?

Mr. **Walter**: A special form of wire when it is being treated electrically.

Mr. **Terrell**: It is plain it is not limited to the metal tungsten in the form of a rod. It is much more general than that. I say it is a patent for making tungsten in any form and when hot hammering it into any shape. Before the date of the patent it was known that you could make incandescent filaments of tungsten. The minute one was told that those high refractory metals were capable of being consolidated by being made intensely hot in the battered form you had got the whole thing. Wilson, Moissan and Welbach told them that.

Lord Justice **Warrington**: And Just and Hanaman told you that.

Mr. **Terrell**: Yes.

Continuing, the learned Counsel said that plaintiffs' patent by itself would have never done anything on the evidence of Mr. Swinburne. Mr. Swinburne was driven into the corner, and said "the patentee told you how to do it." Dealing with Moissan, Mr. **Terrell** read the evidence of Mr. Ballantyne to the effect that Moissan had the reputation of being a chemist of the highest ability, and was known as a great authority on tungsten. He was a very experienced worker with the electric furnace. Counsel said it was beyond doubt that Moissan had in his possession pure coherent malleable tungsten. The secret of the malleability of tungsten was that you elongated the crystals. He submitted that on the evidence plaintiffs' patent was not the foundation of a great industry; it was a patent which had been carefully selected and amended, and made the subject of the present litigation for getting a date in the art of wire-drawing from tungsten. He submitted that on the face of plaintiffs' specification there was no subject matter, and he also contended that the alleged invention was completely anticipated by Moissan and Siemens.

Mr. **Kerly** followed on the same side.

On Monday Mr. Walter replied on behalf of appellants, contending that plaintiffs' patent was the first to tell the world how to get an agglomerated body of tungsten. Nobody before 1906 had ever told the world how to get a solid body of tungsten and work it. It was only by seeing plaintiffs' rod of tungsten that anybody had ever been able to get the smallest particle of molten tungsten. He submitted that plaintiffs' patent was on absolutely sound ground, and that the attack on the specification was not one warranted by the law. He asked the Court to say that the patent was as he had described, and that *per se* it could not be said it had no subject matter; that it was not disclosed in any of the alleged anticipations, and that the specification was sufficient and contained the necessary instructions enabling anybody to work it.

Judgment was reserved.

Trade Mark Case.

Last week Mr. Justice Astbury heard an appeal by the British Thomson-Houston Co. (Ltd.) from the decision of the Registrar of Trade Marks, refusing to register as a trade mark the letters "B.T.-H." inside a circle with scrolls, which the company had used long and extensively to distinguish their goods. The Registrar's grounds for refusal were that initials were not capable of registration as a trade mark, and that a circle even with scrolls was too common to be distinctive of the goods of any particular class of goods with which it was desired to connect them.

The case was argued on behalf of the company by Mr. J. Hunter Gray, and the Registrar was represented by Mr. Austen Cartnell.

Giving judgment, his Lordship said that the company had used the mark continuously and extensively since 1905 as a trade mark, and they said it had become distinctive of their goods. The question was whether it was distinctive within the meaning of the Act, and he had no alternative but to hold that it was in view of the evidence of long and extensive use. Applicants were therefore entitled to have the registration of the mark proceeded with, and he directed the Registrar so to do.

T. W. Vaughan & Co. (1914), Ltd., v. Golder's Green Amusement, &c., Co.

Last week, Mr. Pollock, Official Referee, gave his reserved decision in this action for the recovery of money due for electrical work done at defendants' theatre of varieties. Damages were also claimed for breach of contract both by plaintiffs and defendants. The case was adjourned on several occasions for attendance of witnesses, &c., and it raised two important questions of law, one being as to whether, notice of the assignment of the debt not having been served upon defendants, plaintiffs were entitled to sue, and the other whether damages could be claimed against plaintiffs, they not being the contractors who had carried out the work, but a company to whom the business of the contracting firm had passed.

Mr. Copping (for Mr. C. A. Bennett) appeared for plaintiffs, and said the contract was to put in the electric installation for £1,700, the work to be completed to the satisfaction of the consulting engineer (Mr. A. E. Mitchell), and payments were to be made upon the certificate of the architect at the rate of 75 per cent. of the value of the work executed; half the balance was to be paid on completion, and the remainder in six months after the date of the consulting engineer's certificate of completion. The plaintiffs duly erected and equipped the installation in accordance with the contract, in addition to which they executed certain extra work for which they claimed £500 odd. The whole of the work was completed in March, 1914. Since completion of the work the company which carried it out had been reconstructed, and plaintiffs were the assignees of its assets and its debts. Difficulty had arisen owing to the supply pressure of the Hendon Electric Supply Company being 3,000 instead of 200 volts, which necessitated a large portion of the plant being scrapped. According to the contract the work was to be completed by March, 1914, but it was sufficiently completed to allow of the theatre being opened on Boxing Day, 1913. Defendants admitted the contract, but did not admit that T. W. Vaughan & Co. (1914), Ltd., did the work; and they pleaded that the work was incomplete and defective and not in accordance with the contract, and they denied liability to pay for any extra work beyond that provided for by the contract. The specification laid down that all main and sub-circuit cables, leads, &c., should be designed to have a current density not exceeding 750 amperes per square inch, for which purpose the incandescent lamps were to be taken at certain amperages mentioned. That provision, defendants said, had been disregarded throughout, and cables and leads of smaller sizes than those provided for had been substituted. Moreover, the conduits throughout were too small, and could not carry cables and leads of the size specified. It was, therefore, alleged that it would be necessary to re-wire throughout. The specification provided that the bases of all boards should be of polished slate or marble of, in the large sizes, at least $1\frac{3}{4}$ in. in thickness, but the large boards or bases were not of that thickness. There were a number of other details which were said not to be in accordance with the contract. Defendants did not admit that the payments they had made had been on account of the claim of the contract price (£1,700), and the claim for £559 for extras, but said that they had been made on the architect's certificates for work done, and they counterclaimed £1,000 for breach of contract. Plaintiffs denied the defendants' allegations.

Mr. E. Pollock, K.C. (for defendants), said it would have to be proved that there was an assignment of the debts from the one company to the other. No notice of the assignment had been served upon defendants, and plaintiffs had no right to sue.

After legal argument the case was adjourned to enable plaintiffs to consider their position, and on the resumption the Referee said the case disclosed a singular position of things. There was a company which had entered into a contract to do certain work, which, defendants said, had not been done properly. The company which did the work went into liquidation, and started again as T. W. Vaughan & Co. (1914), Ltd., and they dealt with the matter throughout as if they were in precisely the same position after the assignment as the original company. They never gave any notice or intimation before action that they were the persons who were entitled to recover in respect of the debts of T. W. Vaughan & Co., and they showed distinctly that they were claiming as if they were the original contractors. There had been no equitable assignment, because it was never intimated to defendants that the debt had been assigned. On the contrary, plaintiffs had allowed defendants to believe that they were suing as the original contractors. It was quite clear also that there was no legal assignment, and if an amendment of the pleadings was to be made it must be on the terms that plaintiffs paid the costs up to that time.

Witnesses were then called in support of plaintiffs' case, and Mr. E. Mitchell gave evidence as to the details of the specifications.

The case for plaintiffs having closed, Mr. Ernest Pollock, K.C. (for defendants), said that the contract under which the claim was made was contained in two letters—a letter from the plaintiffs submitting a tender and a reply from defendants accepting it. Plaintiffs offered to fit up the installation at defendants' theatre of varieties for £1,700. They said that they duly equipped the theatre and carried out extra work outside the contract. They admitted having received on account £1,650, and said that they had sold and delivered goods to defendants to the amount of £367. 2s. 9d. Defendants did not dispute the contract, but said that plaintiffs had not done the work properly, and had not completed it. As to the extras, he said that a written order was a condition precedent to any extra work. Defendants further said that the payments made had not been paid on account, but that they had been made upon the architect's certificate in full. Plaintiffs, in their letter of Sept. 16, 1913, had undertaken to do the whole of the work for £1,700, and on that condition alone had defendants accepted. They were to do the whole of the work specified in the schedule, but plaintiffs now said that the defendants interfered with the consulting engineer (Mr. Mitchell), and that in consequence of that they were discharged from doing the work strictly in accordance with the specification. He could not read the correspondence without coming to the conclusion that defendants had recorded in their letters that Mr. Mitchell no longer retained their confidence. The reason and causes of the action of the defendants was not far to see. They found themselves in a difficulty, and put Mr. Mitchell out of action. Under the contract they certainly had no right to do that. They could not supplant a person named in the contract by another person not named in the contract. So far there had been a breach of the terms of the contract, and plaintiffs said that that gave them the right of election, and they could determine what they would do. So far he could not say that plaintiffs were not right, and they could sue for *quantum meruit* or for the contract price, deducting what it would have cost to finish the work. Plaintiffs had elected to sue upon the contract, with a claim for extra work. They had to see the work done, and in suing upon the contract they were still liable to fulfil the conditions precedent and produce the order for the extras, because there was no power to waive the conditions. He was entitled to say, in respect of a number of the items claimed for that no orders in writing had been produced. In some cases there were orders and in others there were not. After the evidence that had been given it was quite clear what the plaintiffs set out to do. They, in fact, put aside the specification altogether, and although it was known by them before the contract was entered into that there was going to be a three-phase instead of a single-phase system. They entered into the contract, but modified the work they did because they said it was good enough for a three-phase system. If they had got what was provided for in the specification and the contract price the cables alone would have exceeded the price charged four times. It would have been four times as great as was necessary to attain the desired end.

Evidence was then called in support of the defendants' case, expert witnesses giving their opinion as to the manner in which the work had been carried out, and the cost of alterations where that work, as alleged, was not in accordance with the specifications. One of the witnesses stated that the cost of altering the work now would be much more than the amount of saving to the contractors had been. He estimated the total amount necessary to make good all defects and put the installation in a condition as required by the specification and the contract, at about £1,169. He went into details of each item of the suggested necessary work, but admitted that he had based his estimates upon an examination made three months ago, after the installation had been in use for three years, and he had heard of no mishap occurring during that time.

On the conclusion of the evidence, counsel summed up the case, and the Official Referee reserved his decision.

In giving judgment, Mr. Pollock said that in November plaintiffs wrote to Mr. Mitchell saying that they were entitled to extra payment for the additional number of switches required. Under the specification the supply was to be the single-phase system, but the Hendon Supply Co. said that it must be a three-phase system. Mr. Mitchell communicated with Mr. Crew, who said that under the circumstances the request for an extra was reasonable, as the supply company had required that supply should be on the three-phase system. That showed that Mr. Crew was ready to take into consideration the question of an extra, but it was only a consent when he knew what the extra was. Plaintiffs sufficiently completed the work to enable the theatre to be opened on Dec. 26. Communication passed between the parties as to the completion of the work, and there did not seem to be any reason why it should not have been completed by the end of January. During February and March various complaints were made about the installation. In March the company, who had entered into the contract, got into difficulties and went into liquidation, when a receiver and manager were appointed. On March 25 the receiver wrote a letter to Mr. Mitchell, asking him to go through the accounts, but there appeared to have been no meeting. In May Mr. Crew wrote to some one representing plaintiffs, giving a list of things which he thought defective which ought to be made good. On May 28 the receiver sent men to do the work which he thought ought to be done. He had given no notice to the theatre people of what he was going to do, and the consequence was that the men could not get in. On June 9 application was again made to be allowed to do the work, but when the men got there Mr. Warren would not allow them to go in, and in the circumstance he (the Referee) was not at all surprised. Another time Mr. Warren found that the condition of things was worse than he had supposed, and the men, it appeared, were only going to make it up. Nothing more was done for some little time. On June 26 Mr. Mitchell resigned his appointment, but he seemed to have carried on a certain amount of supervision afterwards. It was said that Mr. Crew had cancelled the contract, but Mr. Crew did not appear to have done so, and there was no notice of any such cancellation. It could not have been done without the consent of defendants. Nearly a year after the matter got into the hands of the solicitor, and in August, 1915, the solicitors wrote to plaintiffs about the matter, and in October the writ was issued, and a statement of claim was delivered in December of that year. He (the Referee) was satisfied upon the case put before him on behalf of defendants that there was no proper notice of assignment of the old company to the new company which would make defendants liable in an action brought by the assignees. The question then arose as to what were the respective rights of the parties in respect of the contract. There was no doubt that during the first part of this correspondence between the parties plaintiffs thought they were in a position to be able to sue upon the contract, but in his opinion they were not in that position. All they could sue upon was the assignment. Supposing there was any balance beyond the set-off, the defendants could not receive it from plaintiff company. Plaintiffs had launched their case entirely upon the contract—and their right to recover on the amount of the contract—and they now sought to have their claim for extras on a *quantum meruit*. In his opinion they could not do that. When parties had done work on a contract they could not depart from it and must necessarily sue upon the contract. In his opinion Mr. Crew did not, and could not, make any variation in regard to the cables, but Mr. Mitchell had said that they might have an extra in regard to it. It was pointed out that the cables required by the contract would have cost a great deal more than was allowed by the contract. For extras an order in writing was required, but no such orders were given, and, moreover, he was not satisfied that the contract was carried out in accordance with the specifications. In regard to other items, he had looked at the case in this way: Mr. Crew, who had acted on behalf of defendant company, had said that certain things were ordered by the managers, and it was hardly fair under the circumstances for the defendants to say that they would not pay. In the result he found that £744 was due to the plaintiffs, from which had to be deducted £130 to complete, making the amount £614. In addition they were entitled to £50 balance on the contract and other small amounts, making the sum due to the plaintiffs on the claim £684. As to the set off, he thought having regard to the evidence the sum of £700 for the cables was quite moderate, and as to the other matters he awarded £300.

Mr. POLLOCK, K.C., said that the result of the judgment after arranging the figures, was that it wiped out the claim of £684, and left a balance of £186 due to defendants. He, therefore, asked for judgment for defendants on the claim and the set off.

The REFEREE said there would be judgment for defendants on balance of claim and set-off, with costs, and the counterclaim would be dismissed, without costs.

A stay of execution was refused.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

Th[illegible] tra[illegible] from [illegible] me[illegible] the specifications recently published have been [illegible] Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, 7[illegible] and 72, [illegible] London, W.C.

Wh[illegible] the [illegible] differs from the date on which the application was lodged at the Pat[illegible] the former [illegible] given in brackets after the title.

1915 SPECIFICATIONS.

[illegible] E[illegible] water heater. (30/12/15.)
[illegible] W[illegible] electrical conductors of two railway cars.
[illegible] E[illegible] (24/11/14.)

1916 SPECIFICATIONS.

[illegible] A[illegible] projecting radiant energy. (3/1/16.)
[illegible] the combination of an ellipsoidal [illegible] the interior of said reflector [illegible] the apparatus.
[illegible] (22/1/16.) 103,499.
[illegible] T. M. Automatic or semi-[illegible] (1/16.) 103,502.
[illegible] (27/1/16.) (Co[illegible]
[illegible] L. C. Electrical selectors or [illegible] 103,524.
[illegible] Co. & He[illegible] Electric impulse senders.
[illegible] W[illegible] Telephone & Telegraph Co. Trans-[illegible]
[illegible] having a series spark [illegible] electrode of the [illegible] electrode of the spark gap [illegible] the [illegible] conductor arranged [illegible]
[illegible] alternating [illegible] 103,842.
[illegible] the [illegible] that their [illegible]
[illegible] T[illegible] Maats-[illegible]
[illegible] from [illegible]
[illegible] (16/[illegible])
[illegible] from the [illegible]
[illegible] 103,[illegible]1.

2,524 DIXON. Method of and apparatus for transforming motion into electrical waves or impulses. (19/7/15.) 100,940.

Relates to a method of producing current fluctuations in an electric circuit by means of the action of radiant energy on selenium cells and like radio-electro-sensitive devices, which consists in concentrating a pluarlity of pencils of radiant energy at a definite point and permitting them to diverge from such point of concentration, and thereafter re-concentrating said pencils of radiant energy upon one or more radio-electro-sensitive devices, and by acting upon such pencils of radiant energy at their first point of concentration, causing variation of the action of said pencils of radiant energy upon said raido-electro-sensitive device or devices, and consequent variation of an electric current or currents in a circuit or circuits containing such radio-electro-sensitive device or devices.

2,546 ST. JOHN. Electrically-operated valves. (21/2/16.) 103,879.
2,580 RELAY AUTOMATIC TELEPHONE CO. & HERINK. Telephone systems. (21/2/16.) (Addition to 102,330.) 103,880.
2,681 HADFIELD, F. J. Terminals for electrical machinery and appliances. (23/2/16.) 103,545.
2,895 PETITHORY, E. A. Telephone transmitters. (26/2/16.) 103,549.
3,298 MIDGLEY & VANDERVELL. Electric switches. (4/3/16.) 103,719.
4,343 CURTIS, W. Means for controlling the electric lighting of motor vehicles. (23/3/16.) 103,558.
4,347 PETTIGREW. Telephone systems. (23/3/16.) 103,732.
4,606 B.T.-H. CO. (G.E. Co.) Ship propulsion. (29/3/16.) 103,733.
5,570 CROWDUS. Storage batteries. (22/4/15.) 100,315.
5,777 SCOTT. Electrically-operated friction hoists. (20/4/16.) 103,914.
9,232 MARDEN. Dynamo-electric machinery. (30/6/16.) 103,766.

The excitation is effected by means of a homopolar exciter on the spindle of the main machine, which exciter has both a direct and a slip-ring connection with the field winding of the alternator. This homopolar exciter is distinct from the main generator, and may work at a low voltage (say, for instance, from 10 to 20 volts), whereby questions of insulation are considerably simplified. Morerover, parts of the framing of the generator can be included in the exciting circuit, if desired, without danger. In this way the number of slip-rings or sliding contacts used with the homopolar machine may be reduced.

10,100 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric & Mfg. Co.) Circuit-interrupting devices. (18/7/16.) 103,947.
10,101 BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO. (Westinghouse Electric & Manufacturing Co.). Protective relays for electric circuits. (18/7/16. 103,609.

Relates to a reverse-energy relay of the electro-wattmeter or dynamometer type having current and potential coils, the value of the resistance and inductance in the circuit of the potential coil being so adjusted that the current through said coil lags behind the voltage across the coil by an angle equal to the angle which the short-circuit current lags behind the potential in the circuit in which the relay is connected.

10,558 SQUIER & COHEN. Duplex and multiplex telegraphy. (26/7/16.) 103,771.

The receiving circuit is so related inductively to the local transmitting equipment that it is unaffected by the alternating sending current. For simultaneous transmission in both directions the messages are sent from the two communicating stations by alternating currents of different frequencies, and the receiving circuit at each station responds to the current from the distant station while unaffected by the local sending current of different frequency. This is effected by arranging the circuits so that the local sending current induces currents in the local receiving circuit which are self-neutralising, while the said receiving circuit is left free to respond to impulses from the distant station. To obtain the neutralising effect the receiving circuit is preferably inductively coupled both to the line and to the circuit of the local sending equipment, the coupling being such that the two induced currents in the receiving circuit are equal but in opposite phase, so that they cancel each other.

11,267 MAYOR. Apparatus for medical treatment by electricity (25/9/15.) 101,629.
11,358 SIEMENS & HALSKE AKT. GES. Automatic selecting devices for telephone systems. (11/8/16.) (Addition to 23,336/13.) 103,952.
11,435 ALLGEMEINE ELEKTRICITATS-GES. Rotors of electrical machines. (5/8/15.) 101,158.
12,351 TURNER & THOMES. Regenerative braking systems for electrically-driven vehicles. (5/2/16.) 103,959.
12,406 GARRETT, F. & PRATT, H. K. Safety controlling gear for electrically propelled vehicles. (1/9/16.) 103,617.
12,517 SHEPPARD, A. H. & BRITISH EVER-READY CO. Dry batteries. (4/9/16. 103,618.
13,905 HAY. Cooling and ventilating system for electric storage batteries in submarines (30/9/16.) 103,792
14,666 SIMPSON. Impulse transmission dials, and chiefly those used in automatic or semi-automatic telephones. (16/10/16.) 103,970.

1917 SPECIFICATIONS.

254 MURRAY, T. E. Process of electric welding. (18/2/16.) 103,636.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

February 5, 191[illegible].

1,796 AVILA & SIMPLEX CONDUITS (LTD.). Elec. fuses.
1,802 GRYLLS & HEAPE. Manufacture of arc lamp carbons.
1,816 TAIT. Galvanometers, &c.

February 6, 1917.

1,851 B.T.-H. CO. (G.E. Co.) Electromagnetic switches.
1,867 IGRANIC ELEC. CO. (Cutler-Hammer Mfg. Co.) Electromagnets.

February 8, 1917.

1,[illegible]1 D[illegible] & HERSTMANN GEAR CO. Automatic trolley arm or signal for elec. tramcars.
1,[illegible]30 SCHWEITZER. Metering electricity.
1,948 [illegible]. Elec. heating apparatus.
1,[illegible]53 B.T.-H. CO. (G.E. Co.) Electromagnetic switches.
1,9[illegible]2 BRADLEY. Elec. ovens.
1,971 DAVIS & HUNT. Trolley wire locator.

February 9, 1917.

1,[illegible]8 VEITCH. Fault finder for testing cylinders, sparking plugs and magnetos.
1,[illegible] C[illegible]. Elec. lamp locks.
1,7[illegible]6 WATERHOUSE. Elec. fuses.
1,[illegible]7 SPRAGUE SAFETY CONTROL & [illegible] CO. Detectors or relays. (31/12/14, U.S.)
[illegible],011 B.T.-H. CO. & YOUNG. Safety spark gaps for magneto-elec. machines.

February 10, 1917.

[illegible] P[illegible]ILL & PITT. Trolley heads.
2,[illegible]40 KERSHAW. Polyphase electromagnet brakes, clutches, &c.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Further Supply Companies' Results. During the week several additional London and provincial supply companies have issued their reports, and when the conditions prevailing during the past year are taken into account the general results must be considered very favourable.

In the first place the City of London Electric Lighting Co., though the units sold were slightly less than in 1915, increased its total receipts by £21,100. The higher cost of coal and other charges seriously affected the net result. The same dividend is being paid as in the previous year, but the appropriation to reserve is reduced from £50,000 to £40,000, and only £17,132 is carried forward. Lighting restrictions and the Summer Time Act naturally had an adverse effect upon the accounts, but it must not be forgotten that the demand for power and heating is rapidly increasing, and more than 50 per cent. of the company's supply is for these purposes.

The County of London Company, whose annual general meeting is reported in another column, had a very successful year. Considerable progress was made in power supply and also in bulk supplies to other undertakers. Like all other companies, difficulties were encountered in connection with coal supplies, but as the company's City-road and Wandsworth stations are linked up under statutory authority supply can be given from either station, an arrangement which has proved useful and economical. The company, which has acquired a site for a new riverside station, is rapidly developing into a big power supply undertaking, and is destined to play an important part in the future supply of electrical energy for power in the London area.

The Metropolitan Electric Supply Co., whose annual meeting is also reported in another page, has likewise made excellent progress, especially in the company's western area, where the demand for electric power is very great. In fact, the past year's gross receipts are a record since the separation of the Marylebone area. The ordinary dividend is being maintained at 4 per cent., and the company's position has been improved during the past year.

In the West End and City undertakings of the Charing Cross, West End & City Electricity Supply Co. there was an increased sale of electric current, but as working expenses were higher the increase in net revenue was but small. The gross receipts of the West End went up from £139,000 to £150,000, and the net revenue from £68,900 to £71,600, and after allowing for net revenue charges the profit was £35,000, against £32,000. The City's gross earnings rose from £158,400 to £176,500 and the net revenue from £63,800 to £65,600, the net profit being £35,000, against £33,300. The ordinary dividend of the West End is unchanged at 5 per cent. and the preference interest of the City is once more met, while £18,000 is again carried forward. This undertaking sold 11,775,500 compared with 11,440,800 units, and the City 28,397,500 against 24,034,900 units.

Among the provincial companies' reports the most important is that of the Newcastle-upon-Tyne Electric Supply Co. This company's connections increased by 24,360 H.P. during the year (from 258,390 H.P. to 282,750 H.P. The profit was £224,266 (against £204,419), and the ordinary dividend has been increased from 6 to 7 per cent., while the allocations to reserve, &c., are appreciably greater than in 1915. It is announced that as a result of negotiations with the directors of the Cleveland & Durham Electric Power (Ltd.) the Newcastle Company proposes to acquire the shares and funded preference income stock of the Cleveland Company.

The Newcastle & District Electric Lighting Co. also had a good year, as the gross receipts increased by £15,051 (or 19 per cent.), the units sold by 23 per cent. and the net profit by £4,851. A dividend of 2½ per cent. has been declared and £10,000 carried forward.

Generally speaking, companies supplying in seaside health resorts have been badly affected, but the Bournemouth & Poole Electricity Supply Co. sold more electric current to private consumers than in 1915, and received £1,000 more from sales. Fuel cost nearly £1,400 more, and the total expenditure was £2,700 higher. As the revenue from investments has fallen £2,000, the net balance from £38,684 to £35,215. A dividend of 6 per cent. is again paid on the ordinary shares and £8,000 has been carried to reserve for depreciation. The net capital expenditure of the year was only £2,674.

* * * *

Priority Certificates. In order to secure priority for work of national importance, a new Order has been issued by the Minister of Munitions.

Any firm engaged on war work, or work of national importance, will be empowered in future to issue with its orders certificates which will compel the firms executing these orders to give them priority over ordinary work. In addition to securing priority for essential work, the scheme will enable any department, and particularly that of the Director-General of National Service, to ascertain whether firms are, or are not, engaged on work of national importance. Any employer in doubt whether he is entitled to issue a certificate should communicate with the department concerned with his particular output, Director of Army Contracts, National Service, Munitions, and so forth.

* * * *

Assignment of Debts. Electrical engineers and contractors will be interested in the action Vaughan v. Golder's Green Co., reported on another page, as it raises important questions as to the position of a limited liability company formed to acquire the assets and carry on the business of another company which had gone into voluntary liquidation. The latter company had executed a big electrical contract which the defendants alleged had not been carried out properly; the business was then reconstructed and a new company formed. No notice of the transfer or of the assignment of the debts due to and liabilities of the old company was given to the defendants. It will be seen that this omission caused considerable delay and expense to the plaintiffs. and the report of the proceedings before the Official Referee will repay careful perusal.

* * * *

Licensing Wiring Contractors in India. In certain parts of India there is a dearth of skilled electrical contractors capable of carrying out good work for the wiring of premises for electric lighting and power. It is, therefore, interesting to note the steps taken by the Mysore Durbar to meet this state of affairs.

The Electricity Department propose to refuse to supply current to any lighting or power installation in Bangalore and Mysore and in the Civil and Military station of Bangâlore, unless such installations have been carried out by a licensed contractor. Contractors who are not subjects of H.H. the Marahajah will be separately licensed for the station and five firms have already been licensed. The licence fee is only one rupee, the object being not to secure revenue, but to ensure that electrical contractors have sufficient technical qualifications and financial resources to ensure that their work will be satisfactory, and, as far as possible, to prevent defective installations and personal injury. The licence recites that it is issued upon the understanding that the holder agrees to conform to the rules already in force and those which may hereafter be promulgated for regulating the supply of power for heating, lighting and industrial purposes, and that it will be liable to be cancelled at the option of the Chief Electrical Engineer for bad work, or the violation of any of the rules.

* * * *

The Place of Languages in Commercial Education. The Parliamentary Committee of the Hull Chamber of Commerce and Shipping has prepared a report setting out the replies to their questions on the place of modern languages in our educational system.

The Committee state that they found no unwillingness or incapacity by British students to acquire foreign languages. They think that more time should be given to the languages at schools, and that pupils should be taught to converse and not simply write out exercises and translations. The foreign languages found most useful in Hull are French, German, Russian, Italian and Spanish. The Committee hold that the acquisition of foreign languages should be compulsory in all secondary schools and more time allowed for teaching them. The study of foreign countries in their commercial methods and system of commercial penetration should be more fully taken up and taught by expert trade lecturers,

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Manufacturers & Government Demands. A deputation of manufacturers waited on Tuesday upon Lord Derby, Sir E. Carson, Mr. Neville Chamberlain and Dr. Addison, the Minister of Munitions, in order to press on the Government the need for consulting employers before (instead of after) the issue of requisitions and of orders relating both to labour and to the restriction of raw material.

* * * *

Cupro-Nickel Scrap. The Ministry of Munitions has issued an order prohibiting dealings in cupro-nickel scrap except in accordance with instructions from the Director of Non-Ferrous Rolled Metal Strip and Sheet Supply (E.M. 7), Ministry of Munitions, Whitehall-place, London, S.W.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 3, 1917, *to* March 9, 1917.

IMPORTS.

LONDON.—*U.S.A.:* Wire and cable, £2,355; elec. carbons, £175; unenumerated, £1,618. *Japan:* Unenumerated, £5,761. *France:* Elec. carbons, £324; unenumerated, £798. *Switzerland:* Elec. carbons, £1,067; carbon candles, £952; elec. glow lamps, £100; unenumerated, £137. *Holland:* Elec. glow lamps, £1,467.

EXPORTS.

T AUSTRALASIA.—*Auckland:* Unenumerated, £136. *Melbourne:* Elec. machinery, £100; wire and cable, £301; elec. lamps, £474; unenumerated, £1,276. *Sydney:* Elec. machinery, £1,220; unenumerated, £580. *Wellington:* Glow lamps, 2,810 no.; elec. machinery, £31; unenumerated, £380. *Adelaide:* Elec. lamps, 700 no.; unenumerated, £16. *Christchurch:* Wire and cable, £236; telegraph material, £27. *Brisbane:* Elec. machinery, £10; unenumerated, £899. *Dunedin:* Unenumerated, £10. *Hobart:* Elec. machinery, £474. *Perth:* Wire and cable, £61; unenumerated, £368.

AFRICA.—*Cape Town:* Elec. machinery, £152; elec. lamps, 800 no.: unenumerated, £741. *Port Elizabeth:* Elec. machinery, £10; unenumerated, £73. *Durban:* Elec. machinery, £458; telegraph material, £88; wire and cable, £3,184; unenumerated, £1,530. *Delagoa Bay:* Wire and cable, £726; unenumerated, £370. *East London:* Unenumerated, £104. *Ascension:* Telegraph material, £27; unenumerated, £39.

EGYPT.—*Port Sudan:* Unenumerated, £48. *Alexandria:* Elec. machinery, £73; unenumerated £23.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £1,250; elec. lamps, 400 no.; unenumerated, £1,275. *Calcutta:* unenumerated £624. *Madras:* Elec. machinery, £466; unenumerated, £152. *Singapore:* Unenumerated, £5. *Karachi:* Elec. machinery, £192; unenumerated, £165. *Ceylon:* Unenumerated, £43. *Sourabaya:* Wire and cable, £43; unenumerated, £164.

U.S.A.—*New York:* Elec. machinery, £44; unenumerated, £159.

CANADA.—*Montreal:* Unenumerated, £130.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. machinery, £32; wire and cable, £200; unenumerated, £551. *Valparaiso:* unenumerated, £17. *Rio de Janeiro:* Unenumerated, £69. *Pernambuco:* Unenumerated, £36. *Santos:* Wire and cable, £92.

WEST INDIES.—*Barbados:* Unenumerated, £20. *Trinidad:* Wire and cable, £40; unenumerated, £76.

JAVA.—*Batavia:* Wire and cable, £28; unenumerated, £540.

HOLLAND.—*Rotterdam:* Unenumerated, £56. *Amsterdam:* Wire and cable, £216; unenumerated, £281.

FRANCE.—*Paris:* Wire and cable, £389; unenumerated, £1,202. *Marseilles:* Unenumerated, £92. *Dieppe:* Unenumerated, £1,193. *Dunkirk:* Unenumerated, £61. *Bordeaux:* Unenumerated, £89. *Havre:* Telegraph material, £847.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £27. *Bombay:* Elec. lamps, £253; unenumerated, £369. *Durban:* Unenumerated, £52. *Amsterdam:* Unenumerated, £32. *Singapore:* Elec. lamps, 900 no. *Alexandria:* Elec. lamps, 200 no. *Boulogne:* Unenumerated, £39. *Paris:* Unenumerated, £148. *Sydney:* Elec. machinery, £19; unenumerated, £63. *Bordeaux:* Unenumerated, £24. *Calcutta:* Elec. lamps, £460. *Brisbane:* Elec. lamps, £480. *Christchurch:* Unenumerated, £22.

IN TRANSIT.

Calais: Elec. lamps, £460. *East London:* Unenumerated, £30. *Port Elizabeth:* Unenumerated £10. *Durban:* Elec. lamps, £230.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICE.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of April 2. *Further particulars are set out in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

Meetings to receive accounts of the winding up of George F. Milnes & Co. (Ltd.), the British Electric Car Co. (Ltd.) and the Electric Railway & Tramway Carriage Works (Ltd.) will be held on April 10 at the offices of Messrs. Boddington, Strangeways, Manchester.

A meeting to receive an account of the winding up of the Dac Accumulator Synd. (Ltd.) will be held on April 20 at 61 and 62, Lincoln's Inn Fields, London, W.C., where claims are to be sent to Mr. H. C. Bound by April 9.

ELECTRICITY SUPPLY.

EXTENSIONS.

Derby.—As the amount of the tender accepted for the extension of the electricity works is somewhat in excess of the estimates it has been decided to apply to the L.G. Board for sanction to borrow an additional [illegible].

Ilford.—Correspondence is proceeding between the Council and the L.G. Board with regard to an application for sanction to borrow £10,000 to utilise steam at the refuse destructor works and augment the supply of electricity.

Kirkcaldy.—The Council are recommended to apply to the Secretary for Scotland for sanction to borrow £27,500 for additional plant at the generating station.

Stafford.—The Corporation have acquired 1,350 sq. yards of land for extensions of the electricity works and the purchase price is to be met out of revenue.

Stretford.—A report by Mr. T. L. Miller, consulting engineer, relating to the augmentation of the electricity supply and the provision of additional plant is under consideration by the Electricity Committee. In the meantime Mr. Miller has been re-appointed consulting engineer for one year.

Walsall.—In order to raise £45,924 for capital expenditure on the new generating station at Birchills, the Finance Committee recommend that instead of exercising the statutory borrowing powers by the creation and issue of additional Corporation stock, that amount shall be taken from the Corporation loans fund.

Weymouth.—The Corporation have received sanction to borrow £5,560 for laying new cables and £1,050 for switchgear and boosters.

GENERAL.

Birmingham.—The various reports on the position of the electric supply department (abstracted in our last issue) were adopted by the Corporation on the 6th inst.

In the course of the discussion, Mr. S. James thanked Messrs. Appleby and Beale for the searching inquiry they had made. The Electricity Committee had been strengthened and was now thoroughly awake. Therefore, it was perhaps as well to let bygones be bygones. They must remember that, after all, the methods by which committees of the Council were appointed were not those by which a body of directors of important undertakings were appointed. He quoted evidence of delay on the part of the committee, and said it seemed to him that committees of that Council, to whom was entrusted the management of large undertakings, ought not to go behind the opinion of their engineer to the extent the Electric Supply Committee went, or if they did so they ought either to displace him or say they had a higher opinion and were prepared to act upon it.

Mr. Harrison Barrow wished to be assured that what happened last year owing to the plant being worked to its full capacity without proper repairs to boilers would not happen again, and that arrangements would be made for the periodic oversight of and repairs to boilers.

The Chairman (Ald. Jephcott), in reply, said he thought the report afforded some warrant that the committee would see to it they would not be in the same position in the future. The paragraph in the report of Messrs. Appleby and Beale dealing with the future had been written before the agreement had been arrived at by which the committee, if they got the assistance of the Government, would have some 10,000 kw. in addition to the 6,000 kw. they would put in in May. That would enable them to tide over any difficulties next winter, but he wanted them to know it would be "a near tide-over." They would have to be extremely careful as to any additional consumers they might take on. They had not got the final answer of the Government yet, but he was hopeful it would be "Yes," and if it were they would feel more confident, but if "No" he wanted the Council to understand that the committee would do their best during the ensuing winter. It would be a tight situation indeed to supply factories and keep the tramways running all through the winter, as the margin left was very narrow.

Blackpool.—Councillor R. Holt has been appointed chairman of Electricity Committee, in succession to the late Ald. J. Brodie.

Clayton.—An unsuccessful attempt was made last week to get the Urban Council to rescind the resolution passed in December last in favour of the application of the Electrical Distribution of Yorkshire (Ltd.) for a provisional order for the district.

Mr. J. J. ANDREWS, who moved that the resolution be rescinded, said the company had been given every opportunity of coming before the Council, while the Corporation of Bradford, in which Clayton could claim to have some interest, and which had some interest in Clayton, had not been consulted. It was going against the wishes of Clayton ratepayers to take away from them their just and equitable rights of control and hand them over to a limited company. In the event of the company obtaining the powers, the full control of the electric lighting of the district would be lost to the inhabitants for all time.

Mr. W. HINDLE said the position of the Council was a difficult one. On the one hand the Council had already, by their resolution, given their sanction, and on the other hand, since the resolution was passed an exceptional offer had been made by Bradford. Bradford had not been asked for terms previously because the terms offered to Clayton in 1912 were altogether onerous and could not be considered. He thought it should be admitted that a mistake had unwittingly been made in not applying to Bradford before finally adopting the resolution.

Mr. E. FORLDS said that Bradford must have been aware of what Clayton was doing, yet they had not given the Council an opportunity of falling in with them. The terms under which Clayton was supporting the application for a provisional order were not vague; if they were making a mistake, so were 33 other public authorities who were in the same case as Clayton.

Eventually the motion was defeated by 5 votes to 3.

Halifax.—Last week the Council were recommended to increase the salary of the borough electrical engineer (Mr. W. M. Rogerson) from £700 to £800, and that of the Tramways Traffic Manager from

£400 to £425, and that of the Tramways Engineer from £300 to £325 per annum.

The proposed advances of salary to the Tramways Traffic Manager and the Tramways Engineer were granted, but that of the Borough Electrical Engineer was referred back to the Electricity Committee for consideration when the estimates for next year are being prepared.

Ilford.—Mr. G. E. E. Williamson, second charge engineer at the electricity works, has resigned, and Mr. A. Glazier, third charge engineer, has been promoted to the vacancy at a salary of £150 per annum.

Leeds.—The Council have been recommended to grant the following increases of salary :—

Tramways Committee.—Mr. E. W. Cockerlyne, chief assistant engineer, £215 to £240 ; Mr. G. E. Watmough, works and depot superintendent, £300 to £325 ; Mr. J. W. Blakeborough, accountant, £250 to £275 ; Mr. J. Buckley, highways and permanent way superintendent, £250 to £275.

Electricity Committee.—Mr. W. T. Green, assistant manager, £450 to £475 ; Mr. T. R. Hill, assistant station superintendent, £200 to £225 ; Mr. W. Ainscough, mains and sub-station engineer, £250 to £275.

Linking-up in Devon and Cornwall.—At the recent meeting of Torquay Council the acting borough electrical engineer (Mr. J. M. Keenan) reported on the preliminary meeting held at Plymouth on the linking-up of electricity-supply works in Devon and Cornwall.

He said it was suggested that the counties be divided into four areas :—

1. From the River Exe to the River Teign, to be supplied from Exeter. 2. From the River Teign to the River Dart, to be supplied from Torquay. 3. From the Dart to the Tamar, to be supplied from Plymouth. 4. Cornwall to be supplied from Hayle, by the existing company's works.

The general opinion was that the outlay could not be borne by the works concerned. The scheme must be State-aided, and to do this the existing electric lighting acts would have to be altered and amended. Nevertheless, it was decided to go thoroughly into the matter and prepare a scheme with all the necessary details to be ready for the " day " the Torquay, Exeter, Plymouth and Cornwall representatives to collect statistics in their respective areas and report progress to Mr. E. G. Okell, of Plymouth, who was appointed chairman of the following committee : Messrs. J. A. Purvis (Exeter), H. D. Munro (Exeter), L. A. Hards (Cornwall Electrical Power Co.), G. E. Smith (Newton Abbot Supply Co.), G. A. Moncrieff (Totnes), W. G. Heath (Plymouth), J. M. Keenan (Torquay) and F. Hayes (Plymouth), who was appointed secretary to the committee.

Manchester.—As the special Committee on the allocation of the profits of the trading departments to relief of rates will not be able to report in time, it is proposed to continue the present rule for another year.

For the past three years the tramways department has given £100,000 in relief of rates, the Gas department £50,000, and the electricity supply department £30,000 per year.

Marylebone.—The Electric Supply Committee has directed the General Manager to discontinue the special rate which is being charged to premises used for war purposes where the Government is making a grant towards the expenses of the institution.

St. Pancras (London).—The salary of the superintendent at King's-road station (Mr. T. W. Merry) has been increased to £233 per annum, with a further increase to £250 in 12 months.

Walsall.—The Electric Supply Committee report that so long as there is only one generating set at the new station it will be necessary to keep the old station fully staffed and ready to take the load at any moment.

The electricity mains are to be extended to the works of Gas Developments (Ltd.), at an estimated cost of £120.

Worcester.—The Council recently considered a report from the electrical engineer (Mr. C. M. Shaw) recommending the purchase of an additional boiler for the electricity works.

The Electricity Committee reported that Mr. Shaw had pointed out that for some time past the boiler plant at Hylton-road works had been insufficient, and he advised the installation of a boiler and other plant, costing £4,350. By using a large boiler in place of several small ones there would be a saving of about probably £300 per annum, and there would be a saving in maintenance sufficient to meet the interest and sinking fund charges (£348). With the present boiler plant some of the boilers were running at overloads continuously for many hours daily. He was quite willing to operate the boilers under such strenuous conditions, but could not guarantee continuity of service. Mr. Shaw desired to be relieved of responsibility for the increased cost, and pointed out the grave responsibility upon the Committee as to the maintenance of a proper supply and the increased risk to the workmen and the equipment. The Works Sub-committee had come to the conclusion that it was desirable to postpone the installation of the new boiler, but authorised expenditure for overhauling the present boilers. The Committee set out the circumstances under which they approved of the sub-committee's decision, and suggested that if the overhauling of the boilers be expedited it would be possible to postpone the installation of new boiler plant until after the annual accounts were received. However, the Committee invited the Council to express their views upon their decision.

A long debate ensued, but the matter was ultimately sent back to the Committee for a definite recommendation on Mr. Shaw's report.

Wortley.—The Board of Trade are to hold an inquiry into the application for an electric lighting provisional order for the district. Sheffield Corporation is opposing the order.

TRACTION NOTES.

Belfast.—The Tramways and Electricity Committee have subdivided the work of the tramways department and in future it is to be controlled by two sub-committees, one dealing with permanent way and the other with electricity supply.

Blackpool.—On July 26 next the Corporation tramway service will be extended to Squire's Gate.

Chester.—Owing to the shortage of labour, and the urgent necessity of repairs, the Sunday tramway service has been suspended.

The fares have been slightly increased to a basis of 1d. a mile, but the ½d. fare for school children has been retained.

Doncaster.—The Council have decided to spend £1,200 on doubling a portion of the tramway track, and the track of the Balby route is to be doubled after the war as an estimated cost of £10,000.

Exeter.—On the 7th inst. a tramcar, which was going down Fore-street, got out of control, and on Exe Bridge it struck the parapet and was overturned. One passenger was killed and the driver and another passenger were injured.

Ipswich.—Owing to the great increase in working expenses the tramway fares have been raised.

All ordinary fares have been increased by a half-penny and the minimum ordinary adult's fare is 1½d. except upon the Cornhill Railway Station route, where the present penny fare will be retained ; the minimum fare for children is 1d., to cover the same stages as the present half-penny children's ticket ; the minimum workmen's fares are 1d., to cover the same stages as the present 1½d. ordinary adult's fare stages ; the present 1d. and 2d. worker's return tickets to be sold at 1½d. and 3d. respectively. Other changes in the return fares have been adopted, but no alteration has been made in the 1d. tickets for the conveyance of luggage and dogs.

Liverpool.—Yesterday (Thursday) the Tramways Committee inaugurated a circular tramway route, commencing at the Old Haymarket, and thence proceeding via William Brown-street, West Derby-road, Prescot-road, Lime-street and St. John's-lane, back to the Old Haymarket. Three other experimental belt routes are to be inaugurated shortly.

Middlesbrough.—The General Purposes Committee recommend the purchase by the Corporation of the Teeside tramways system, provided a satisfactory agreement can be arrived at.

Sheffield.—Sanction has been received for carrying out alterations to the Townhead-street depot.

The death is announced of Mr. J. W. Nuttall, cash clerk to the tramways department. He had been 20 years in the employment of the Council.

Swiss Electric Railways.—At the end of 1916 there was an aggregate of 1,678 km. (1,040 miles) of electric railways in Switzerland.

The " Schweizerische Bauzeitung " gives the length of the 10 standard gauge railways as 172 km. (about 107 miles) ; of these, 20 per cent. are on the continuous current-system, 22 per cent. on the three-phase, and 58 per cent. on the monophase system. On the 63 narrow-gauge and rack railways (one of which, 5¼ miles, is standard gauge), of 1,020 km. (632 miles) 87 per cent. of the lines use the continuous-current system, and only 4 and 9 per cent. on the three-phase and monophase systems. The 31 tramway lines of 1,486 km. in length (922 miles) are, with one exception (monophase system), on the continuous-current.

LIGHTING & POWER NOTES.

Chorley.—The Guardians are advised by Mr. A. W. Paul, consulting engineer, to provide an up-to-date centralised system of heating and hot-water supply for the workhouse, and also a steam-driven electric lighting plant, the exhaust steam from the plant to be used in the calorifiers for heating and hot water supply.

Such a combination would, in Mr. Paul's opinion, give a thoroughly efficient heating apparatus and hot-water supply, and save one-half the present fuel consumption, also a great part of the gas account.

Electricity in Coal Mining.—At the Blackheath colliery near Ipswich (Queensland) there is an electric power and lighting plant.

The coal is brought to No. 2 tunnel (800 yds. long) from the working faces by electric haulage gears. The power plant includes a Davey Paxman six-cylinder single-acting engine, coupled to a Lancashire generator of 100 kw., a McEwen horizontal engine of 160 H.P., belt-connected to a 100 kw. Jeffrey generator and a Belliss-Morcom high-speed engine of 170 H.P., coupled to an E.C.C. direct-current generator of 100 kw. Three Lancashire hand-fired boilers supply steam at this section of the works. The underground equipment includes six electric pumps, and three electrically-driven 40 in. Sirocco fans, one in each tunnel and one in the shaft, each capable of delivering 32,000 c.ft. against 1½ in. water gauge. There are six electric haulage gears, and nine electric coal cutters.

Islington (London).—The special committee on street lighting, which was appointed on Jan. 26, has issued its report, recommending the substitution of half-watt lamps for the existing arc lamps, and submitting other suggestions for the improvement of the public lighting. The report has been referred to the Lighting Committee.

TELEGRAPH AND TELEPHONE NOTES.

Radio-Telegraph Notes.—It is reported that a large Vera Cruz wireless station is being erected near Mexico City by German engineers and contractors.

The U.S.A. Government has been semi-officially advised that Mexico City is in direct communication with Germany by wireless. It is also stated that the wireless station at Chapultepec, believed to be the most powerful in Mexico, recently picked up several messages from European stations.

The Telephone in Denmark.—"Engineering" announces that as the concessions of the 10 important telephone undertakings in Denmark expire between 1918 and 1920, the Danish Government has appointed a commission to investigate and report upon the whole question of how the telephone problem has to be solved for the future, whether the telephone system in its entirety is to be State owned or not.

The 10 undertakings comprise the Copenhagen Telephone Co. (which works the whole of Seeland), the municipal telephones of the island of Fuhnen, two companies in Jutland, and some in the smaller islands, including the Faroe Islands' municipal telephones. There are about 130,000 subscribers, and the number of telephone conversations last financial year was about 300,000,000. The Copenhagen Telephone Co., which is the largest, has an aggregate length of 300,000 km. of line and 74,000 subscribers.

EMPIRE NOTES.

Canadian Hydro-Electric Power.—The Ontario Hydro-Electric Commission has demanded from the Canadian Niagara Power Company an additional 50,000 H.P. by April 1, and the "Electrical World" announces that this means further curtailment of the power that is now being sent across the Niagara frontier into New York.

The Canadian power companies recently allowed the Commission 50,000 H.P., and the new demand means a shortage of power for the industrial undertakings in Western New York. It is stated that unless there is an extension of time granted by the War Department, or prompt legislation is enacted by Congress, many industries will be forced into temporary idleness after July 1, or else to take up residence in Canada.

India.—"Indian Engineering" says Karachi is having trouble with its electric tramways owing to the difficulty of getting out fittings, &c., and it has been suggested that the use of horses should be resumed temporarily.

Mr. Wilson, electrical engineer of the M. & S. M. Railway Co., recently paid a visit to Kolar in connection with the proposal to adopt electric lighting at the stations on the Kolar Gold Fields Railway, current being supplied by the Kolar Mines power station.

The recent step taken by the Mysore Durbar to control the uses of [illegible] current in Bangalore and Mysore show that it is the intention of the Electricity Department in future to refuse to supply current [illegible] lighting power installation in those cities and in the [illegible] of Bangalore, unless such installations have been [illegible] by a licensed contractor. Contractors, who are not [illegible], will be separately licensed for the station. The [illegible] and the object of issuing licences is to ensure [illegible] sufficient technical qualifications and [illegible] that their work will be satisfactory, and, as far as possible, to prevent defective installations.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Compañía Alemana Transatlántica de Electricidad have petitioned the Argentine Chamber of Deputies asking that coal and petroleum should be exempted from the operation of the new law, which imposes a 5 per cent. import duty on goods hitherto imported free.

The Anglo-Argentine Tramways Co. have also presented a petition to the Chamber of Deputies asking that they should be exempted from the payment of the 5 per cent. import duty, so far as effects the construction of their underground lines and the surface lines connected therewith. The company's underground system was projected on the basis of cost prices of articles, free of duty.

There has been established in the Patents and Trades Marks Office at Buenos Aires a register of the designations of firms or enterprises engaged in trade, industry and agriculture in Argentina. Applications for inscription on this register must be made on stamped paper of 10 pesos currency (about 17s. 6d.), and in accordance with the regulations which the office will issue in due course.

Costa Rica.—An important ruling, affecting manufacturers of well-known articles sold under trade marks which are not registered in Costa Rica, was recently given by the President of the Republic.

A certain article had been sold in Costa Rica for many years, but neither the name nor the mark had been registered. A local company secured the registration of a similar mark, and served notice of its intention to prosecute infringements. The users of the original mark contended that the two marks were not identical, and the local company thereupon applied for the registration of the original mark without variation. The President held that since the original mark was widely known to be the property of another company, the application by the local company would be refused, and hereafter no trade mark which is well known in Costa Rica by reason of sales of goods bearing the mark, or by advertisements, should be registered, except upon proper proof of ownership.

Lourenco Marques.—In 1914 a concession was secured by a British company from the Portuguese Minister of Colonies for the supply of electric power to the Government railway and docks at Lourenço Marques, a proviso being that it should not come into operation until a year after the termination of the war.

Events forced the hand of the Government, and the demand for power for Government purposes became so great that, on the advice of Messrs. Mordey & Dawbarn, consulting engineers, it was decided that the company should proceed with a part of the work. A futher unit of 400 kw. and two new boilers with automatic stokers were ordered at a cost of about £6,500. The boilers and stokers were completed in August, and the remainder of the plant is on its way to Lourenço Marques. The economy in coal effected by the former is said to be nearly 30 per cent.

MISCELLANEOUS NOTES.

Change of Name Case.—At the Mansion House on Tuesday a fine of £100, or 81 days' imprisonment, was imposed by the Lord Mayor on Christian Joseph Hahn, an enemy alien, for using a name other than that by which he was known at the beginning of the war.

It was stated that defendant was employed by Messrs. Sanders, Rehders & Co., and that Mr. Sanders suggested that he should make his signature "less aggressively German," and a clerk then said it looked like "Neale." Since then he had been addressed as Neale as a joke, but everyone knew him as Hahn. Defendant said he had never concealed his name or that he was a German.

Enemy Firms Wound Up.—The Controller of the Quarzlampen Gesellschaft m.b.H. has applied for a release. Objections to the Board of Trade before March 17.

Claims against the Mea Magneto Co. (Ltd.) are to be sent by March 31 to Mr. C. R. Beeby, 66, Basinghall-street, London, E.C.

The Board of Trade has ordered the winding up of 422 businesses controlled by alien enemies. The latest list includes Mersey Chemical Works (Ltd.), Alderman's House, Bishopsgate, London, E.C., manufacturers of dyes and other chemicals (Controller: W. E. Mounsey, 3, Lord-street, Liverpool); Meirowsky & Co., Carriage-street, Old Trafford, Manchester, electrical insulation manufacturers (Controller: G. H. Warmington, 33, St. Swithin's lane, London, E.C.).

Register of Employees.—By an Order in Council of 13th inst., employers must now keep a register of all male employees of 16 years and over, instead of between the ages of 18 and 41, as hitherto.

Tribunal Case.—At Bolton Munitions Tribunal last week an electrician employed by the Corporation applied for a leaving certificate on the ground that his skill and qualifications were not employed to the best national interest in his present employment.

Applicant wished to go to a neighbouring Council's electrical distribution plant to take charge. His present wages were only 2 guineas per week, while at the other place he could get £2 10s.

It was stated that applicant was engaged on work of great national importance and the Corporation had spent over £7,000 on additional plant at the request of the Government. There was no one to replace him.

The leaving certificate was refused.

Workmen's Committees of Ministry of Labour.—A committee has been appointed to advise the employment department of the Ministry of Labour on matters affecting workmen in the building trades in connection with the working of the Employment Exchanges.

The Committee includes Messrs. J. H. Edmiston (Operative Plumbers), J. Kinniburgh (Electricians), E. J. Vickers (Heating Engineers), and W. Wentworth (Woodcutting Machinists).

The Minister proposes to take steps to form a corresponding committee of employers' representatives and similar committees in other trades.

TENDERS INVITED.

Turbo-alternators, Transformers and Condensing Plant.

GLASGOW.—The Corporation of Glasgow invites tenders returnable April 5 for Turbo-alternators (15,000 kw.), transformers and condensing plant for their new generating station at Dalmarnock. Particulars from W. W. Lackie, Chief Engineer and Manager, 75, Waterloo-street, Glasgow.

Arc Lamp Carbons.

ST. PANCRAS (London) Borough Council invite tenders for the supply of arc lamp carbons, delivery to be made as required. Specification, conditions of contract and form of tenders from the Electricity Department, Offices 57, Pratt-street, Camden Town, N.W. Tenders to the town clerk, Mr. C. H. F. Barrett, by noon of Thursday, April 12.

BUENOS AYRES Municipality invite tenders for the supply of Electric Carbons during 1917. Conditions of tender may be consulted at the Oficina de Licitaciones, Avenida de Mayo 525, Buenos Ayres, when tenders will be received until March 30.

Electrical and Tramway Stores, Meters, &c.

BOLTON Tramways Committee require tenders by noon March 19 for one year's supply of overhead materials, lamps, carbons, insulating materials, gear and pinion wheels, castings, &c. Specifications from the General Manager.

DUNDEE Corporation require tenders by 9 a.m. March 28 for 12 months' supply of Meters and Electrical and General Stores to their electricity department. Specifications from the Electricity Dept. Offices, Dudhope, Crescent-road, Dundee.

RHONDDA Urban Council require tenders by noon March 21 for one year's supply of House Service Meters. Specification from the Electrical Engineer, Electricity Works, Porth, Glam.

The Town Clerk, Cardiff, will receive tenders until 10 a.m. Feb. 22 for six months' supply of Electric Lighting Sundries, Ironmongery, &c., to the Welsh Metropolitan War Hospital, WHITCHURCH, near Cardiff. Forms of tender, &c., from the Clerk and Steward.

TOXTETH PARK Guardians require tenders by noon March 19 for three months' Electrical Supplies. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

WARRINGTON Guardians require tenders by 5 p.m. March 20 for six months' supply of Electrical Goods, Ironmongery, &c. Forms of tender from the Clerk, Bewsey-chambers, Warrington.

Synchronous Condensers.

The TORONTO ELECTRIC COMMISSIONERS invite tenders for Synchronous Condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28.

Electric Light and Power Concession (Extension of Time).

The time for the receipt of tenders for a 30 years' concession by the Government of Grenada for Generating and Supplying Electricity for Lighting and Power in the town of St. George's and the residential suburbs has been further extended, and tenders will now be received at the Office of the Colonial Secretary up to March 31. The concession will be renewable, and the Government retain the sole right to purchase at a price to be fixed by arbitration. The contracting firm will be allowed to import free of duty all materials required for electric lighting. Particulars from the office of the Colonial Secretary, Grenada, British West Indies.

TENDERS RECEIVED AND ACCEPTED

DERBY.—The Council have accepted the tender of E. Morley & Sons (£12,150) for extension of power station, and that of J. A. Aiton, Ltd. (£424) for the supply of steam piping.

KEIGHLEY.—The tender of Messrs. Hugh Spencer & Sons has been accepted for electrical work at the Keighley War Hospital and at the Morton Banks Sanatorium for one year.

CHELTENHAM.—The Corporation have placed an order with Messrs. Ransomes, Sims & Jefferies for an electric vehicle at £924.

NUNEATON.—The Electricity Committee has placed an order with Messrs. G. & J. Weir & Co. for a steam-driven feed pump at £110.

MELBOURNE (VICTORIA).—The City Council have accepted the tender of the General Electric Co. for the supply of 10,600 assorted metal filament lamps at £790. 6s. 3d.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Metropolitan Electric Supply Co. (Ltd.)

The 30th Ordinary General Meeting was held on Tuesday, Mr. A. W. Tait, the chairman of the company, presiding.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice convening the meeting and the auditors' report.

The CHAIRMAN stated that the gross revenue for the past year had been £277,909, an increase on that of the previous year of £48,708. The units sold had been 24,595,118, an increase of 4,750,388. The gross revenue showed an increase of approximately 21 per cent. and the units sold an increase of approximately 24 per cent. The gross revenue obtained was the largest since the company lost the Marylebone area. Those were gratifying figures of increase, but he must ask the shareholders to bear in mind that we were living in exceptional times and that a large part of the increase was attributable to power supplied for special purposes, particularly in the company's western area and also in a measure to the increased charges for the supply which the company had had to impose, in common with all other London companies, to cover part of the great increase in cost of generation. The growth in the western area had consequently been abnormal, but it was also encouraging. The company still continued to suffer from the lighting restrictions, but the directors hoped that some of the lost revenue might be regained during the current year. Return to normal conditions could not, however, be looked for until the conclusion of the war. There had also been a certain loss of revenue due to the Summer Time Act. The total number of new connections made during the year was encouraging, but the greater proportion had been in the western area. The costs of generation and distribution of electricity and management and other expenses were clearly set forth in the revenue account. The only item which showed any serious advance was that of coal, and this the shareholders would naturally expect in consequence of the large increase in the number of units generated and sold. There was, however, in addition, a considerable increase in the item owing to the increase in price per ton, which was no less than 25 per cent. on the average price paid in 1915. They must expect some further substantial advance in the present year. It was a matter of vital necessity to the company to maintain larger stocks of coal; at present they had a reasonable stock and were well covered for future supplies. The amount set aside to depreciation and reserve fund was £40,000, compared with £27,000. The capital expenditure had increased during the year by £34,493 to £2,293,093. If an electric supply business was to be progressive and successful, capital expenditure in some from or another must continue from year to year. The investments stood at cost (£229,721) in the balance sheet, whereas the approximate value of those on the 15th ult. was £207,211. The securities were largely of the trustee class. The directors did not consider it necessary to depart from the practice of dealing with depreciation on investments as and when the same might be realised. On the liabilities side the loan from bankers, which stood at £135,000, showed a decrease of £5,000 compared with the previous year, notwithstanding the amount of capital expenditure which had been undertaken in that period. The depreciation and reserve fund, with the addition of £40,000 from the year's revenue, stood at £377,358. The amount appropriated from revenue had not been arrived at by any process of taking certain percentages on the various items of capital expenditure based upon the assumption of their probable life, but it had been considered a reasonable provision for a company whose assets were of such magnitude to set aside for the purposes of depreciation and reserve. Referring to the question of the consolidation of the electric supply undertakings of London, he said he only hoped that when the proper time arrived for the negotiations to be taken up again with the same end in view the subject would be approached with a broad and give-and-take spirit by all the London supply companies and also, he trusted, by the London County Council. After warmly recognising the excellent work done by the staff, he concluded by proposing a resolution for the adoption of the report and accounts, and the payment, in addition to the interim dividend of 1s. per share, of a further dividend of 2s. per share on the whole of the ordinary shares.

Mr. W. HARRISON CRIPPS seconded the resolution, and after a brief discussion the motion was carried unanimously. The retiring directors and auditors were re-elected, and the proceedings terminated with a vote of thanks to the chairman.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—At the meeting on Wednesday it was reported that the capital expended during 1916 on account of the Bournemouth Order (1890), the Poole and Branksome Order (1897), the Christchurch and District Order (1899) and the Pokesdown Order (1902) amounted to £2,293, making a total expenditure £492,916. The year's profit after deducting generation and distribution costs, rent, rates, taxes, wages, directors' fees, general establishment and other charges, and proportion of salaries, was £35,215, and with £3,607 brought forward the total was £38,822. Deducting interest on debenture stock and on temporary loans (£8,782), leasehold and special redemption funds and interest (£2,047), and amount carried to reserve for depreciation, &c. (£8,000), the balance available was £19,993, 5s. 9d. Interim dividends on the 4½ per cent. preference shares, on the 6 per cent. second preference shares and on the ordinary shares at the rate of 5 per cent. per annum for the half-year ended June 30 (less tax) have been paid, leaving for further distribution £11,443, 5s. 9d. Final dividends on the 4½ per cent. preference and the 6 per cent. second preference shares for the half-year ended Dec. 31, 1916, have also been paid, and the directors recommended that a final dividend on the ordinary shares at the rate of 7 per cent. per annum, for the half-year ended Dec. 31, 1916 (less tax) be declared (making 6 per cent. for the year), leaving £2,265, 3s. 3d. to be carried forward. The total applications received at Dec. 31 last amounted to the equivalent of 11,459 kw., an increase of 910 kw., and the total number of units sold was 4,082,836.

BRITISH ENGINE, BOILER & ELECTRICAL INSURANCE CO. (LTD).—At the recent meeting the directors reported that an interim dividend of 5s. per share (less tax) was paid in July last and, after writing off £7,553 from investments and furniture, &c., and adding £5,000 to reserve for current risks, the credit balance is £8,360. The directors recommended payment of a final dividend of 6s. per share and a bonus of 4s. (both less tax) for the year 1916, which would absorb £7,781.

Mr. R. CHARLES LONGRIDGE (Chairman) said that the results of the past year's operations had been most satisfactory, having regard to the conditions under which business had been carried on. There had been a marked growth in the number of firms insuring their plant against breakdown, with the result that the premium income had increased from £117,112 to £125,851—the largest advance in any single year, with one exception, since the formation of the company. During the year, however, they had felt the effects of a noticeable increase in the cost of repairs and in the cost of travelling expenses, &c. The profit earned, nevertheless, showed only a small reduction from the previous year. The company were gratified by the honour conferred upon its chief engineer (Mr. Michael Longridge, M.A., M.I.C.E., M.I.M.E.), who has been elected to the position of President of the Institution of Mechanical Engineers.

BROMPTON & KENSINGTON ELECTRICITY CO. (LTD.)—For the year ended Dec. 31, 1916, the directors recommend, after appropriating £7,150 to depreciation and reserve, a final dividend at rate of 7 per cent. on the preferred shares and a final distribution at rate of 10 per cent. on the ordinary shares, making 9 per cent. for the year (less tax), carrying forward £5,075.

BRUCE PEEBLES & CO. (LTD.). The total profit for the year 1916 amounts to £21,168 11s. 2d., and after deducting administration expenses, interest paid on the mortgage debentures, and allowing for interest accrued on the unsecured debentures and for depreciation, the net profit is £11,930 1s. 9d., which is subject to excess profits duty and control taxation for the years 1915 and 1916, the amounts of which have not yet been ascertained. The works have been entirely employed during the year on War work. Having regard to the abnormal times and difficulties the directors consider the results are satisfactory.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. D. Murray) said that the severe lighting restrictions had affected them adversely, but the increased demand for power had compensated them somewhat. Coal cost £800 more than in 1915, and rates and taxes increased by £100. He thought that if they could pay 5 per cent. the shareholders would be contented.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—The gross earnings of the West End undertaking from sales of current, rents, &c., were £150,173 (against £138,961 in 1915), the expenses (excluding depreciation) were £78,831 (£70,068), and the net earnings were £71,342 (£68,893). Adding balance brought forward (£18,041) and interest accrued for 1916 (£3,537), the total available is £92,920. After providing for interest on debenture stock (£17,829) and setting aside for depreciation £22,000, the balance is £53,090. Out of this has been paid the dividend on the preference shares for the year (£18,000), and an interim dividend for the first half of 1916 at rate of 4 per cent. per annum on the ordinary shares (£8,000), leaving to be dealt with £27,090. The directors recommend that a final dividend be paid on the ordinary shares for the second half-year at the rate of 6 per cent. per annum, making 5 per cent. for the whole year, absorbing £12,000, and that there be carried forward £15,090. The company has now connected to its West End mains a total equivalent of 724,418 (30 watt) lamps; 457,185 in lighting, 42,798 in heating and 224,435 (9,025 H.P.) in motive power.

The gross earnings of the City undertaking from sales of current, rents, &c., were £176,464 (against £158,357), and the expenses were £110,909 (£94,590), the net earnings being £65,555 (£63,767). With balance from previous year (£18,000) the total available is £83,555. After providing for interest on debenture stock, loans and advances (£29,816), the balance is £53,738, 16s. 8d., out of which has been paid the dividend on the preference shares (£18,000), leaving £35,738, 16s. 8d. The directors recommend that £17,738, 16s. 8d. be transferred to general reserve (income) account, and that £18,000 be carried forward. The company has now connected to City mains the total equivalent of 748,623 (30 watt) lamps: 319,160 in lighting, 69,640 in heating and 359,823 (14,470 H.P.) in motive power.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The total capital expenditure on Dec. 31, 1915, was £2,648,764, and the expenditure during 1916 on additions, extensions and replacements was £7,775, making £2,656,540. The total amount written off prior to Dec. 31, 1915, was £618,932, and a further amount of £5,587 has been written off in respect of buildings, plant and other works dismantled during 1916, making the net expenditure at Dec. 31 last £2,032,020, or an increase of £2,188 during 1916. The annual profit has again been prejudiced by the enforced reduction of lighting, by the further increased cost of coal and of all other items or production, and by the effects of the Summer Time Act. The revenue for the year was £330,751, and interest on investments and discounts, &c., was £2,184, a total of £332,936 (against £311,819 in 1915). Deducting expenses of generation and distribution (£103,322), repairs and maintenance of buildings, machinery, &c. (£9,747), street lighting expenses other than supply of electricity (£3,217), rent, rates, taxes, management expenses and special charges (£82,824) the balance is £133,825, and with £18,024 brought forward, the total available revenue is £151,849. Of this sum the following amounts have been distributed or provided for: Interest on loan from bankers, consumers' deposits, &c. (£2,841), interest on first and second debenture stock for year 1916 (£25,962, 10s.), interest transferred to debenture stock premium redemption account (£1,622), leasehold redemption account, interest and appropriation (£309), contributions to employés' provident and benevolent funds and under National Insurance Act (£1,567), stores written down (£47), and amount transferred to reserve (£40,000), leaving available for dividends on preference and ordinary shares, &c., £79,501.

The directors now recommend that the following dividends for the year be declared (less tax): On the preference shares, 12s. per share, being at full rate of 6 per cent. per annum; on the ordinary shares, 16s. per share, being at rate of 8 per cent. per annum (as against a distribution of 8 per cent. for 1915). On account of these dividends 6s. per share on both classes of shares was distributed in September (£25,713), leaving to be distributed 6s. per share on the preference and 10s. per share on the ordinary shares. The total dividends for year amounted to £62,369, and the balance carried forward was £17,132. The average price per unit for private supply was 2·51d., against 2·27d. in 1915, and 2·26d. in 1914. The total number of consumers was 14,616, a decrease of 104, compared with 1915, and the connections were equivalent to 47,131 kw. (against 46,161 kw.). The reduction in the number of customers is entirely due to war conditions, which have caused the suspension of many businesses, notably among stockbrokers and foreign banks and firms. 33,758,872 units were generated (against 34,643,297 units), and the units sold 28,982,456 (against 479,079). The power and heating supplies continue to show a steady increase, the total units sold for these purposes in 1916 being as follows: Power 12,321,795 and heating 3,165,613 units, total of 15,487,408 units, or 54·9 per cent. of the total units sold for private supply. A considerable quantity of power is now being supplied to factories. Major the Marquess of Winchester, one of the directors, is still serving with the British Army in France, and leave of absence has been granted to Mr. A. F. Harrison, secretary to the company, to enable him to accept a commission in the Royal Defence Corps. The directors regret that nine members of the staff who joined H.M. Forces have been killed; 19 have been wounded or invalided, and one is a prisoner of war.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—Mr. J. B. Braithwaite presided over the meeting on Monday, and said that the results of the past year's working reflected very great credit upon both departments of the company's administration—the commercial side, under Mr. H. B. Renwick, and the technical side, under Mr. C. P. Sparks—particularly in view of the difficult circumstances which had surrounded all electric supply undertakings. The receipts from the sale of current alone had increased by nearly £44,000, and although the cost of coal had gone up 90 per cent. their coal cost during the past year showed an increase of only 65 per cent. compared with 1914. He might mention that whereas in 1914 the freight from the Tyne to London was 3s. per ton at the present time it was 18s. The total receipts on revenue account were £343,066, compared with £298,268 in 1915, and to that increase every item on the list contributed except the rental of meters, from which for the first time they had deducted the cost of repairs of meters. There was an apparent decrease in the interest and dividends receivable, but that was accounted for by the increased income tax deducted. The total expenses were £186,171, against £150,393, and the net revenue was £156,894, against £159,639. They had been able for the first time to debit the whole of repairs against revenue instead of against reserve for depreciation; and if a comparison were made on even terms the figure would be £167,000, against £159,000. The amount they were appropriating to depreciation was being increased from £40.000 to £45,000, and they intended ultimately to raise it to £50,000, which was the figure he had always had in his mind as the one they must reach before paying an increased dividend. It was somewhat unfortunate that during the war the riverside stations, which in the ordinary course of things were far more economical than stations dependent upon railway supplies, were now more expensive owing to the heavy rise in freights. At present rail-borne coal was cheaper than sea-borne coal. Fortunately, however, the company were able to use both, and by means of the interconnection between City-road and Wandsworth they were able to utilise their coal supplies at either end. After the war freights would no doubt come down with a run, and stations with water facilities should again prove their greater advantages. They were paying the same dividend as for the previous year—namely, 7 per cent.—on the ordinary shares, leaving £18,377 to be carried forward, against £14,499 brought in. They were carrying forward nearly £4,000 more, placing £5,000 more to reserve for depreciation, and were meeting the whole cost of the repairs, amounting to about £10,000, out of revenue. In addition they were writing off various suspense accounts. They could hardly have had a more difficult year than 1916 had proved, but so far their officers had managed to bring them through successfully. After writing off substantial sums from the reserve for depreciation they carried forward on that account £101,439, against £78,052 last year. The premium reserve account stood at £10,161. The arrangement entered into for giving a bulk supply to various tramways and lighting undertakings south of the Thames, at Sutton and elsewhere, had been working very satisfactorily during the past year, over one and a-half million units having been sold for that purpose, and they had now come to a similar agreement with the South London Electric Supply Co., in which they themselves were very large shareholders. They hoped that that further interconnection would be made by the end of the present year, and were expecting to sell to that company a large amount of current. As opportunity offered they were steadily pursuing the policy of linking up and concentrating electric supply in a smaller number of big stations rather than in a large number of small stations. With regard to their scheduled site at Barking for a large power house, that was now carefully protected and secured beyond question. With regard to the actual progress made by the company during the year, it would be seen that applications were secured amounting to over 4,500 kw., and the current actually sold showed an increase of about 4,500,000 units, which, in view of all the restrictions and difficulties, met with was a very satisfactory result. He was afraid they must anticipate the war continuing throughout this year, and that would probably mean that the high price of coal would continue, with probably increased difficulties in that respect, and also restrictions in various other directions. The Summer Time Act would come into force earlier this year than it did in 1916. The second advance of 10 per cent., however, in the price of current, which came into effect on April 1, 1916, would help their receipts in the first quarter of the present year, compared with the corresponding period of last year, and as they had sold an extra 1,000,000 units already, they would see that the company had done very well up to date, though he did not want to predict what the final result would be for the year.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—The directors have declared further interim dividends on account of the year 1916 of 3½ per cent. on the preference shares (making 7 per cent.) and of 7 per cent. on the ordinary shares, less tax in both cases. The directors will not be in a position to adjust finally the accounts for 1916 until they have settled with the Ministry of Munitions in regard to the duties payable.

JARROW & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The revenue for 1916 was £8,755, a decrease of £100, compared with 1915. After paying expenses (including interest on debentures and loans) and making a provision of £800 for renewals, there remains £2,213. With £1,039 brought forward the available balance is £3,253. The directors now propose to place to reserve £900 and to pay a dividend on the ordinary shares at the rate of 3 per cent. for the year, leaving £855 to be carried forward.

MELTON MOWBRAY ELECTRIC LIGHT CO. (LTD.) At the recent meeting a dividend of 2 per cent. was declared, £800 was placed to plant renewals reserve and £395 carried forward. The chairman (Mr. W. J. New) said that the report was satisfactory under the circumstances, though the dividend had fallen off. No reduction in cost of coal could be expected, and a further increase in charges to consumers would be made at an early date. With £867 brought forward the year's revenue was £2,549 14s. 5d., and having provided £955 debenture interest, the available balance was £1,594. 14s. 5d.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.).—The connections to the company's system at the end of 1916 amounted to 282,750 H.P., compared with 258,390 H.P. in 1915, or an increase of 24,360 H.P. The profit for the year is £224,266 (against £204,419), and with balance brought forward the total is £229,457 (against £210,365), against which has been charged interest on debenture stocks, loans, &c. (£60,568, against £58,698), leaving an available balance of £168,889 (£151,669). The directors recommend a dividend of 2½ per cent. on the preference shares, making with the interim dividend 5 per cent. for the year (£45,617), and a dividend of 4½ per cent. on the ordinary shares, making with the interim dividend 7 per cent. for the year (£55,838), the transfer of £30,000 to reserve for depreciation and of £30,000 to general reserve, carrying forward £7,434. 15s. 11d. Out of the amount passed to general reserve account at the last annual meeting (£28,000) the balance of the cost in connection with the issue of first and second mortgage debenture stocks, amounting to £13,797. 18s. 5d., has been written off, and £12,593 was transferred as a provision for possible loss on realisation of investments, leaving in general reserve account £2,013. 15s. 5d. The plant, mains, &c., have been efficiently maintained, the sum of £98,199 having been spent thereon out of revenue. The additions to capital expenditure account for the year amounted to £63,881. 14s. 6d., and represent payments on account of extensions in progress at Carville and Dunston power stations, and also to the general distribution system. As a result of negotiations which have taken place between the boards of the Cleveland & Durham Electric Power Co. (Ltd.) and the company, the directors recommend that the company should make an offer to acquire (by an exchange of shares) the shares and funded preference income stock of the Cleveland Co. The proposed exchange of shares will involve an increase of the company's capital.

NORTHALLERTON ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting it was reported that the past year's net profit was £232. 4s. 5d., against £496. 0s. 2d. in 1915. The sum of £156. had been expended out of revenue in order to maintain the buildings, machinery, &c. The decrease in profits was entirely due to the effects of the war.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—The accounts for 1916 show that £5,500 has been added to depreciation account and £925 written off hired motors. The reserve fund is increased by £1,000. The dividend on the ordinary shares is at the same rate as for the preceding year, 8 per cent. for the half-year, making 6½ per cent. for the year, and £2,009 is carried forward, against £3,114. The lamps, motors and heating devices installed (reckoned as 32-watt lamps) were 19,596, making a total equivalent of 242,853 lamps. The increase in horse-power of motors was 576, making a total of 5,144 H.P., of which 3,580 were let out on hire. During the year 1,071 yards of l.t. distributing mains were laid, making a total length of 35 miles 525 yards, also 5 miles 444 yards of e.h.t. three-phase mains, bringing the total of those mains up to 7 miles 1,099 yards. The maximum winter load on the plant was 2,756 kw. and the total of the units sold for the year was 5,526,482, an increase of 9·3 per cent. A large amount of work was accomplished during the year in connection with the new generating station.

The report and accounts were adopted at the meeting on Friday last.

OXFORD ELECTRIC CO. (LTD.).—Sir Henry Mance stated at the recent meeting that the decrease in the dividend on the ordinary shares of 1 per cent. was due to the war. The colleges were practically all closed, the lodging houses had suffered severely and were most of them empty. The "Daylight Saving" Act had probably caused a loss of £1,000, while the restricted lighting in the streets and shops made a very appreciable difference in their revenue. On the other hand, the demand for power, heating and cooking helped them to some extent, and the hospitals made up for the loss of one or two colleges. They had increased the price of current owing to the great increase in the price of all commodities. With regard to the future, he feared they would have to wait until the end of the war before they could expect to see any considerable increase in their business. Taking one consideration with another, he thought that when things came back to their normal conditions they might reasonably look forward to a speedy return to that degree of prosperity which the company enjoyed before the war.

RUSHDEN & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—At Dec. 31 last there were 151 consumers (an increase of 28 over 1915) and the motors connected increased from 292½ H.P. to 459 H.P. The units sold were 464,713, an increase of 86 per cent., and the revenue from sale of current increased from £1,699 to £3,060. For depreciation of hired motors £70 has been written off, £400 has been added to general depreciation account and £163 written off preliminary expenses. A dividend of 5 per cent., absorbing £888, has been declared, leaving £94 to be carried forward.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.).—The gross receipts for 1916 were £59,037 8s. 10d. and the expenditure was £30,649 7s. 11d., leaving a profit balance of £28,388 0s. 11d. With £3,009 18s. 8d. brought forward the total amount available is £31,397 19s. 7d. After placing to depreciation account £7,000, also making provision for the dividend on 6 per cent. cumulative preference shares to the end of the year, debenture and other interest, &c. (£15,344 18s. 2d.), the balance is £16,053 1s. 5d. Out of this the Board recommend a dividend on the ordinary shares at the rate of 5 per cent. for the year (amounting to £13,000), carrying forward a balance of £3,053 1s. 5d. During the year new connections representing the equivalent of 26,481 (35 watt) lamps, or 927 kw., were added to the Company's system, making a total connection at the end of the year of 392,999 (35 watt) lamps, the equivalent of 13,754 kw. The units sold during the year amount to 6,698,357, an increase of 380,217 over the previous year.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Lord Geo. Hamilton, who presided at the meeting on Friday last, said that the traffic results of the five transportation companies amounted to £6,038,529, an increase over 1915 of £557,385. The revenue liabilities of those companies, which included the working expenses, interest on debentures, guaranteed stocks, rent-charge stocks and preference stocks (except the second preference stock of the District Railway), as well as the provision made for depreciation and reserves, amounted to £5,531,561, an increase of £501,783. The sum retained for depreciation and reserve by the railway companies was increased by £45,000. The total surplus of the operating companies, after paying working expenses and all prior charges, including preference dividends, but before allowing for reserves, had increased by £100,184. The less satisfactory feature of the position had been the accelerated rate of increase in working expenses, and there was every indication that those would become still greater in the current year. Owing to the scarcity of both material and labour, the maintenance of the various properties, while sufficient for safe and regular operation, had not been up to the usual high standard. These facts induced the railway companies materially to increase their reserves rather than further increase dividends. The total income of the Underground Co. amounted to £653,361, a decrease of £27,380 compared with 1915. That reduction was practically equal to the reduction in the dividends of the Associated Equipment Co., the return from the transportation companies being in the aggregate nearly the same as in 1915. That income permitted the payment of all fixed and cumulative charges and 5 per cent. (tax free) for the year on the six per cent. income bonds. There was a new item in the revenue account—namely, "Difference in exchange"—amounting to £20,289. The coupons on the 4½ per cent. bonds and on the income bonds were payable at certain places abroad at fixed rates of exchange, and British holders had taken full advantage of the difference in exchange by sending their coupons abroad for collection. The company had paid in income-tax on the interest on the 4½ per cent. bonds and the income bonds £42,000 more than in 1915, and that in spite of the reduction in the total interest paid through the reduction in the rate from 6 per cent. to 5 per cent. That, with the increased loss in exchange, made a total additional charge of £57,000. If conditions as to exchange and rate of income-tax had been as in the days before the war they would have had sufficient income not only to pay the full 6 per cent. on the income bonds, but also £35,000 towards dividends on the ordinary and "A" shares. Under present conditions no considerable schemes of development and improvement to the properties in which they were interested could be carried out. Arrangements, however, had been completed for the through running of the London electric railway trains over the London and North-Western line to Watford, and it was expected that that service would be commenced on April 2. The greatest obstacle to the increased prosperity of the operating companies at present was the increase in cost of everything they required. The aggregate revenue from poster advertising on the stations, in the cars and lifts and on the omnibuses was not far from £100,000. The recent order issued by the Government regarding the use of advertising posters prohibited the display of posters in many cases, and that was likely to result in the loss of a considerable part of their advertising revenue. While the directors were still believers in the lowest reasonable fares, both in the interest of the public and of the shareholders, the increase in the cost of all the materials the operating companies purchased would probably compel them to consider a re-adjustment in rates of fares. That was not as simple a proposal as it appeared, for nothing was easier than to drive away traffic, whereas to regain it was a long and slow process, but the directors believed that the necessity for some re-adjustment to the new price levels would be recognised by the public who made use of their enterprises.

WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS (LTD.)—The profit earned during the year ended Jan. 31, after deducting administration expenses, amount to £40,080 (against £39,819 in previous year). Deducting amount transferred to credit of reserve account (£11,500, against £11,000), and adding balance from previous year (£16,931, against £14,212), the sum available is £45,511 (£43,031), the directors propose to declare a dividend at rate of 8 per cent. for the year, which will absorb £25,600 (£25,600), leaving to be carried forward £19,911 (£17,431). The new generating plant at Weardale power station has been delivered, and it is expected that the erection will be completed at an early date. With this new plant the coke oven gas will be utilised in an internal combustion engine, instead of under boilers, as is done at present. The extensions to Grangetown power station have just been completed and are now in operation. Capital expenditure incurred during the year on these new works amounted to £37,738. The revenue from units generated at the different power stations has been satisfactorily maintained, the amount of waste heat and gas having been approximately the same as during the previous year, but the amount is still below the average obtained prior to the war. Arrangements have been made, in conjunction with the Cleveland & Durham Power Co., under which a power station will be erected at Horden for the utilisation of waste heat and gas from coke ovens being constructed by the Horden Collieries (Ltd.), and plant of a capacity of 3,000 H.P. will be installed.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

BRITISH ELECTRON CO. (LTD.) (146,067). Private company. Reg. Feb. 1[illegible], capital £[illegible],000 in £1 shares, to carry on the business of [illegible] and dealers in metals, metal scrap and ores, [illegible] metallurgists, tinners, &c. First directors are H. D. [illegible], [illegible] Keith [illegible] and C. R. Adams.

CENTRAL SUPPLIES CO. (LTD.) (146,013). Private Company, reg. Feb. 1[illegible], capital £2,000 in £1 shares (1,000 pref.), to carry on the business of [illegible] dealers in electrical and mechanical goods, novelties and [illegible] [illegible] instruments, &c. Reg. office: 4, [illegible]

CHAS. W. COOK (LTD.) (14[illegible],981). Private Company, reg. Feb. 13, capital £7,000 in £1 shares, to take over the business of an engineer and [illegible] carried on by C. W. Cook at Manchester, also to carry on the business of electrical engineers, chemical manufacturers, &c. First directors are C. W. Cook (governing director) and C. [illegible] and A. W. Cook. Reg. office: University Works, Bridge-[illegible], Manchester.

DEPTFORD STEEL & IRONWORKS (LTD.) (146,087). Private Company, reg. Feb. 1[illegible], capital £20,000 in £1 shares (10,000 preferred ordinary) to take over the business of an electro-metallurgist, galvaniser, &c., carried on by N. C. M[illegible] as the Deptford Steel & Ironworks and the H[illegible] [illegible] Co.

FAIRFIELD SUPPLIES CO. (LTD. (145,953.)—Reg. Feb. 9, capital £4,000 in £1 shares, to take over the business of iron and steel merchants carried on as the Fairfield Supplies Co., also to carry on the business of engineers, tool makers, manufacturers of and dealers in motor cars, electrical accessories, &c. Private company. First directors are G. Schoolfield (managing director) and P. S. Abraham (both permanent).

GOODRICH & HAMLYN (LTD.) (146,020).—Private company, reg. Feb. 15, capital £4,000 in £1 shares, to carry on the business of iron-founders, mechanical and electrical engineers, metal-workers, &c. First directors are :—W. F. Goodrich and W. R. Hamlyn.

INTERNATIONAL UTILITIES (LTD.) (145,894)—Private company. Capital £20,000 in 15,000 ordinary shares of £1 each and 100,000 deferred shares of 1s. each, to carry on the business of iron and brass founders, engineers, hardware manufacturers, boiler makers, electrical engineers, &c. First directors are H. de Courcy Hamilton, J. H. Sofio and W. M. McIntosh.

LITTLE WONDER BATTERY CO. (LTD.) (146,385)— Private company Reg. March 9, capital £7,500 in £1 shares (3,100 10 per cent. cumulative preference), to take over the business of manufacturers of electric dry batteries of Albert A. Ball & Co. (Ltd.). Reg. office: 4, Budge-row, E.C.

NETHERTON METALLIC WORKS (LTD.) (9,751).—Private company, Reg. in Edinburgh on Feb. 7; capital £4,000 in £1 shares, to carry on the business of metal workers, mechanical and electrical engineers, &c. First directors are :—Jas. Martin, A. W. Torrance, W. Stevenson and A. K. Reid. Reg. office: 243, Vincent-street, Glasgow.

ROBERT H. LASH (LTD.) (146,158)—Private company. Reg. Feb. 22, capital £5,000 in £1 shares, to take over the business carried on by R. H. Lash at Letchworth and London, and to carry on the business of mechanical and electrical engineers, makers of engineering tools, &c. R. H. Lash is first director. Reg. office: 29-31, Portugal-street, W.C.

ROTAX MOTOR ACCESSORIES CO. (LTD.) (145,967.)—Private company. Reg. Feb. 9, capital £175,000 in £1 shares, to take over the business carried on at Willesden as the Rotax Motor Accessories Co., also to carry on business as manufacturers of lighting equipment for railways, tramways, motor cars and vehicles, &c. First directors are Eugen Aron and Hermann Aron (both permanent managing directors). Reg. office, Rotax Works, Chandos-road, Willesden Junction, N.W.

YOUNG & HODGSON (LTD.) (146,199.)—Private company; reg. Feb. 26, capital £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in hardware, glass, china, electric light and gas fittings, electric bulbs, chemicals, motor cars and cycles, &c. Reg. office, 1, Britannia-street, King's Cross-road, W.C.

MORTGAGES AND CHARGES.

BRECKNELL, MUNRO & ROGERS (LTD.)—Mortgage on lands, factories, &c., at Bristol, dated March 1, 1917, to secure all moneys due or to become due from company to Lloyds Bank.

LLANRWST ELECTRICITY SUPPLY CO. (LTD.)—A memorandum of satisfaction in full on Sept. 5, 1916, of first, second and third mortgage debentures dated 1905, securing £900, £600 and £400 respectively.

SEEAR, SCOTT & CO. (LTD.)—Particulars of £1,000 debentures created Jan. 26, 1917, have been filed, whole amount being now issued. Property charged: Company's undertaking and property, present and future. No Trustees.

CITY NOTES.

MEMORANDA.—(March 13).—Consols, 52⅞xd. Consols Pay Day, April 4. Stocks and Shares Ticket Day, March 28. Pay Day, March 29. Price of Silver, 36$\frac{9}{16}$d.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The warrants for the ordinary dividend (5 per cent.) will be posted on the 26th inst. and payable on the 27th inst.

BIRMINGHAM DISTRICT POWER & TRACTION CO. (LIMITED & REDUCED).—A petition for confirming a resolution reducing the capital of this company from £1,050,000 to £700,000 will be heard by Mr. Justice Neville on March 23.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The directors recommend a dividend of 7½ per cent. on the preference shares.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The board recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares (less tax), and a dividend (tax free) at the rate of 6 per cent. per annum on the ordinary shares (making 5 per cent. for the year 1916), both for the half year ended Dec. 31 last, and payable on the 2nd prox. In addition to the above the directors recommend the payment of a bonus on the ordinary shares of 2 per cent. for the year 1916 (tax free).

NATIONAL BOILER & GENERAL INSURANCE CO. (LTD.)—The directors propose to dispose of the £20,038 standing to credit of the profit and loss account for 1916 by paying a dividend of 13s. per share, less tax (£7,312), placing to reserve for excess profits duty £5,000, to reserve fund £3,000, and investment reserve, £3,000, carrying forward £1,726.

TRACTION & POWER SECURITIES CO. (LTD.)—The net profits for 1916 were £26,211, and £8,579 was brought forward. A dividend of 6s. per share is proposed (tax free), carrying forward £9,167.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the second quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1917, being at rate of 6 per cent. per annum. The transfer books will be closed from March 16 to 23, inclusive, and the dividend will be payable on the 24th inst.

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NOTES.

Electric Power Supply.

IT is announced that the President of the Board of Trade has decided to appoint a Departmental Committee "to consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of power for their proper development." We believe that neither the precise scope of the inquiry nor the composition of the Committee has yet been settled, but we hope that it will be a strong one, and that its members will command the confidence of the whole electrical industry. The decision of the Board has not been arrived at too soon, for many electric supply undertakings find themselves faced with great difficulties in maintaining their supplies of electrical energy for power, traction and lighting. In the majority of cases no private lighting consumers are being connected, and in some towns the tramway supply is cut off from time to time in order to give sufficient power to factories. Soon after the outbreak of war we urged Government departments to give reasonable facilities for extensions of plant, as we were aware of the importance of a regular and reliable supply of power for industrial purposes and the increasing tendency to adopt electric driving. Since then the situation has become more difficult, for, apart from the shortage of skilled labour and the difficulty of obtaining supplies of coal, many local authorities and supply companies are running without sufficient reserves of plant, and the chances of obtaining new plant or effecting repairs of the existing machinery are not very promising at present. A glance at the electric supply notes in another part of this week's issue will show the difficulties of several supply authorities. For months past we have had to record week by week a similar state of affairs in many districts, and it thus appears that the immediate future of some undertakings is beset with difficulties. We are glad, therefore, to see that Sir ALBERT STANLEY, who has first-hand knowledge of the great importance of a cheap and reliable supply of electrical energy for power purposes, has decided to obtain a report on the present position of affairs, and we hope that one of the results of the Committee's investigation will be that electricity supply authorities will be given better facilities for obtaining plant, so as to diminish the present risk of breakdown.

WE hope that another result of the Committee's work will be the evolution of a national scheme for the development of electricity supply after the war. In some cases temporary relief may be—and is, as a matter of fact, being—afforded by linking-up schemes and by taking supplies of energy in bulk from power companies; but there are a great number of small stations with inefficient generating plant which should be scrapped at the earliest opportunity. Instances of stations of this character may be found in almost any issue of THE ELECTRICIAN, but one of the most recent that has come before us is that of Worcester. The electrical engineer reported that more boiler plant was required, and as there were certain small boilers that had been in use for several years, he recommended that they be sold and a large new boiler purchased. The Electricity Committee, being afraid of incurring expenditure, referred the question to the Corporation, who referred it back to the Committee for a definite recommendation. The lot of the engineer who has to deal with a timid committee and a hesitating Council is an unhappy one. If anything goes wrong with the supply he has to bear the greater part of the blame, while the town and the nation suffer by the use of obsolete and wasteful plant, though the economies to be effected by new plant would more than pay for the interest and sinking fund of the capital expenditure entailed.

Engineering Standards Committee.

WE have from time to time drawn attention to the fact that the Engineering Standards Committee has not in the past received the support which it deserves, and that its work cannot bear fruit to the full extent until such support is forthcoming. We are glad to see from a note which we publish in another column, that local committees are being formed in some 12 countries abroad, and that in due course British standard specifications will be available both in English and in foreign languages at a flat rate of 1s. each. The work entailed in carrying out this programme is considerable, and must involve a corresponding amount of money; but it is satisfactory to note that the technical institutions, trade associations and manufacturing firms of this country have so far recognised the desirability of this work that a sum of £12,000 has been subscribed, and the Treasury is to ask Parliament to grant the Committee a sum of £10,000 for this special purpose. The benefits that will accrue to British trade and to the country at large through this action will undoubtedly be considerable, and, therefore, we hope that the Committee will continue to receive substantial support, not merely in this particular effort, but in its work as a whole. We do not know that the Committee's many activities are fully realised. Only last week we suggested that the Committee would do well to take up the standardisation of control gear. We now understand, however, that the standardisation of motor starters and controllers has been under the consideration of a sub-committee for some time past. Work is being carried out in close co-operation with the B.E.A.M.A., and the question of standardisation of a class of apparatus suitable for heavy duty is receiving careful consideration. Representatives of the I.M.E.A., as well as other large users, are also taking an active part in the work, so that there can be no doubt that the subject is receiving the consideration which its importance deserves. Work of this kind is of a somewhat delicate nature, and cannot be quickly carried through, but its value is undoubted, and the industry should be grateful, both theoretically and practically, for what is being done.

Welfare Study.

We have received a short pamphlet on the subject of Welfare Study, which we gather has been issued with the approval of the Ministry of Munitions. It is a very brief exposition of the importance of the subject, and is an attempt to answer some of the critics. The only argument advanced by the author, with which we do not wholly agree is the reason for carrying out such work. The reason given is that, apart from all question of general or individual comfort, welfare work pays. We quite admit that it pays; but the statement in this fashion may give the idea that it pays the employer, as distinct from the employé, and any such idea may arouse suspicion. In our opinion, it pays both the employer and the employé. It pays the employer because by this means every part of his organisation is working more willingly, and it pays the employé because he or she is in a happier frame of mind, and therefore in a more healthy condition of mind and body. The author rightly emphasises the point that the great object of welfare work should be to create a proper atmosphere, to promote a better mental attitude, a feeling that the worker is not a mere machine, and in return a sense of loyalty to the employer. We hope that this pamphlet will do something to convert the employer who still does not believe in welfare work, and that it will bring him to the view that much is to be gained by looking at things more from the human point of view. The time is past when the employer can afford to disregard his duty to labour. We only hope that engineering organisations will adopt this view before it is too late. We do not know yet what steps are being taken by the B.E.A.M.A. in this direction, but we trust sincerely that the subject is not being lost sight of, and that such questions as tariffs, which can never provide a substitute for a proper understanding with labour, are not [illegible] the consideration of other important matters. We are glad to see Mr. DUDLEY DOCKER'S reference to the subject at the recent meeting of the Federation of British Industries. He remarked that it will be necessary to speak plainly to labour in the future, not to be afraid of asking what they wanted, and not to be afraid to give what they ought to give for fear of something more being demanded. This appears to us to be a manly statement of the case and a recognition of the fact that there must be a mutual understanding between the two parties.

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Further Electrification on the Chicago, Milwaukee & St. Paul Railway. It is reported that on Jan. 27 the above railway decided to convert to electrical operation their line from Othello to Tacoma. The estimated cost is £1,250,000, exclusive of the locomotives. It is anticipated that the work will be completed in 191[illegible]

Committee on Supply of Electric Power.—At the meeting of the London County Council on Tuesday it was announced that the President of the Board of Trade proposed to appoint a departmental committee to consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of power for their proper development.

Having in view the position of the Council in the matter, Sir Albert Stanley considered it important that the Council should be represented on the Committee, and had suggested that the Council might be prepared to nominate Mr. G. H. Hume to serve as a member of the Committee. Having regard to the knowledge of the question which Mr. Hume possessed as it affected London, the County Council nominated him to represent them on the Departmental Committee, on the understanding that the Council is in no way committed as to its policy in the matter.

Birmingham Electrical Engineers Volunteers.—The work of the Birmingham Electrical Engineers (V.), attached to the R. N. Volunteer Reserve, is unknown to the majority of people, although it is highly appreciated by the Admiralty, and is fulfilling a very useful function.

Recruits are drawn from the following skilled trades:—Turners and fitters (with experience in screw-cutting), electrical instrument makers and repairers, wiremen (with experience in turning and fitting), armature winders, coppersmiths, acetylene welders, blacksmiths, moulders (metal), carpenters and joiners, and mechanical draughtsmen. They are sent to depot ships, where they are engaged in experimental and constructional work. Fifteen months ago the corps made arrangements with the Admiralty, whereby members were accepted for periods of temporary service and the scheme was started by 10 Volunteers being sent to H.M.S. Vernon. The numbers gradually increased, and the Admiralty was so pleased with the work done that it opened two more depot ships—H.M.S. Defiance and H.M.S. Actaeon to Birmingham recruits. Seventy local men are now on board these three depot ships, but altogether 170 men from the corps have served varying periods since January, 1916.

Recruits, skilled in the above-mentioned trades, are still needed urgently, and they have the double advantage of being able to enrol either for continuous service or for service at regular intervals for not less than two weeks at a time. The corps provides a splendid opportunity for those who wish to do their duty to the country, but who are under or over military age, &c. A naval representative attends at Thorp-street Barracks, Birmingham every Friday night between 6.30 and 7.30 to interview prospective recruits and to supply information. The commanding officer is Mr. David Shanks, J.P., and the company commander and adjutant is Mr. S. T. Pemberton, A.M.I.E.E.

Electricity in Agricultural Developments.—At a recent meeting of the Council of the I.M.E.A., the President (Mr. F. M. Long) referred to the Paper read by Mr. Kerr at the Annual Convention in June last, and suggested that the Council should take the initiative in developing this subject. The Council recognising the important part that electricity may be made to play in the better cultivation and greater production of the land, and in the extension of rural industries have formed the nucleus of what is ultimately intended to be a Committee representative of all interests with the object of a thorough investigation into the technical and commercial problems underlying the application of electrical energy for such purposes, by forming a small committee (with powers to add to its numbers), namely:

S. E. Britton, city electrical engineer, Chester (Chairman); F. M. Long, city electrical engineer, Norwich; H. Faraday Proctor, city electrical engineer, Bristol; J. Christie, engineer and manager of Electric Supply Dept., Brighton; S. T. Allen, engineer and manager of Electric Supply Dept., Wolverhampton; and F. Ayton, engineer and manager of Electric supply department, Ipswich.

To this committee, which will be known as "The Committee on the Development of Electricity in Agricultural Areas," Mr. W. T. Kerr, city electrical engineer, of Hereford, has been added, while two sub-committees have been formed to deal with publicity and technical matters with Mr. Kerr and Mr. Long as chairman respectively. The objects of the Committee will be:—(1) To investigate and advise upon the problems underlying the supply and use of electrical energy in agricultural areas for power, lighting, heating, culture and other purposes for farms, villages and rural industries; (2) to collect and collate information and publish literature bearing upon the above; (3) to co-operate with agricultural and other associations; (4) to investigate in co-operation with manufacturers the development, manufacture and adaptation of agricultural machinery and appliances for utilising electrical energy; (5) to promote the exhibition of such machinery and appliances at agricultural shows and elsewhere; (6) to offer assistance in arranging demonstrations and lectures in connection with farmers' associations, clubs, &c.; (7) to promote any legislation necessary to facilitate the application of electrical energy to agricultural areas.

Communications should be addressed to Mr. S. E. Britton, city electrical engineer, New Crane-street, Chester.

OBITUARY.

C. K. Hamilton.—We regret to announce the death of Mr. C. K. Hamilton, who was a member of Messrs. W. T. Glover & Co.'s staff for some 15 years. During the greater portion of the time he represented the company in the south of England. Mr. Hamilton, who had been in failing health for the past two or three years, died on the 15th inst.

Deaths on Active Service.—The following deaths on active service are reported :—

Sec.-Lieut. Cyril D. McCourt, London Regt., who has been killed in action, was 34 years of age, had taken the diploma in chemistry of the City and Guilds Institute, and was subsequently private assistant to Prof. H. E. Armstrong, and from 1903 to 1909 was chief chemist to the Morgan Crucible Co., and afterwards managing director of Radiant Heating (Ltd.) and chemist and technical adviser of the Bonecourt Surface Combustion Co. (Ltd.) and the Commercial Laboratories Ltd.).

Pte. W. Stevenson (K.O.R. Lancasters), reported killed, was only 19 years of age, and was until recently a conductor on the Blackpool, Lytham & St. Anne's tramways.

Pte. Wm. Boden (East Lancs Regt.), after being wounded by shrapnel, died of fever at Plymouth on the 8th inst. He was 25 years of age, and was formerly on the office staff of the Burnley tramways.

PERSONAL.

Sir William Crookes, O.M., F.R.S., has been elected a foreign member of the Swedish Royal Academy of Science.

Judging from the fact that 700 new members were enrolled during the past year, it is not surprising to learn that the popular retiring president of the M.T.A. (Mr. Arthur Goodwin, of "C.A.V." fame) has been elected for a second term of office.

The position of president of this growing and powerful trade organisation is by no means a sinecure, but Mr. Goodwin, from all accounts, has more than fulfilled the hopes entertained of him when elected in March, 1916.

In the estimates of the Ministry of Munitions for 1917-18 provision is made for an extra statutory grant of £300 a year to the widow and children of the late Mr. Leslie S. Robertson, who was drowned with Lord Kitchener.

Naval Appointments.—The following appointments are gazetted: *R.N.V.R.*—Dr. James R. Erskine Murray, F.R.S.E., to be temporary lieutenant. Lieut. Haydn T. Harrison to be lieut. commander.

Military Appointments.—The following appointments have been made :—

Royal Engineers (*T.F.*).—Major E. F. C. Trench, M.Inst.C.E., to be Lieut.-Colonel. Sergt. W. W. Wilson (from London Electrical Engineers) to be sec. lieutenant.

Royal Defence Corps.—Mr. A. F. Harrison (secretary of the City of London Electric Lighting Co.) has been granted a commission.

APPOINTMENTS VACANT AND FILLED.

London County Council invite applications for the position of electrical engineer in the tramways department, at a salary ranging from £1,200 to £1,500 a year. Applications on official form to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., must be returned by 1 p.m. April 23. *See an advertisement.*

An engineer is wanted at St. Andrew's Hospital, Northampton, with experience in managing oil and gas engines, and capable of running electric plant for a large establishment. *See advertisement.*

Neath Rural Council require a mains superintendent and a shift engineer. Applications by March 28.

Glasgow Electricity Committee recommend that Mr. R. B. Mitchell, superintendent of street mains, be promoted to the position of assistant electrical engineer, in succession to Mr. Page, at £600 per annum, rising by annual increments of £50 to a maximum of £800, and that Mr. G. L. Black, district mains superintendent, be appointed mains superintendent at £300 per annum, rising by annual increments of £25 to £500.

Mr. W. J. Carter, of Batley, has been appointed deputy electrical engineer at the Loughborough municipal electricity works.

INSTITUTIONS AND SOCIETIES.

Royal Society.—At the meeting of this Society held yesterday, a Paper was read by Prof. E. Wilson and Prof. J. W. Nicholson, on "Residual Magnetism in Relation to Magnetic Shielding." Communicated by Prof. J. A. Fleming, F.R.S.

Engineering Standards Committee.—The chairman of the committee, Sir John Wolfe Barry, K.C.B., F.R.S., has accepted the invitation of the Council of the Institution of Civil Engineers to give the "James Forrest" Lecture on Wednesday, May 2nd, at 5.30 in the afternoon. As the initiator of the organised movement of Standardisation in this country, the lecturer has very appropriately taken as his subject : "The Standardisation of engineering materials and its influence on the trade and prosperity of the country."

The growth of the principle of standardisation has been due in great measure to the steady work of the Engineering Standards Committee during the past 16 years, covering, as it does, most of the branches of engineering practice. The lecturer intends to draw particular attention to the new and important step taken by the committee which has for its object the furthering of British trade abroad through the wider dissemination in the British Dominions and in foreign countries of the British Standard Specifications translated into French, Spanish and Russian. Mention will also be made of the local Standards Committees which are being formed in some 12 countries abroad, and, lastly, of the fact that, when the necessary arrangements can be completed, British Standard Specifications will be available to the public, both in their English and foreign editions, at a flat rate of 1s. each, or its equivalent in foreign moneys. In connection with this development we are informed that the appeal which the committee has lately issued to the engineering industry of the country has so far resulted in the receipt of contributions amounting to over £12,000 from the leading technical institutions, trade associations and manufacturing firms, and that H.M. Treasury has quite recently intimated the intention to ask Parliament to grant the committee a sum of £10,000 for this special purpose.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 23rd (to-day)

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, S.W. Prof. P. Langevin will deliver (in English) the Third Guthrie Lecture, the subject being "Molecular Orientation."

TUESDAY, March 27th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. Great George-street, Westminster, S.W., Lecture on "The Decimal System of Coinage, Weights and Measures," by Mr. Harry Allcock.

WEDNESDAY, March 28th.

BIRMINGHAM LOCAL SECTION INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At Birmingham University, Edmund-street, Birmingham. Paper on "Machine-Switching Telephone Gear," by Mr. F. R. McBerty.

THURSDAY, March 29th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "Modern Improvements in Telegraphy and Telephony : Telephony," by Prof. J. A. Fleming F.R.S. (Lecture II).

AERONAUTICAL INSTITUTE OF GREAT BRITAIN.

8 p.m. At the Central Hall, Westminster, S.W. Paper "On the Necessity for New and Special Treatment of Metals Employed in Aircraft Construction," by Mr. J. de Kozlowski.

FRIDAY, March 30th.

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, W. Discourse on "Recent Developments of Molecular Physics," by Prof. J. H. Jeans, F.R.S.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. CLAY, V.D.

Officer for the Week.—Platoon Commander C. E. Campbell.

Next for Duty.—Platoon Commander Watkins.

Monday, March 26.—Technical for Platoon No. 9, at Regency-street : Squad and Platoon Drill, Platoon No 10 ; Signalling Class ; Recruits' Drill, 6.30 to 8.

Wednesday, March 28.—Instructional Class, 8.15 ; Platoon Drill, Platoon No. 2.

Thursday, March 29.—Platoon Drill, Platoon Nos. 5 and 6 ; Ambulance Class by M.O., 6.30 ; Signalling Class.

Friday, March 30.—Technical for Platoon No. 10, Regency-street : Squad and Platoon Drill, No. 9 ; Recruits' Drill, 6.30 to 8.30.

Saturday, March 31.—Commandant's Parade, 2.45, uniform for drill, in Hyde Park.

Sunday, April 1.—Special work at Bombing School. Parade Clapham Common Station (City & S.L. Railway), 9.45 a.m. Uniform, haversacks, water bottles. Midday rations to be carried. As this work is very important, the Commandant would like to see much larger parades.

Easter Training.—Will be at Esher. Special technical instruction will be given for the first hour to all Platoons on their respective drill nights, in order to prepare them for the course which has been arranged.

Musketry.—For all Companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all Drills will take place at Headquarters (Balderton-street, Oxford-street, W.).

SELF-PROPELLED ELECTRIC VEHICLES AND THEIR APPLICATIONS.*

BY L. BROEKMAN.

(*Concluded from page* 709.)

OPERATING COSTS.

In the following tables fair running and garage circumstances are assumed in the users' own interest, but otherwise no rosy aspect of operating conditions has been allowed to influence costs favourably. There should thus be no real difficulty in improving on the figures stated in actual practice under intelligent management.

Interest Charges.—Allowed for at 5 per cent. per annum on the total outlay, regardless of the proportion written off annually as depreciation.

Depreciation.—Normal annual rate depending on type of vehicle and records of its average useful life.

Electric vehicles, 8 per cent. per annum at nominal mileage: 10 per cent. at 50 miles per day. Petrol vehicles, 12½ per cent. per annum at nominal mileage; 15 per cent. at 40 miles per day. Steam vehicles, 10 per cent. per annum at nominal mileage; 12 per cent. at 40 miles per day.

The formula for depreciation is taken as:—

$$\text{Min. rate, } \left(1+\frac{\text{miles per day}}{200}\right) \text{ per cent.}$$

Repair Parts, Chassis and Body Painting, &c., Garage Labour, Adjustments, Washing.—Formula taken is:

$$\text{Min. annual cost, } \left(1+\frac{\text{miles per day}}{200}\right).$$

Insurance.—This includes provision against fire, accident, and third party risk.

Tyres.—Based on makers' usual guarantee of 10,000 miles per annum.

Battery Renewals.—Based on makers' guarantee. The actual performances of batteries and the useful service period obtained therefrom, according to owners' records, are entirely ignored. Nor has the residual value of batteries been taken into account after they become displaced. Makers' guarantee for ironclad exide batteries = two years, independent of mileage. Makers' guarantee for nickel-alkaline batteries = eight years, or 60,000 miles, whichever limit is reached first.

Fuel or Feed.—Horses' fodder at 17s. 6d. per week per horse; petrol at 1s. 6d. per gallon; coal at 1s. 6d. per cwt.; coke at 1s. per cwt.; electricity at 1d. per Board of Trade unit.

Garage or Stables.—Covering rent, rates, taxes, licence, and registration.

Average Load.—Estimated as 75 per cent. of actual loading capacity. If carried one way only the cost per ton-mile has been calculated on the basis that it is 10 per cent. less than double the cost of the average load conveyed both ways.

Working Days.—Five days per week average; 250 days per year. The short hours worked on Saturday have only been regarded, in general, as helping to bring to its proper value the average for the other five week days.

Establishment Charges.—Are not provided for, as the ratio varies widely according to class of traffic, claim risks, &c. On one car of a fleet in a large concern this charge will bear very lightly, whereas if it happens to be the sole stock in trade of a haulage contractor the item assumes importance. The correct proportion of this charge must be added, therefore, in each instance to suit individual experience.

Advertising Value.—As a set off to charges in respect of operation the undoubted advertising value of electric vehicles claims a substantial allowance. Their spick and span appearance, silent and [illegible] running, impress favourably by contrast with other equipment, and reflect credit on the owner.

Horse Haulage.—Detailed costs of a two-horse lorry, working under fair conditions [illegible] per day, are given in Table I.

An [illegible] comparison between the results, under the same [illegible] in the same locality, from horse haulage and from electric vehicles respectively, was published in the "Power Wagon" of November 1, 1913, from statements by one of the most important public supply companies in the United States, and reproduced [illegible].

Depreciation Charge at 10 per cent. per annum is favourable to horses. Electric energy at 4 cents per unit (2d.).

Table I.—*Two-Horse Lorry.*

Approximate Capital Outlay.

	£	s.	d.
Two heavy horses at £60 each	£120	0	0
Two sets of harness at £25 each	50	0	0
One lorry	30	0	0
	£200	0	0

Approximate Annual Expenditure.

	£	s.	d.	
Interest 5 per cent. on £200	£10	0	0	
*Depreciation 10 per cent.	20	0	0	
Fodder 17s. 6d. each per week per horse...	91	0	0	
Stabling £10 each per year per horse	20	0	0	
Veterinary charges £1. 10s. per horse	3	0	0	
Shoeing £3. 10s. per horse	7	0	0	
Driver 35s. per week	91	0	0	
Insurance	5	0	0	
Vehicle and harness repairs and cleaning	16	0	0	
	£263	0	0	per annum.
†For 250 days per year =	£1	1	0	per day.
For five days per week =	5	5	0	per week.
Daily mileage, average load 2 tons	15 miles.			
Pence per vehicle mile	16·8			
Pence per ton-mile average load both ways	8·4			
Pence per ton-mile, average load one way only	15·0			

Load Capacity.

Light one-horse van	½ ton.
Light two-horse van	1 ton.
Heavy one-horse van	1 ton.
Heavy two-horse van	2 tons.
Heavy four-horse van	3 tons.
Walking speed, light team	3 miles per hour.
Trotting speed, light team	6 miles per hour.
Walking speed, heavy team	2½ miles per hour.
Trotting speed, heavy team	5 miles per hour.

As a check on the preceding tabulation of estimated horse-haulage costs in this country the figure of 31·2 cents—or nearly 16d.—per mile of a single-horse van in 1912, compared with 16·8d. per mile of two-horse heavy van at present-day prices for horses, fodder, &c.

With 107 horse vehicles and 130 horses owned, the average performance per vehicle per month was 383 miles of ½ ton loads, costing £24. 11s.

Cost per ton-mile, therefore	30·6 pence.
52 electric vehicles carried an average per month per vehicle of 749 miles of 1-ton loads, costing	£38 13 7
Cost per ton-mile, therefore	12·37 pence.

The ratio is thus 2·47 : 1 in favour of electric vehicles.

Some details of running costs are given in Table II.

SPECIAL APPLICATIONS.

Among the great variety of utility purposes, besides goods' deliveries, for which battery vehicles are particularly well suited, the following applications are of interest:—

Refuse electric collecting vans are in use by the Corporations of Glasgow (2), Birmingham (2), Barnes (4), Chester (4), Dover (6), Sheffield (4) and others. Experience in every single instance has been most satisfactory.

Street Electric Sprinklers.—Blackpool Corporation has one vehicle in use, and a second one on order. Operating nine hours per day over 48 miles of streets, it is capable of sprinkling 18,000 gallons of sea water, and uses 70 units of electricity. The capacity of the tank is 750 gallons. This vehicle has displaced six horse-drawn vans and four men. The tank is removable, so that a van body may be put in its place, and the vehicle used for refuse collecting or other purposes, when not required for sprinkling.

Coal and ash electric wagons are in use by the Corporations of Bradford, Ipswich, Croydon, Ilford, Plymouth, South Shields and others. They possess steel tipping bodies electrically operated, and are from 1 to 5 tons' capacity. The cost per ton carted is 9·5d., as against 11d. and 1s. per ton previously.

Trolley and battery vehicles employed by the Bradford Corporation are equipped to run on tramway routes for parcels service, their capacity being 2 tons. They are fitted also with a storage battery for house-to-house deliveries. While taking current from overhead wires, contact with the rails is made by means of a cast-iron block attached to the steering gear, automatically steering the vehicle.

Electric Tower Wagons.—The Corporations of Ilford, Derby, Belfast and Southampton use this type of vehicle, weighing 3 tons, and consuming approximately 1 unit per mile.

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* Abstract of a Paper read before the Institution of Engineers and Shipbuilders in Scotland.

* Impossible to determine owing to continual sale of older stock and purchase of young horses. May be as high as 25 per cent. per annum.

† 15 per cent. extra horses required to cover sickness, time shoeing, &c.

Table II.—*Electric Petrol and Steam Motor Vehicles. Running Costs per Day (approximate). Five Days per Week; 250 Working Days per Year; Miles per Day, 40.*

	Electric vehicle: Capacity, 1 ton; av. load, 15 cwt. Mileage - 10,000 per annum for Exide and 80,000 in 8 years for Edison.		Petrol motor vehicles (high grade).	Steam motor vehicles (rubber tyres).
	With ironclad Exide battery.	With Edison battery.	Capacity, 2 tons. Average load, 1½ tons.	Capacity, 3 tons. Average load, 2¼ tons
Standing Charges—	s. d.	s. d.	s. d.	s. d.
5 per cent. per annum interest on capital ...	3 0 (9·6%)	3 5 (9·6%)	2 4 (15%)	2 5 (12%)
Depreciation, exclusive battery and tyres ...	4 5	4 5	6 9 (12½%)	5 3 (10%)
Insurance, &c.	1 6 (2½%)	1 9 (2½%)	1 2	1 2
Rent, rates, &c.	0 9	0 9	1 0	1 2
Driver's wages, 30s. per week	6 0	6 0	...	...
Driver's wages, 40s. per week	...	...	8 0	8 0
Helper's wages, 30s. per week	...	...	...	6 0
Running Charges—				
Battery maintenance	5 1	3 6	...	...
Tyre maintenance	2 5	2 5	3 3	5 3
Electric energy	2 2	3 1	...	...
Motor spirit, 1s. 6d. per gallon	...	...	6 0	...
Coal, 1s. 6d. per cwt.; coke, 1s. per cwt.	...	...	...	4 0
Repairs: Chassis, body, &c.	1 6	1 6	2 5	2 10
Garage, labour, &c.	1 0	1 0	1 2	1 6
Lubricants	0 3	0 3	0 10	1 1
Total per day (approximate)	28 1	28 1	32 11	38 8
Pence per vehicle-mile	8·42	8·42	9·90	11·60
Pence per ton-mile, average load both ways ...	11·22	11·22	6·60	5·15
Pence per ton-mile, average load one way only	20·20	20·20	11·90	9·27
Cost per week (s. and d. approximate)	140·5	140 5	164·7	193·4
Cost per year (approximate)	£351	£351	£412	£483

Electric Pump Wagons.—For removing water from manholes, 18 cwt. wagons are used at Boston. Each wagon is fitted with a rotary pump, driven by a 2 H.P. motor for raising 75 gallons per minute through 20 ft., as against 5 gallons per minute by two men with pails. They daily inspect and serve from 15 to 20 manholes, covering a distance of 20 miles. In this company's area of 700 square miles there are 8,000 manholes, and 5½ million gallons were dealt with in 1915. The same company makes use also of a portable equipment, carried on two motor trucks, for making tests on cables and transformers in sub-stations. Further, on some of its 2-ton electric trucks, it employs derricks, mounted on the rear end of the platform for pole setting, the line being hauled in by motor winches.

Electric Road Rollers and Scarifiers.—For eight or ten-ton rollers the working day is usually of 10 hours' duration. They are silent, efficacious and cheap, and their batteries are charged at night.

Electric fire engines and ladders may be seen in the cities of London and Liverpool.

Electromobile Ladders.—For plasterers, painters, wiremen, &c., these ladders are fitted with duplex control from the top and below. One operator only is required, as against four with the hand-operated type.

Electric Shunting Locomotives and Trackless Tractors.—At docks, in goods yards, and works, where in use there is no fire risk, and no power is consumed while at rest. The Pennsylvania Railroad Co. at Jersey City has displaced horses, previously used for shunting trucks, by a trackless tractor. The capital outlay on the tractor amounted to £2,750, and as a result of its application the total operating costs by horse haulage, which had previously amounted to £8,630 during a period of 30 months, have been reduced to £3,760 by the electric tractor for the same length of time.

Electric Couple-gear Tractors for Attachment to Existing Horse-drawn Wagons.—In this most ingenious construction the electric motors are built into the centre of the road wheels. The latter are divided vertically into two parts, each fitted with a cog-rack inside. The motor armature-shaft terminates at both ends in a pinion, one of which engages the cog-rack of the inner, the other that of the outer wheel-section. The entire force of the motor is thus applied to the rim of the road wheel at two opposite points and in the direction of motion. A simple rocker device in the armature-shaft ensures a balanced division of the work between the two pinions, producing a couple-action from which the name "couple-gear" is derived. The axle stubs on which the wheels turn are integral with the motor casting, an elongation of the inside stub, keyed to a taper sleeve in the steering knuckle, and holding the motor in a fixed horizontal position while the wheel revolves around it. This construction, in two or three wheel-power units, is specially adapted for converting any and all types of horse-drawn equipments into motor vehicles. This type of machine is a very attractive and economical proposition, both from the aspects of capital outlay and operating costs. By removing the horse shafts and front axle from existing lorries, suitably strengthening the same for the higher speeds, the power unit is coupled to the frame, and loads from 3 to 15 tons can be dealt with at speed and mileage to meet requirements.

Electric Battery Trucks and Tractors for Industrial, Warehouse, Railway and Quayside Service.—The electric "stevedore" or "handy man" supplements factory trams, runaways, conveyors, gravity and live-rollers, &c., by a flexible, trackless link. The ramifications in this field of work are enormous, as it covers the entire industrial world. These self-contained carriers can deal effectively with loads up to 2 tons at from five to seven miles per hour, depending on the quality of the flooring, grade, &c. Inclusive costs are from 6d. to 8d. per hour, the rate of pay for one labourer; while each truck is capable of doing the work of six men and more.

The trailer equipment may be anything on wheels, and trains up to 200 ft. long, turning "S" form, are being run successfully, displacing from 10 to 15 pushers. The tractor and trailer scheme is capable of being worked out to immense advantage, as the valuable power unit need never be detained idle while being loaded. The drawbar pull required may be taken at 65 lb. per ton gross (trailers and load) on a fairly level concrete floor.

ELECTRIC PLEASURE CARS.

The application of the all-electric principle to the propulsion of pleasure vehicles was the very first to be mooted, and early attempts date back to 1892. Ingenuity since has excelled itself and produced the true chauffeurless car adapted to the supreme personal enjoyment of its owner. As an example of effortless manipulation, it may be mentioned that the electromagnetic controllers with which the well-known "Ohio" cars are equipped, govern practically the entire range of operations. A small lettered and grooved disc, fitting easily into the hand, has mounted on it centrally (so as to touch the middle of the palm), a push button for warning signals. It provides for four forward speeds, an acceleration button, located conveniently to the foot, adding an extra speed. The three reverse speeds are controlled by simply turning the disc forwards or backwards, adjusting the speed as desired. The disc cannot be reversed without pressing the guard button; this prevents it being turned the wrong way accidentally. The controller lock-button when pushed, locks the disc and renders the car inoperative. The disc can be locked only when in a neutral position. To start, insert the key and turn it, the lock-button is released, and the disc is free to move. The door locks are served by the same key. The magnetic brake button when pressed retards the car under all conditions; likewise it prevents skidding. Supplementing this a service foot brake is available. Cars cannot be started until the brakes have been released, nor can the brakes be set without shutting off power; in short, to make any mistake has been rendered next to impossible. There is certainly nothing to perplex the driver.

From American data the entire upkeep and running costs to be debited against an electric car, if attended to and charged at a public garage and brought to the user's house daily, are: For 6,000 miles yearly, 6½d. per mile: and for 12,000 miles yearly, 5d. per mile. British garages should be in a position to improve materially on these figures without the slightest doubt. Present-day inducements considered dispassionately electromobiles for personal use are a thoroughly sound proposition.

The introduction of electric taxicabs here on a large scale would have taken place under normal conditions long before, even though the price of petrol had remained at its former level. From a business point of view there can be no question which will be favoured in future. In Detroit, which, like Coventry, is the home of the petrol motor, the average costs of electric taxis, over two years, works out at only two-thirds of those for petrol cabs.

The Corporations of York, Lancaster, South Shields, West Bromwich and Southend have made a very useful beginning with battery omnibuses during the last two years. Mr. J. W. Hame, the city electrical engineer of York, records a total for the year of 65,470 miles, at a cost of 5¼d. per 'bus-mile, exclusive of interest and sinking fund.

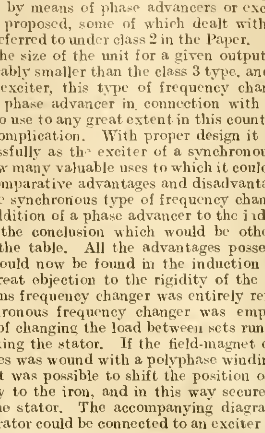
Electric motor chairs are ideal, tiller steered, with control suited to the case, speed up to seven miles per hour, for a range of about 25 miles, the occupant is his own skipper, and enjoys the relative independence of movement.

Too much stress cannot be laid on sound garaging practice, methodical supervision, and the keeping of records where users have to house and care for vehicles in their own establishments. As the use of electromobiles becomes general, an independent organisation will be called into life to occupy a place between the two groups of interested parties—namely, between manufacturers and electricity supply undertakings, on the one side, and electric vehicle owners on the other. Such organisations will aim at providing "service garages" in suitable localities throughout the country, where electric cars and trucks may be cleaned, charged, stored and delivered to residence or business premises. Along with this class of service another function will be to maintain vehicles permanently in full operating condition—*i.e.*, to effect needful repairs and renewals of every description, recharge, or exchange batteries (to admit of day and night duty of the trucks) for an inclusive fixed fee per mile run. On that principle users need only find remunerative work for the vehicles, being fully assured as to costs for upkeep and running.

FREQUENCY CHANGERS.

The following is an account of a discussion which took place at the Manchester Section of the Institution of Electrical Engineers on Mr. R. Townend's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of Feb. 9.

Prof. **MILES WALKER** said the points of special interest were the magnification of the angle of displacement the necessity of securing a correct relation between the positions of the poles of the motor and the poles of the generator and the very large number of possible relations between poles which could be obtained in some frequency changers by interchanging the phases. Not only did the Paper cover a great many points of interest but it continually suggested other considerations. For example, there was the coupling of two power stations by means of a synchronous frequency changer, which, as pointed out by the author, presented a coupling analogous to a solid coupling connecting two machines driven by independent prime movers. Considering two large power stations, each running at its own particular speed, one, say, at 50 cycles and the other 40 cycles, it was not discreet to connect them together by means of a synchronous frequency changer unless the motor generator had a fairly large output compared with the output of the power station. This appeared to be one of the great difficulties in the [illegible] synchronous sets. In cases of this kind asynchronous [illegible], and if required to circulate power either way two sets [illegible], one having the asynchronous motor connected to the mains of one power station and the other having a synchronous motor connected to the other power station. This was one solution of the problem, [illegible]. If it were permissible to introduce a commutating [illegible] into the rotor circuit of the induction motor, as proposed by [illegible], all sorts of possibilities presented themselves, not only of controlling the power factor of the induction motor [illegible] as an asynchronous generator, but also [illegible] through the set independently of [illegible] stations. For example, a frequency changer might [illegible] 50-cycle synchronous generator direct [illegible] to a 40-cycle [illegible] motor connected to the 40-cycle supply. [illegible] would run at [illegible] per min., so that the induction motor would be running at [illegible] synchronous speed and would tend [illegible] power to the [illegible]. If, now, the rotor circuit of the induction motor was connected to a phase advancer whose excitation was so arranged that it [illegible] the E.M.F. generated in the rotor conductors, the asynchronous machine could be made to operate as a motor, notwithstanding the fact that it was running above synchronous speed: and at the same time, by suitable arrangement of the field coils, the power factor could be kept near unity or leading. Moreover, when the asynchronous machine was required to supply a generator load, the phase advancer could be used to supply the wattless component of the load. Several alternative methods of controlling the speeds and loads of induction motors by means of phase advancers or exciters in the rotor circuit had been proposed, some of which dealt with the type of frequency changer referred to under class 2 in the Paper. This class had the advantage that the size of the unit for a given output could sometimes be made considerably smaller than the class 3 type, and, when combined with a Leblanc exciter, this type of frequency changer seemed very attractive. The phase advancer in connection with induction motors had not come into use to any great extent in this country on the grounds of unnecessary complication. With proper design it could be made to operate as successfully as the exciter of a synchronous motor, and the future would show many valuable uses to which it could be put. Turning to the table of comparative advantages and disadvantages of the induction type and the synchronous type of frequency changers, it would be found that the addition of a phase advancer to the induction type completely changed the conclusion which would be otherwise arrived at from perusal of the table. All the advantages possessed by the synchronous type would now be found in the induction type, and at the same time the great objection to the rigidity of the coupling incident to the synchronons frequency changer was entirely removed. In cases where the synchronous frequency changer was employed there was another method of changing the load between sets run in parallel, other than that of rocking the stator. If the field-magnet of one of the synchronous machines was wound with a polyphase winding, say as a three-phase machine, it was possible to shift the position of the poles of the magnet relatively to the iron, and in this way secure the same effect as by rocking the stator. The accompanying diagram showed how a three-phase generator could be connected to an exciter and two rheostats so as to obtain a shifting of the pole through an angle of 60 deg. If all the exciting current was passed through phases A and B the resultant field would be AB. If the current after passing through A was equally divided between B and C, the line of the poles would be in phase with A.



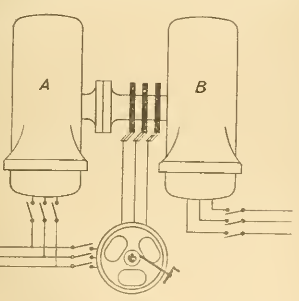
If all the current was passed through phases A and C, the line of the poles would take a position A.C. It was also possible to build a special exciter which would give any required phase position of the excitation on the rotor, and in cases where perfectly synchronous running was required the exciter operated as a continuous-current generator. If it was required slowly to change the pole position on the rotor in order to produce a slip, the exciter could be operated at the frequency required to produce the desired result.

Mr. **H. A. RATCLIFF** raised the question of the efficiency of a synchronous set, as it appeared that such a machine would have to run at loads sufficiently low to avoid the risk of pulling out of step when linking up two systems. Did the characteristics of the transmission line have any significant bearing on where the frequency changer was placed, *i.e.*, the high or low frequency station? Whilst no reference was made to the matter in the Paper it would appear that synchronous and induction frequency changers would not operate in parallel. Rocking stators seemed quite correct for small machines, but it was questionable if they could be used for large units. It appeared possible to use resistance or reactances between an incoming machine and a machine on load in order to reduce the shock on paralleling. Regarding the adjustment of load between two synchronous frequency changers, could not this be carried out by varying the excitation of the motors? The operation of reversing the excitation, to "slip a pole," would be rather too severe for the type of field switch generally supplied.

Mr. **J. FRITH** suggested the use of a friction clutch between the two machines of a synchronous frequency changer in order to simplify the operation of paralleling. Each machine would be started up as a motor set and the two gradually brought together by means of the clutch.

Mr. **J. S. PECK** asked the author to give a table of the possible speeds at which frequency changers could be run for the different frequencies in common use. He (the speaker) described a machine which was very interesting from a theoretical standpoint but not a commercial proposition. The machine was a motor converter with slip rings connected to the connections between the two machines.

Prof. **A. B. FIELD** said the author's discussion of the conditions requisite for paralleling frequency changers, on both high and low frequency sides, gave a very lucid explanation of the problems arising, in particular his demonstration of the necessary phase difference between the incoming machine and its loaded neighbours on, say, the low frequency side when the high frequency side had already been paralleled. The device which the author described was a neat one, whereby the synchroscope had a movable dial or zero bar, which could be displaced from the normal zero position by an amount depending upon the load upon the operating set. With such an indicator and by slipping poles on the motor side of the incoming set, it would be possible to pick up fairly quickly the correct motor position for completing the paralleling on the generator side and *vice versa*. After all, the movable stator appeared the rational method to adopt, and it might have been expected that purchasers would specify that system generally unless there were obstructions of a patent nature in this country. The method had been in use in the United States for many years and had not infrequently been adopted by manufacturers in cases where parallel operation with existing sets was known to be required, although this type of machine was not specified. The author had passed rather lightly over the second class of machine in which part of the energy was converted mechanically and part electromagnetically. This type had many points of interest, and its size might be greatly reduced in comparison with the straight synchronous set. Considering the case in which the outfit consisted of two rotating field machines coupled together, the low frequency one A, assuming this to be the motor, might be an ordinary separately excited synchronous machine, and the generator B might comprise a similar stator, and a polyphse wound rotor fed from the low frequency side through a potential regulator. The arrangement would be as shown diagrammatically in the figure. The maximum mechanical speed of this set consistent with the frequencies was the same as for a straight synchronous set, but the number of poles of the generator corresponded to a higher speed, since the field rotated at a speed greater than that of the shaft. If the field was arranged to rotate backwards relatively to the speed of the rotor, the set became larger than a straight synchronous set. The relative size of the generator stator per kilowatt output depended upon the speed of rotation of its field, not its shaft, and consequently, in comparison with the straight synchronous set, this size was reduced in about the proportion of the shaft speed to the field speed, or in the ratio of the difference of frequencies to the higher one; the same applied roughly to the remainder of the set. It would be seen that the advantage in size became greatest when the two frequencies were near together, provided the output was not greater than could be conveniently taken care of with the small number of poles involved for the B machine. For example, a linking together of 40 and 50 cycles would allow a maximum speed of 600 revs. per min. with the ordinary synchronous outfit; this corresponded to 8 and 10 poles. 600 revs. per min. would also be the maximum mechanical speed available for the arrangement shown in the figure, but while the A machine would retain eight poles the B machine would have two, and would gain the electrical advantages of a speed of 3,000 revs. per min. with only the mechanical difficulties of 600 revs. per min. For a 5,000 kw. transfer, the A machine would only be rated at 1,000 kw. plus losses, or less than one fourth the normal size, while the B stator would be that of a 5,000 kw. 3,000 revs. per min. machine instead of a 5,000 kw. 600 revs. per min. It became necessary in order to take care of the variations in voltage on each system, to introduce a polyphase induction regulator, and the size of this would depend entirely upon the amount of voltage variation to be provided for, and the reactive drops in the double wound machine. For example, in a certain 30 to 60 cycle case the possible variations in voltage on both systems under extreme conditions of load and power factor, were estimated to be well taken care of by a ± 15 per cent. voltage regulation. As this regulation needed to be effected in respect of the electrical input to the rotor only, *i.e.*, about half the rating of the set, and as the voltage introduced by the regulator could either assist or oppose the supply, the rating of the potential regulator amounted only to some 8 per cent. of that of the set. However, the use of this subsidiary piece of apparatus, and the necessity of obtaining part of the excitation by alternating current, were distinct drawbacks to this type of frequency changer. It was of interest to note that with sets of this type there were two frequency systems tied together, electro mechanically through the shaft and electromagnetically through the high frequency machine. Disconnecting the low frequency stator from its busbars, the two systems were still tied together by the B half only of the frequency changer. This tie alone would not allow any energy to be transmitted from one system to the other, so that it exerted no control on the ratio of frequencies, but it did allow of wattless k.v.a. being transmitted in either direction as desired. In fact, the B portion of the set operating thus would transmit energy from the one to the other system, only when allowed to do mechanical work simultaneously or receive mechanical power. The reason why such a machine floating upon the two systems could not by itself transfer power, while the somewhat similar rotary converter floating upon an alternating current and direct-current system could do so in either direction would be apparent upon a little reflection. It involved the fact that in the present case the flow of power occurred to both the rotor and stator while the rotor only was concerned in the case of the rotary converter.



Mr. SWINBURNE said that since the question of linking-up had become a matter of national interest, standardisation of systems, &c., was most desirable. He considered it the duty of the Institution to decide which type of frequency changer should be adopted and if necessary make the adoption compulsory. In view of the recent progress in alternating-current commutating machines, was this type suitable as a frequency changer?

Mr. JUHLIN referred to the advantages of the synchronous type of machine; also the disadvantage of the induction type when used as a generator, owing to the fact that it could not supply any wattless component of the load on the system. He also considered the rocking stator to be essential in the case of high voltage machines of large output in order to avoid shock when paralleling loaded and unloaded machines.

Mr. TOWNEND, in reply, said Prof. Walker's remarks were of considerable interest. There was no doubt that the use of a phase advancer, in conjunction with an induction frequency changer, would give operating characteristics which were on an equality with, and in some respects better than, those of the synchronous set, but in the majority of cases the cost of the former would be higher than the latter, also attention and maintenance would be slightly greater. The arrangement shown in the diagram gave a simple way of obtaining a displacement of the poles, but no doubt a standard type of machine with salient poles and a movable stator was more desirable and less expensive.

Regarding the efficiency of synchronous frequency changers as requested by Mr. Ratcliff, the figures would of course depend upon the rating of the set, but a 1,000 kw. frequency changer having a speed of about 500 revs. per min. would have an overall efficiency of approximately 89 per cent. at full load and 82 per cent. at half load. It was quite correct that the characteristics of the transmission line and the general lay out of the cable system might in some cases determine whether the frequency changer should be installed in the high or low frequency station, but when the line characteristics were of no importance, it was usually immaterial, from the performance point of view, in which the station set was installed. It was not usually practicable to run synchronous and induction frequency changers in parallel, but in some cases it might be done e.g., 25 and 60 period systems could be linked up by means of a synchronous set running at 214 revs. per min., and by an induction set operating at 720 revs. per min. When two such sets were running in parallel, the induction set would always carry the load, which would give a motor slip of 4 per cent. There was no great difficulty in building machines with movable stators, and this had been satisfactorily done with machines having a capacity of at least 5,000 k.v.a. With large machines it was desirable to move the stator by means of a motor controlled from the switchboard. The shock caused by paralleling unloaded and loaded synchronous sets could be reduced by inserting resistances or reactances between the loaded and unloaded machines, but this involved additional apparatus and was not so simple as using the movable stator. It was possible to obtain a variation in the load distribution between two synchronous sets running in parallel by varying the motor excitation, but the variation would be small, only about 10 per cent. of full load. There was no difficulty in making a field switch for reversing the field excitation, provided it was mechanically strong, and fitted with an efficient discharge resistance. Mr. Frith had suggested the use of a friction-clutch between the two machines of a synchronous set in order to simplify the paralleling operation. This would certainly be the case if only one set had to be run, but if a second set had to be paralleled with it, it would be necessary to give the requisite angular displacement between the motor and generator of the incoming set before closing the clutch in order to make the latter set take its share of the load. This, of course, was impracticable. As suggested by Mr. Peck, a table of possible operating speeds for synchronous frequency changers would be prepared. The machine described by Mr. Peck was certainly interesting, although, as pointed out, it was very doubtful whether it had any commercial value. It was a modification of the second type given in the Paper and had the disadvantages mentioned in connection with that type. Prof. Field had given careful consideration to the second type of frequency changer. There was no doubt that machines of this type might be considerably smaller than machines of the third type, but, as Prof. Field pointed out, the necessity for an induction regulator and for obtaining part of the excitation by alternating current were distinct disadvantages. It was also necessary to collect the greater portion of the power from slip rings, and, in the case of high-voltage machines, this was very undesirable. Mr. Swinburne wished to standardise the type of frequency changer to be used in linking up, but the author did not consider any one type sufficient to meet the requirements of every case, and the only satisfactory method was to adopt the type of machine best suited to the case under consideration. A frequency changer having an alternating current commutator motor instead of an induction or synchronous motor would enable a variable ratio of frequency transformation to be obtained, but the set would not be reversible. The author agreed with Mr. Juhlin regarding the disadvantages of the induction generator and the necessity of a movable stator in the case of large high-voltage machines.

PRESSURE HARMONICS IN POLYPHASE SYSTEMS AND WINDINGS.

BY B. HAGUE, B.SC., D.I.C.

(*Continued from page* 712.)

Summary.—In this article the properties of pressure harmonics in a polyphase system are first discussed by the use of the well-known theory; after which the effect of the distribution of the armature winding of the alternator (from which the system is derived) on the magnitude of the harmonics is considered. Tables of distribution factors are given for single-layer windings and for double-layer lap windings, forming an extension to similar tables published by Dr. S. P. Smith and Mr. R. S. H. Boulding.

IV. Interlinked Polyphase Systems.—(*a*) *Symmetrical Systems.*—Up till now we have only considered polyphase systems derived from N independent or separate phases, each phase having its own pair of terminals and leads. We shall now consider a fundamental property of all symmetrical polyphase systems which enables us to interlink the phases in various ways, and thereby secure important advantages. This property depends on the fact that at any instant the sum of the pressures in a symmetrical polyphase system is zero, as seen from the following.

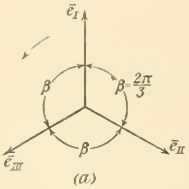


FIG. 4A.—VECTOR DIAGRAM OF PRESSURES IN SYMMETRICAL THREE-PHASE SYSTEM.

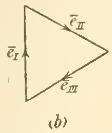


FIG. 4B.—RESULTANT VECTOR POLYGON.

Referring to equation (3), we have

$$e_I+e_{II}+e_{III}+\ldots+e_N=\sum_{r=1}^{r=N}e_r=\bar{e}\sum_{r=1}^{r=N}\sin\left(\omega t-\overline{r-1}\,.\,2\pi/N\right)$$

$$=\bar{e}\,.\sin\left(\omega t-\frac{N-1}{2}\,.\,\frac{2\pi}{N}\right)\frac{\sin\frac{N}{2}\,.\,\frac{2\pi}{N}}{\sin\frac{1}{2}\,.\,\frac{2\pi}{N}}=0,$$

since in the numerator $\sin\pi$ is always zero, and $\sin\pi/N$ in the denominator is never zero if N be greater than 1. Thus, in every symmetrical polyphase system the sum of all the pressures is zero at every instant. The same is also true of the currents when the load is balanced.

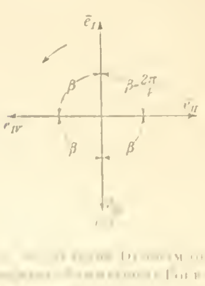


FIG. 5A.—VECTOR DIAGRAM OF PRESSURES IN SYMMETRICAL FOUR-PHASE SYSTEM.

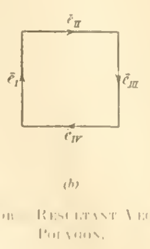


FIG. 5B.—RESULTANT VECTOR POLYGON.

This property is also seen to follow at once from the vector diagrams, Figs. 4–6, which in all cases give a closed polygon when the vectors are added geometrically, thus proving that the resultant is zero. Thus in Fig. 4 the vector diagram for a symmetrical three-phase system is drawn wherein $N=3$ and $\beta=2\pi/3=120$ deg. It is seen that the addition of the vectors gives a closed triangle, so that the resultant is zero. Or, again with $N=4$ and 6 we get a closed square and hexagon respectively for the vector polygon, as shown in Figs. 5 and 6. It is in consequence of this property that it becomes possible to interlink the separate phases in certain ways, which we must now consider in detail.

The most important interlinked systems are the mesh (Fig. 9), where all the phases are joined in series; and the star (Fig. 7), where the corresponding terminal of all the phases is joined to a common point, known as the neutral or star point.

(*i*) *Star-connected Systems.*—To join the N phases of a symmetrical system in star, all the N points $\beta=2\pi/N$ radians apart are connected together. Thus, all the starting points s or all the finishing points f of the phases are joined together to form the star point, as in Fig. 7. A customary diagrammatic way of representing star-connected systems is shown in Fig. 8, along with the corresponding vector diagrams.

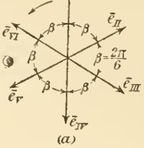


FIG. 6A.—VECTOR DIAGRAM OF PRESSURES IN SYMMETRICAL SIX-PHASE SYSTEM.

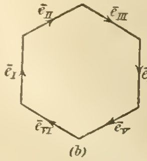


FIG. 6B.—RESULTANT VECTOR POLYGON.

Currents in a Star-connected System.—It is at once obvious that the line current I_l is equal to the phase current I_p.

Pressures in a Star-connected System. Let $\bar{e}_p$ be the maximum value of the pressure in any phase of a symmetrical N-phase system. Then we have for the instantaneous phase pressures of the rth and $r+1$th phases:—

$$e_{pr}=\bar{e}_p\sin\left(\omega t-\overline{r-1}\,.\,\frac{2\pi}{N}\right),$$

$$e_{p,\,r+1}=\bar{e}_p\sin\left(\omega t-r\,.\,\frac{2\pi}{N}\right).$$

Since the two starts or the two finishes of these phases are joined together, the pressures in the phases are in opposition, so that the line pressure e_l will be the difference between e_{pr} and $e_{p,r+1}$. Or, if v denotes the instantaneous potential of the neutral point and v_r and v_{r+1} the potentials of the free terminals of the rth and $r+1$th phases, then it is obvious that $e_{pr}=v_r-v$, and $e_{p,r+1}=v_{r+1}-v$; hence, the difference of potential between the lines is:

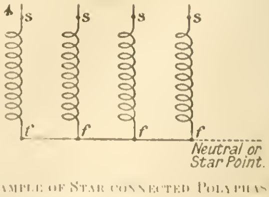


FIG. 7.—EXAMPLE OF STAR CONNECTED POLYPHASE SYSTEM (*s* denotes start and *f* finish of phases.)

$$e_l=v_r-v_{r+1},$$

$$=\bar{e}_p\left[\sin\left(\omega t-\overline{r-1}\,.\,\frac{2\pi}{N}\right)-\sin\left(\omega t-r\,.\,\frac{2\pi}{N}\right)\right]$$

$$=\bar{e}_p\left[2\cos\left(\omega t-\overline{2r-1}\,.\,\frac{\pi}{N}\right)\sin\frac{\pi}{N}\right].$$

Therefore, $\bar{e}_l=2\bar{e}_p\sin\pi/N$, and the R.M.S. values are

$$E_l=2E_p\sin\pi/N=KE_p. \qquad (8)$$

where $K=2\sin\pi/N$ has the following values for different values of N :—

No. of phases ......$N=2$	3	4	5	6	8	12
$K=2\sin\pi/N=2$	$\sqrt{3}$	$\sqrt{2}$	1·176	1	0·765	0·518

Power in Star-connected Systems.—From equation (7) we have :—

$$P=NE_pI_p\cos\varphi,$$

and, therefore,

$$P=\frac{NE_lI_l\cos\varphi}{2\sin\pi/N}, \qquad (9)$$

by substitution from above for E_p and I_p.

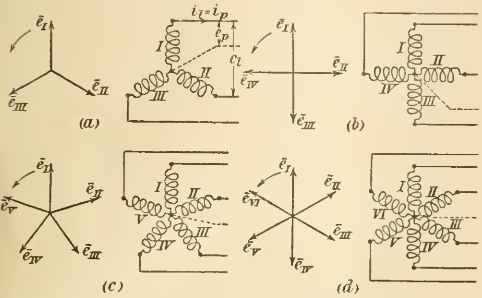


FIG. 8.—VECTOR DIAGRAMS AND DIAGRAMMATIC REPRESENTATION OF SYMMETRICAL STAR-CONNECTED SYSTEMS.
(*a*) Three-phase. (*b*) Four-phase. (*c*) Five-phase. (*d*) Six-phase.

(*ii.*) *Mesh-connected Systems.*—To join the N phases of a symmetrical system in mesh, all the phases are joined in series, *i.e.*, the finish of one phase is connected to the start of the next, and so on until a closed mesh is obtained, as in Fig. 9. A customary diagrammatic way of representing mesh-connected systems is shown in Fig. 10, along with the corresponding vector diagrams.

Currents in a Mesh-connected System.—Inserting the current directions in the rth and $r+1$th phases in accordance with the vector diagram, we see that at any instant the line current is the vector difference between the currents of two phases meeting at the point to which the line is connected. Thus we have :—

$$i_l=i_{pr}-i_{p,\,r+1}$$

$$=\bar{i}_p\left[\sin\left(\omega t-\overline{r-1}\cdot\frac{2\pi}{N}\right)-\sin\left(\omega t-r\cdot\frac{2\pi}{N}\right)\right]$$

$$=2\bar{i}_p\left[\cos\left(\omega t-\overline{2r-1}\cdot\frac{\pi}{N}\right)\sin\pi/N\right].$$

whence,

$$I_l=2I_p\sin\pi/N=KI_p, \qquad (10)$$

where K has the same significance as in equation (8), and the values in the table following that equation.

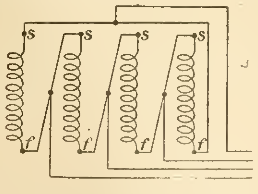


FIG. 9.—EXAMPLE OF MESH-CONNECTED POLYPHASE SYSTEM.
(*s* denotes start and *f* finish of phases.)

Pressures in Mesh-connected Systems.—It is obvious at once that the phase pressure E_p is equal to the line pressure E_l.

Power in Mesh-connected Systems.—From equation (7) we have by substitution,

$$P=\frac{NE_lI_l\cos\varphi}{2\sin\pi/N}. \qquad (11)$$

(*b*) *Hemi-symmetrical Systems.*—The phases of a hemi-symmetrical system can also be interlinked by connecting them in star, but the neutral wire now carries a definite current, as can be easily proved as follows :—

Currents in a Hemi-symmetrical Star-connected System.—If the loads are connected between the N lines and the neutral wire, and i_I, i_{II}, i_{III}, &c., be the instantaneous currents in the lines, we have for the instantaneous current in the neutral wire, i_n,

$$i_n=i_I+i_{II}+i_{III}+i_{IV}+\ldots\ldots+i_N$$

$$=\sum_{r=I}^{r=N}\bar{i}_l\sin\left(\omega t-\overline{r-1}\cdot\frac{\pi}{N}\right)$$

$$=\bar{i}_l\sin\left(\omega t-\frac{N-1}{2}\cdot\frac{\pi}{N}\right)\frac{\sin\frac{N}{2}\cdot\frac{\pi}{N}}{\sin\frac{1}{2}\cdot\frac{\pi}{N}}.$$

Therefore,

$$I_n=\frac{I_l}{\sin\pi/2N}.$$

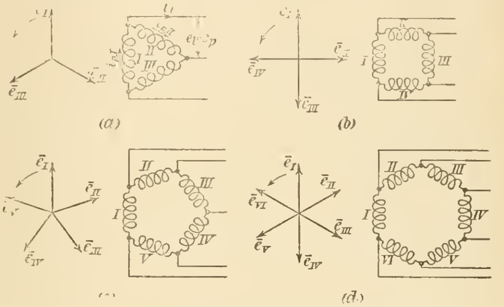


FIG. 10.—VECTOR DIAGRAMS AND DIAGRAMMATIC REPRESENTATION OF SYMMETRICAL MESH-CONNECTED SYSTEMS.
(*a*) Three-phase. (*b*) Four-phase. (*c*) Five-phase. (*d*) Six-phase.

Hence, compared with the $2N$ leads needed when the phases are loaded separately we have now N leads of the original section, and one of $1/\sin\pi/2N$ times that section. For example, if we take a three-phase system with starts at 60 deg., and join the finishes to a common point, we get a hemi-symmetrical three-phase system, and the current in the neutral wire will be $1/\sin\pi/6=2$ times the line current.

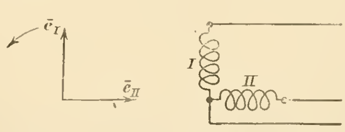


FIG. 11.—VECTOR DIAGRAM AND DIAGRAMMATIC REPRESENTATION OF HEMI-SYMMETRICAL TWO-PHASE OR QUARTER-PHASE SYSTEM.

The only important case in practice is the "quarter-phase," or hemi-symmetrical two-phase system, shown in Fig. 11. The section of the neutral lead will be $\sqrt{2}$ times that of the lines.

Pressures in a Hemi-symmetrical Star-connected System.—The pressure between the lines connected to the rth and the $r+1$th phase is

$$e_l=e_r-e_{r+1}=\bar{e}_p\left[\sin\left(\omega t-\overline{r-1}\cdot\frac{\pi}{N}\right)-\sin\left(\omega t-r\cdot\frac{\pi}{N}\right)\right]$$

$$=\bar{e}_p\left[2\cos\left(\omega t-\overline{2r-1}\,\frac{\pi}{2N}\right)\sin\frac{\pi}{2N}\right]$$

Therefore, $E = 2E_p \sin \pi/2N$. Applying this to the standard practical case of the hemi-symmetrical two-phase system, we have,

$$E_l = 2E_p \sin \pi/4 = \sqrt{2}E_p.$$

Power in Hemi-symmetrical Star-connected Systems.—From equation (7) we have, by substitution,

$$P = \frac{NE_lI_l \cos\phi}{2\sin\pi/2N}.$$

V. *Harmonics in Symmetrical Polyphase Systems.*—In general, harmonics are present in polyphase systems together with the fundamental, and we shall now consider some of their properties in symmetrical systems.

For the nth harmonic in the rth phase of a symmetrical system we have

$$e_{n,r} = \bar{e}_n \sin n(\omega t - \overline{r-1}\beta),$$
$$= \bar{e}_n \sin n\left(\omega t - \overline{r-1}\frac{2\pi}{N}\right). \quad . \quad . \quad . \quad (12)$$

where $\bar{e}_n$ is the amplitude of the nth harmonic.

Since it is only possible to have odd harmonics in symmetrical wave shapes, n can be expressed as

$$n = kN + x, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where k and x are integers chosen to make $kN + x$ an odd integer. For the fundamental, $k=0$, and $x=1$.

We can now transform equation (12) as follows :

$$e_{(kN+x),r} = \bar{e}_{(kN+x)} \sin\left[(kN+x)\omega t - (r-1)x \cdot \frac{2\pi}{N}\right], \quad . \quad (14)$$

since $kN \cdot 2\pi/N = 2k\pi$ does not alter the value of the sine.

Hence, for the N phases of a symmetrical system we get

$$e_{(kN+x)I} = \bar{e}_{(kN+x)} \sin (kN+x)\omega t,$$
$$e_{(kN+x)II} = \bar{e}_{(kN+x)} \sin\left[(kN+x)\omega t - x\frac{2\pi}{N}\right],$$
$$e_{(kN+x)III} = \bar{e}_{(kN+x)} \sin\left[(kN+x)\omega t - 2x\frac{2\pi}{N}\right]. \quad . \quad . \quad . \quad (15)$$
$$e_{(kN+x)N} = \bar{e}_{(kN+x)} \sin\left[(kN+x)\omega t - \overline{N-1} \cdot x\frac{2\pi}{N}\right]$$
$$= \bar{e}_{(kN+x)} \sin\left[(kN+x)\omega t + x\frac{2\pi}{N}\right].$$

In order to evaluate these equations for the practical cases of three, four and six phases, we have only to substitute $x = \pm 1$ and 3 in turn, to obtain all the harmonics, as the following table shows.

TABLE XI. *Values of k to Give all Possible Harmonics in Symmetrical Three Four and Six-phase Systems.*

No. of phases.	x	k	Order of harmonics $n = kN + x$.
3	0	1, 3, 5, 7	3, 9, 15, 21
	1	0, 2, 4, 6	1, 7, 13, 19
	−1	2, 4, 6, 8	5, 11, 17, 23
4	1	0, 1, 2, 3	1, 5, 9, 13
	−1	1, 2, 3, 4	3, 7, 11, 15
6	1	0, 1, 2, 3	1, 7, 13, 19
	−1	1, 2, 3, 4	5, 11, 17, 23
	3	0, 1, 2, 3	3, 9, 15, 21

[illegible] $x = \pm 1$ and $x = 3$ in equation (15) [illegible] corresponding vector diagrams are [illegible]

[illegible] N and k must [illegible] These [illegible] an odd multiple of the [illegible] are equal [illegible] and can be represented by a single vector rotating at [illegible] speed. For example, in a three-phase system the third harmonics in all the phases are represented by one vector rotating at three times the fundamental frequency.

(β) $x=1$, and $n=kN+1$. Here k is even if N be odd, and odd or even when N is even. Inserting this in equation (15), we see that all the harmonics of this order have the same phase displacements as the fundamental, for which $k=0$. Thus, the harmonics of the order $kN+1$ (where k is restricted as stated) have vector diagrams similar to that of the fundamental, the order in which the harmonics attain their maxima in the respective phases being the same as the order in which the fundamentals attain their maxima; that is to say, these harmonics are numbered in the same direction around the vector diagram as the fundamental. Thus, in a three-phase system, the vector diagram of the seventh harmonic is the same as that of the fundamental, though it rotates at seven times the speed of the latter.

(γ) $x=-1$, and $n=kN-1$. Here, again, k is even if N be odd, and odd or even if N be even. Putting $x=-1$ in equation (15) changes the sign of all the phase angles—*i.e.*, the order of the vectors for these harmonics is opposite to that of the fundamental. Thus, harmonics of the order $kN-1$ (where k is restricted as stated) have vector diagrams like that of the fundamental, but with the vectors numbered in the opposite direction round the diagram.

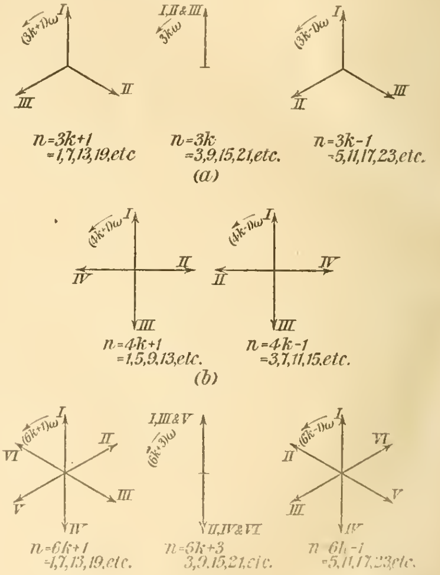


FIG. 12.—VECTOR DIAGRAMS OF HARMONICS IN PHASES OF SYMMETRICAL POLYPHASE SYSTEMS.

(*a*) Three-phase. (*b*) Four-phase. (*c*) Six phase.

(δ) $x=3$, *and* $n=kN+3$. This case has only to be considered for the six phase system, so that $n=6k+3$. Remembering that the nth harmonic in the rth phase is displaced from the corresponding harmonic in phase *I* by an angle, $(r-1)x\beta = (r-1)3 \cdot 2\pi/6 = (r-1)\pi$, we have then

Phase No....	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*
$(r-1)\pi$.	0	π	2π	3π	4π	5π

The vectors of the phases *I*, *III*, and *V*, are thus in phase, and displaced by 180 deg. from the vectors of the phases *II*, *IV* and *VI*.

The vector diagrams of the several harmonics in the phases of the symmetrical three, four and six phase systems as deduced above are shown in Fig. 12. A similar set of results has been drawn up for $N=8$ and $N=12$, but these systems are not of sufficient importance at present to justify the space required for their inclusion.

(*a*) *Effect of Interlinking on Harmonics.*—We have seen that at every instant the algebraic sum of the fundamental E.M.F.s in a symmetrical polyphase system is zero, and in virtue of this fact it is permissible to interlink the phases in star or mesh. We must now consider the effect of interlinking the phases on the harmonics which may be present in the phase pressures.

(*i*) *Star-connected Systems.*—In the rth and $r+1$th phases of a symmetrical polyphase system the pressures due to the nth harmonic are

$$e_{n,r}=\bar{e}_n \sin n\left(\omega t-\overline{r-1}\cdot\frac{2\pi}{N}\right),$$

$$e_{n,r+1}=\bar{e}_n \sin n\left(\omega t-r\cdot\frac{2\pi}{N}\right).$$

When the phases are interlinked in star, the line pressure measured across the terminals of the rth and $r+1$th phases will be

$$e_{n,l}=e_{n,r}-e_{n,r+1}=\bar{e}_n\left[\sin n\left(\omega t-\overline{r-1}\cdot\frac{2\pi}{N}\right)-\sin n\left(\omega t-r\cdot\frac{2\pi}{N}\right)\right]$$

$$=2\bar{e}_n \sin n\left(\omega t-\overline{2r-1}\cdot\frac{\pi}{N}\right)\sin n\pi/N.$$

Hence, the amplitude is $\bar{e}_{n,l}=2\bar{e}_n \sin n\pi/N$.

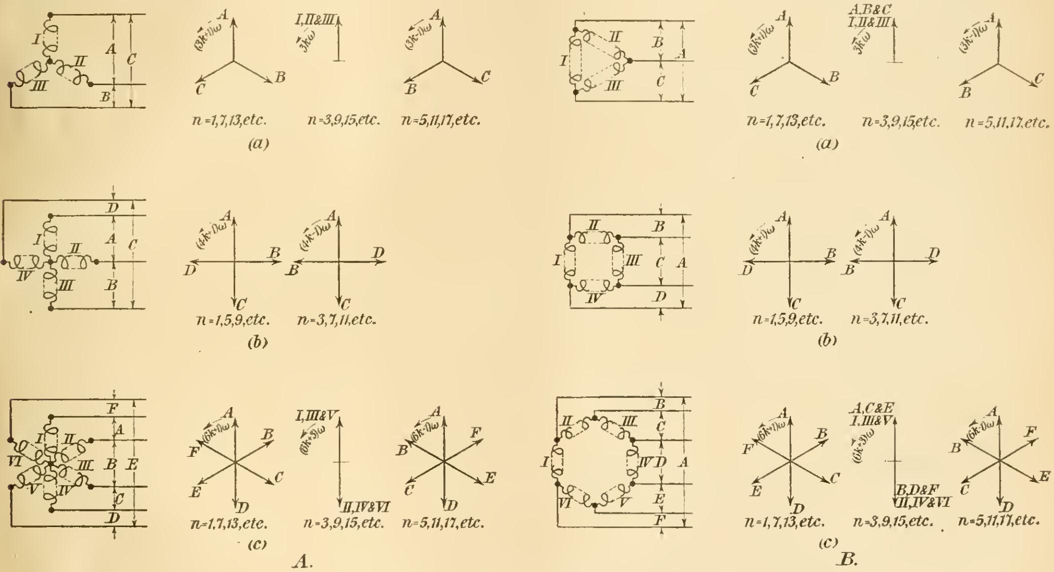


FIG. 13.—VECTOR DIAGRAMS OF HARMONICS IN INTERLINKED SYMMETRICAL POLYPHASE SYSTEMS.

A.—Star-connected systems.—(*a*) Three-phase, (*b*) Four-phase, (*c*) Six-phase.
B.—Mesh-connected systems.—(*a*) Three-phase, (*b*) Four-phase, (*c*) Six-phase.

Putting, as before, $n=kN+x$, we get

$$\sin n\pi/N=\sin(kN+x)\pi/N=\sin\left(k\pi+x\frac{\pi}{N}\right)=(-1)^k \sin x\pi/N,$$

so that, by substitution,

$$\bar{e}_{n,l}=2\bar{e}^n(-1)^k \sin x\pi/N.$$

Three-phase System.—The only important symmetrical star-connected system is the three-phase system. We can then find the behaviour of the harmonics therein by simple application of the above equations for $N=3$, giving

$$\bar{e}_{n,l}\doteq 2\bar{e}_n(-1)^k \sin x\pi/3.$$

(*a*) Let $x=0$, *i.e.*, $n=3k$, giving the third, ninth, &c., harmonics when $k=1, 3, 5$, &c. Then, whatever the value of k, $\bar{e}_{n,l}=0$; that is to say, no third or any odd multiple of the third harmonic will appear in the line pressure, and consequently it is impossible for currents of these orders to flow in the lines unless some additional path is provided.

(β) Let $x=1$, *i.e.*, $n=3k+1$, giving the fundamental, seventh, thirteenth, nineteenth, &c., harmonics, when k is 0, 2, 4, 6, &c. Then, since k is even, we have $\bar{e}_{n,l}=2\bar{e}_n \sin \pi/3 =2\bar{e}_n\sqrt{3}/2=\sqrt{3}\bar{e}_n$. Hence, harmonics of these orders in the phase pressures will appear in the line pressure increased in amplitude $\sqrt{3}$ times, and have the same sign as the phase pressures producing them.

(γ) Let $x=-1$—*i.e.*, $n=3k-1$—giving the fifth, eleventh, seventeenth, &c., harmonics, when k is 2, 4, 6, &c. Then, since k is even, we get $\bar{e}_{n,l}=-\sqrt{3}\bar{e}_n$. Hence, the harmonics of these orders will appear in the line pressure $\sqrt{3}$ times as large as in the phase pressure, but of opposite sign.

Collecting the results just obtained, we have for the harmonics in the line pressure of a symmetrical three-phase system :—

Harmonics of order $n=3k$ vanish ;
" " $n=3k+1$ are increased $\sqrt{3}$ times and are positive ;
" " $n=3k-1$ are increased $\sqrt{3}$ times and are negative.

These results can be readily deduced from the vector diagram of Fig. 12, and the effects of the various harmonics are shown in Fig. 13A for various star-connected polyphase systems.

(*ii.*) *Mesh-connected Systems.*—In this case the phase pressure is the same as the line pressure, except in so far as the mesh forms a closed circuit for harmonics of the order $n=kN$. If the impedance of the mesh is sufficiently low, these harmonics will be practically short-circuited, and, therefore, not appear at all at the terminals ; and under these conditions large circulating currents of these orders will flow in the mesh.

If a mesh-connected system were opened at any point, the pressure between the two ends would be due to harmonics of the order $n=kN$. In this way a pressure of a high frequency could be obtained without using the fundamental, although the application of a mesh-connected system for such a purpose would be confined to alternators and the like, used for wireless telegraphy.

In a similar manner to that employed for the star-connected system the behaviour of the harmonics in a mesh-connected system can be deduced from the vector diagrams of Fig. 12, and the results are shown in Fig. 13B.

(*To be concluded.*)

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ON FEROCITY IN TECHNICAL DISCUSSIONS.

In a recent issue of the "Observer" reference was made to the fact that within 24 hours of Mr. CHURCHILL's earnest plea for a revival of ferocity in the debates of Parliament a member was heard shouting across the floor to an opponent that the latter was little better than a common hangman.

If this demonic gift, says the "Observer," were a possession common to every Parliamentarian, as Mr CHURCHILL would like it to be, Parliament would doubtless gain enormously in interest, though those whose business might compel them to become acclimatised to its seven-times heated atmosphere would probably find it expedient especially on occasions of full-dress ferocity—to acquire the precious secret that brought SHADRACH, MESHACH and ABEDNEGO scathless through a not dissimilar ordeal.

We take it that "terminological inexactitude" is an example of ferocity in what the "Observer" quaintly calls the Churchillian sense. The reader who knows the meaning of such long words as these can find much shorter words of even greater ferocity to express the same idea. Other and at least equally eminent statesmen have not been above calling a spade a spade when it suited their purpose so to do. Thus, no less a man than DISRAELI on one occasion classified untruths as "lies, damned lies, and statistics."

It were idle to state that we hold no brief for either of these authorities, but it does appear to us that the short and direct method of expressing a thought is to be preferred in Parliament and out of it. Pressure of work in modern business is, or should be, such as to make it physically impossible for one to do other than follow DISRAELI's direct method of stating a fact.

Like Mr. CHURCHILL, we also make an earnest plea for ferocity in the discussions which follow the reading of Papers before the scientific societies and engineering institutions. Under present conditions (and under conditions which prevailed immediately before the war) such discussions, like the atmosphere round the earth, appear to get thinner and thinner, until there is a likelihood of infinite vacuum both in the Papers themselves and in the discussion upon them. We imagine that it is this danger of finding a 29.5 in. vacuum that compels Mr. E. HILL's engineer, after listening to a most interesting Paper on some hydro-electric scheme, to keep half an eye on the President and the other eye and a half on his watch, "anxious to know if he can get to the Waldorf or to the Coal Hole before closing time." If only the engineers and scientists would introduce ferocity into their discussions no thought of closing time would curtail the proceedings, and in course of time those presiding at the meetings would learn not to plead the lateness of the hour as an excuse for bringing a discussion to a premature close. To become acclimatised to a seven-times heated atmosphere, members not in possession of SHADRACH's secret would probably find it expedient to carry about their persons something to make them immune from the effects of the overheated atmosphere. This were preferable to indulging in sleep induced by the deadly dulness of the discussion.

The absolutely tame manner in which the members of the Institution of Electrical Engineers agreed to the handing over of their home is a case in point. Had they shown as much spirit as the members of, say, the Automobile Club, columns of correspondence would have appeared in the daily Press, and as a result the British public would have been made to understand that the Institution is not a second-rate association of third-rate wiremen.

In journalism scarcity of paper in these days precludes the possibility of Churchillian ferocity. But even if paper were plentiful the desire to limit one's overtime would of itself tend to the use of the everyday and common methods of expressing a thought. What Mr. CHURCHILL speaks of as a "terminological inexactitude" and DISRAELI as a "damned lie," the journalist, not having time for the one, nor being allowed by his employer to use the other, must perforce strike as happy a mean as he can between these two extremes, and state that so and so is contrary to fact.

Now, we venture to think that the phrase "contrary to fact" is insufficient adequately to express one's feelings when an opponent (in an engineering sense) has not spoken the truth. A simple illustration will enable us to make our meaning clear. Suppose, for instance, that the talented journalist who contributes the Electricity Supply Memoranda to the "Gas Journal" were to state that, because the dividends paid last year by the *Nil Desperandum* Gas Engine Co. were larger than previous dividends, therefore there must be a boom in the gas-engine trade. Having thus supposed we ask the reader if "contrary to fact" would be regarded by him as a complete answer to such an absurd assertion? Nevertheless, polite journalism, in these days, is such as to rule out of court every other form of reply.

Given greater freedom one could, of course, parry the blow delivered by such a skilful fencer as the Memorandist by stating that even electrical firms have been able to declare bigger dividends than formerly because the philanthropic spending departments of the State pay a higher price for shells than ought to be paid. Given unlimited freedom one could say that to bring forward high dividends as proof of prosperity in a particular trade was sheer unadulterated nonsense. Were one to accept such foolish evidence one would be led to an altogether wrong conclusion regarding the shipping industry. Like the dividends paid by the gas-engine companies the dividends of the shipping firms have been greatly exalted, but nobody in full possession of his senses will accept the one as proof that the general desire is for people to possess gas engines and the other as proof that the dividend is due to the enormous tonnage handled.

Even our very good friend of the "Gas Journal" knows better than to think that any such argument of his will be taken seriously. But, as we have said, scarcity of paper will not allow of ferocity in the Churchillian sense nor will observance of the amenities allow us to model a reply on lines laid down by DISRAELI. Hence, with considerable reluctance, we have to fall back upon the stock phrase of debate, and state that, in our opinion, what the Memorandist has said is contrary to fact.

The Economics of Empire. In a recent Paper before the North East Coast Institution of Engineers and Shipbuilders, Newcastle on Tyne, Mr. Moreton Frewen refers to the economic problems arising from the war, and their effect on future industrial and national conditions. He urges the application on a far larger scale of State aid for the development of the resources of the Empire, and contends that such expenditure would bring in a rich return. As an instance of such State action he refers to the Panama Canal, and dwells upon the possibilities of development of the fertile lands of Canada, the fostering of Canadian fisheries and similar projects as a means of meeting the war debts now being accumulated.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Four Lectures on Mathematics. By J. HADAMARD. (New York: Columbia University Press.) Pp. v.+53. $0·75.

The "Saturday Morning Lectures" delivered by Prof. Hadamard, of the Collège de France and the Ecole Polytechnique, in the autumn of 1911 at Columbia University were taken down by Dr. A. N. Goldsmith and after revision by the author are now published. They are in every respect admirable. The first lecture is on the determination of the solution of linear partial equations by the boundary conditions. General solutions of linear partial equations of the second order have been obtained. But they are of little use. The solution of a partial equation is determined mainly by the boundary conditions. In this connection, as Poincaré has pointed out, physical considerations often enable us to foresee the solution.

In the second lecture, recent researches in the theory of ordinary differential and integral equations are described. Poincaré, in his wonderful memoirs published in 1887, points out so many new difficulties and describes so many paradoxes that the reader feels that the advances made by mathematicians in the solution of these equations are almost insignificant. For instance, in electricity we talk as if tubes of force were closed, and in other branches of physics, hydrodynamics, heat, &c., we talk of tubes of flow or tubes of vortices (provided they do not go to infinity) as if they were closed. Now considering a tube of force as defined by the ordinary differential equations, Poincaré showed that it is not a closed curve. To use a crude comparison, the tube of force does not get back home and put its key in the lock. It puts its key above, below or on either side, but never succeeds in getting it in exactly. Although the area of the cross-section of the tube of force is constant its shape in general continually varies. Prof. Hadamard points out the curious fact that although the assumption that the tube of force is closed is completely false, yet the conclusions drawn by physicists who make this assumption are very often true.

In the last lecture the six Green's functions are given, and it is pointed out that as they have a simple relation connecting them, they give rise to a new kind of geometry.

A. RUSSELL.

Gli Strumenti per Misure Elettriche Industriali. By ING. DINO NOBILI. (Milano: Rivista Tecnico di Elettricità). Pp. 501. L. 8.

The author is to be congratulated upon producing a book, not often met with in this country, in which an attempt is made to collect in one volume the data and descriptions of the instruments used in making electrical measurements for industrial purposes. Measurements of a purely scientific character are not dealt with, but only those of a technical nature. The more advanced parts are given in much greater detail than the elementary parts, and for this reason the work constitutes a handy book of reference on alternating current working, especially three-phase practice.

The first chapter really constitutes a book of mathematical and physical constants, but it includes certain novel features, among which are comprehensive tables and diagrams for the connection between British and metric units of length, area, mass, &c. The sources from which the figures are derived are not given, which is a pity. The value of 4·167 is given as Joule's equivalent, and in the tables of dimensions of electrical and magnetic quantities μ and k are ignored, although both the electromagnetic and electrostatic systems are given. Conductivity and resistance tables for copper find a place, and the rules and tables for finding the approximate resistances and heating effects for high frequency currents should prove useful, as well as a table of discharge distances between point and plane.

Chapter II. is given up to an account of measuring instruments in general, classified under the heads electromagnetic, magneto-electric, electrodynamic, electrostatic, thermic induction and those for measuring energy and quantity. Sensibility and percentage accuracy is then discussed, particularly with reference to guarantees of accuracy given when instruments are supplied by the makers. Curves showing percentage of accuracy for reading at various parts of the scale are given in three cases, namely, when the scale is one of equal division, when the scale indicates the square of some quantity, and thirdly, when an attempt is made to construct a scale which shall have approximately constant percentage error through the greater part of its length. Recording instruments and portable instruments are also discussed.

In Chapter III. methods and instruments for the measurement of resistance are summarised. Resistance is here used in its widest sense to include both ohmic resistance and inductive resistance or reactance. The Wheatstone and Kelvin bridges and the ohmmeter are given; also a section on the measurement of the resistance of the insulation of cables. Chapter IV. is devoted to the measurement of E.M.F. and difference of potential and Chapter V. to the measurement of current. Moving coil, recording and portable instruments are all described. Chapter VI. is devoted to power measurement and is one of the fullest of the chapters and includes phase error and correction, wattmeters on three-phase systems and recording wattmeters. Chapter VII., power factor; Chapter VIII., energy, work; Chapter IX., angular velocity and frequency, then follow. The principles involved, as well as the instruments, are given. The last two chapters are devoted respectively to special forms of instruments and to tariff. The five appendices are small and do not add much to the value of the book.

In these days when books on special branches of work are rapidly taking the place of general text-books on technical subjects, a work such as this, which reviews one aspect of the subject is desirable, and from the satisfactory manner in which the material is presented, this book should find a place in the electrical engineer's library.

S. G. S.

MACHINE-SWITCHING TELEPHONE GEAR.*

BY F. R. MCBERTY.

Summary.—The Author reviews comprehensively the subject of automatic telephony. After some general considerations, computation of traffic is dealt with and a comparison is made between observed results and computed chances. The advantages of automatic telephony are shown and in conclusion results are given for the maintenance of machine switches.

The Author deals first with the operations involved in manual switching and then proceeds to discuss the difficulties of mechanical substitution. Three limitations—time of switching, cost and number of machines—have determined the nature of mechanical line switches and each has given rise to a series of inventions and developments. Of these the time-limit within which the switching operation must be completed has imposed the most rigid restrictions and has resulted in the most various and striking characteristics of switching mechanism. Because of physical conditions, it has not been found feasible for commercial service to propel the movable terminal over more than about 50 or 60 terminals per second—a number which is not satisfactorily large. A number of inventors have solved the problem of driving a movable member over a sufficiently long row of fixed terminals by means of two motors of different speeds, the member being driven at high speed nearly to the desired point, say to the preceding decimal, by the first motor, after which it is connected with the low-speed motor which moves it at a rate suitable for accurate stopping to the particular terminal. By this means, a straight row of terminals up to 500 can be covered within the available period.

A type of quick-acting switch better represented in the art is that having terminals in several rows in a compact rectangular field, the wanted terminal being reached in the field by choosing first the desired row and then the desired point in the row—commonly known as the "co-ordinate" switch. This form of switch is able to connect with the desired point in the field with a minimum of motion, and thus with the same speed permits a relatively massive construction. With such co-ordinate switches it is practicable to reach the most remote of 200 terminal points in one second.

The single row of terminals has been arranged in a straight line, in an arc, and in a complete circle. The motor elements required for producing the motion of movable terminals are correspondingly various; but developemnt has favoured two general types, of which one is the ratchet or "step-by-step" motor, and the other the power-driven motor, each with a different characteristic method of control.

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* Abstract of a Paper read last night before the Institution of Electrical Engineers.

With the demand for massive construction, high speeds, and large switch capacity, the limitations of ratchet motors have been found serious and recourse has been had to constantly driven motors to which the moving-switch member is clutched as required. The ratchet motor has the advantage of being quiet, except at the moments of propelling the switch member, which may amount to no more than one or two minutes per day. Aside from the presence of a constantly moving part, simplicity of construction and easy maintenance would seem to be in favour of the power-driven clutch. For such work as is required of a telephone switch, it is a surprising fact that the annual cost of a piece of shafting maintained in constant motion is very little more than that of the same piece of metal still, and much less than the cost of maintaining a more complex form of motor device.

Size of Machines and Number of Multiples.—The machine for maximum economy in first cost must therefore represent a choice between a large number of terminals very inefficiently employed, with a minimum number of motors and movable members very efficiently employed, on the one hand, and on the other a small number of terminals efficiently employed and a large number of motor and moving members inefficiently employed. The subsequent cost of maintenance is of weight, since this cost is affected in a more important way by the multiplication of moving parts than it is by the multiplication of fixed parts.

The motion of the switching machine may be controlled primarily in either of two ways, for functions which may be described as "seeking" and "choosing" respectively. The switching functions are not essentially different; the moving terminal of a seeker or finder is driven to the required points and stopped there by the different condition of the point itself; whereas in the choosing-switch or selector, the moving terminal is propelled through a measured distance which is controlled from a distant point; both funtions are sometimes combined in the same switch. Nevertheless, the finders commonly require a smaller field of terminals for efficient operation than selectors, and each of the developed machine switching systems contains two forms of switching machine based on this difference of function.

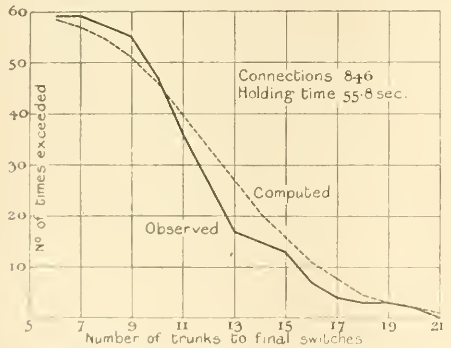

FIG. 1.—COMPARISON OF OBSERVED AND COMPUTED TRUNK EFFICIENCY.

Trunking Through Switches.—The manual switchboard is limited to about 10,000 lines within reach of the operator with a plug. The largest machine switch so far constructed is limited to about 500 lines within reach of the movable terminal. Recourse is therefore had to combinations of machine switches operating in series. It is unnecessary to emphasise the desirability of concentrating the traffic of the telephone system in the minimum number of machine switches; the extent to which it can be carried determines both the dimensions and number of the switching machines and thus the cost of the equipment. This concentration has been one of the main causes of the reduction in cost of machine switching equipments to a point at which such equipments can compete with manual switching systems. In planning the machine equipment, the constructor, as well as the purchaser, must make a choice between first cost and quality of service.

For the constructor, the engineer, and the purchaser of machine-switching equipments, the computation of the number of paths from calling to called lines, and the number of machines and trunk lines necessary for producing the paths, becomes essential.

A subscriber calling, either gets through and speaks with his wanted subscriber, or he fails to get the wanted party; the result of failure will be definite loss of revenue for the owner of the equipment coupled with dissatisfaction on the part of the users or a large increase in calling rate resulting from repeated futile calls. Each such repeated call may involve the use of the plant to almost the same extent as a successful and revenue-producing connection.

In the manual-switching system the calculation in advance of the elements for use in common has not been essential. In the planning of machine-switching equipments the accurate adjustment of the switching capacity to traffic in advance of construction is important. Discussion of relative merits of the several mathematical methods of computing capacity is not within the scope of this paper; but some reference to the practical aspects of the current discussion of methods may be desirable.

It must be stated that telephone calls are not originated, or distributed amongst lines, purely by chance, but rather to some extent in accordance with fixed social and physical conditions; nevertheless a large number of calls originating under defined conditions can be treated as though they were initiated and distributed purely by chance through given periods of time and as originating and terminating at random in the different numerical or geographical groups of lines. Studies of chance are employed to determine the probable deviation from the average. It is not expedient to provide for an absolute maximum of paths, but it is necessary to compute and make such provision that the switching capacity of any portion of the exchange probably shall not be exceeded more than a certain small number of times, which will appear negligible.

Illustrations are given of results computed by means of the theory of chance. These show a close correspondence between the computed and the observed results.

The correspondence between the number of switches required by traffic of given amount and character as observed and as computed from observed duration of conversation, is shown in Fig. 1. The observations were made in a semi-automatic machine-switching equipment known hereafter as "1." The total number of connections during the period of observation was 846, the average holding time per connection being 55·9 seconds. The selectors observed contained 22 trunks in a group; the 22nd trunk was not required during the period of observations, though 21 trunks were required. As computed for one call lost in the period, 22 trunks might have been once exceeded. The correspondence between observed and computed results is noticeably close.

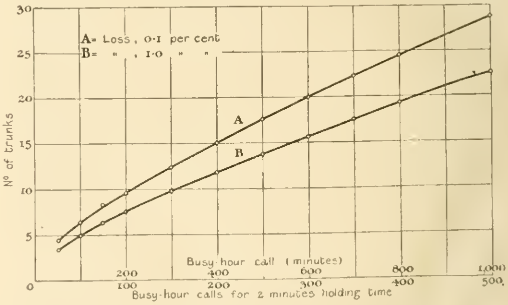

FIG. 2. RELATION OF TRUNKS TO TRAFFIC FOR DIFFERENT PERCENTAGES OF CALLS LOST OR DELAYED.

Practical Bearing of Computations of Probable Traffic. Reference has been made in the foregoing pages to the percentage of calls lost or delayed by reason of deficient junctions or switching machines. The formulæ for computing chances permit the calculation of a switching capacity at the various trunk links and switching machines which will be adequate for all but a certain peak of load; this peak of originating load unprovided for will consist in calls delayed, or blocked, by a busy back signal. The cost of accommodating the peak—particularly when the day's traffic curve shows sharp peaks—may be considerable. Fig. 2 shows the number of switching machines (and trunk lines) for two equipments otherwise identical, the capacity of one of which is such as to produce a delay or loss of 1 per cent. of the day's originated calls in the switching equipment (excluding the loss at the called party's line), while the other gives the capacity which would produce about 0·1 per cent. loss in the day's calls. The curves are figured on the assumption of four orders of switching machines, two busy hours per day (80 per cent. of the peak traffic being taken as a busy hour), one-eighth of the day's calls in the busy hour, and a holding time of two minutes.

A system equipped in accordance with the lower of these curves would produce a number of "trunk-busy-tests" during the busy hour equal to about 4 per cent. of the originated calls.

Controlling the Switches; Full Automatic and Semi-automatic Systems.—The manner of controlling the movements of the two types of switches with ratchet and power motors are characteristically different: the ratchet motor impulses of current are produced by the controlling means which operate the motor magnets of the switches successively step-by-step, advancing the moving member to an extent corresponding to the number of impulses; in the power-driven switch, the switch is set in motion and in its motion transmits back to the controlling means impulses of current which measure the progress of the switch and enable the controlling means to stop it when the desired displacement has been produced. The employment of the ratchet motor driven by a succession of current impulses involves a stoppage of the switch at each impulse and thus tends toward the reduction of mass to permit prompt stopping and starting. The second named type, which is known as the revertive impulse control, permits an uninterrupted motion of the switch parts and so permits the employment of relatively large masses, high speeds and extensive movements.

The standard form of controller for ratchet motors is a break wheel driven at a regulated speed which produces successive interruptions of current to the required number in the circuit containing the motor magnet. The revertive impulse type requires as a controlling device some form of magnet-driven apparatus which counts the impulses measuring the progress of the switch and breaks the circuit of the motor or clutch at the correct number.

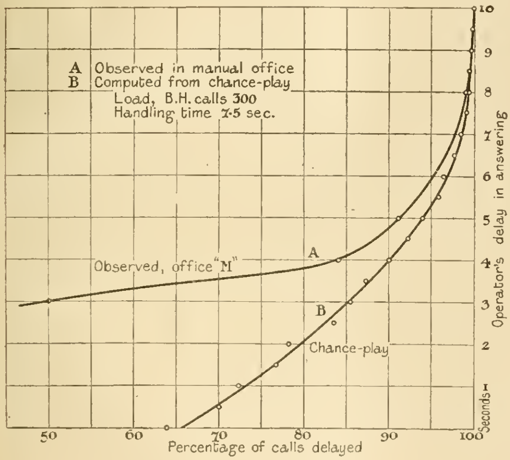

FIG. 3.—DELAY IN ANSWERING.

The control of the switching machines may be exercised either by the subscriber himself, furnished with a number-transmitting dial, or by an operator acting under the subscriber's direction by telephone. Some particulars are given of the control.

Call Distribution to Semi-automatic Operators.—The use of seeking machines, whether pre-selectors or finders, for concentrating the incoming calls upon the group-choosing switches, in semi-automatic operating, permits at the same time a concentration of the work of answering, establishing and supervising connections upon a minimum number of operators and the equable distribution of the work amongst them. It is profitable to concentrate the incoming calls upon an operator up to her full capacity, which may be about 500 or 600 connections per hour. A condition limiting the load is the delay imposed upon the individual subscriber's call before it receives attention, which can be kept down only by reducing the load on the operator and so increasing the wage cost per connection, or by distributing calls to a larger number of operators and thereby increasing the quantity of distributing machinery. The standard of promptness in answering a subscriber's call has already been fixed by experience with manual systems and cannot now be exceeded. This service is of the character in which averages are not particularly significant, but extremes determine the character of the service. The aim of good manual practice is to answer the calling subscriber in an average time of 3½ seconds, with no more than 5 per cent. of the calls delayed more than 10 seconds.

Fairly close correspondence is found between observed results and chance plays, and the latter method is therefore valuable for determining the effects of call distribution. Fig. 3 illustrates the correspondence between chance plays and the results observed, for example, in the manual switchboard "M" when the operators were specially loaded to 300 calls each in the busy hour, with team work amongst three operators. The operator's delay in answering a call in a manual switchboard is composed of two factors, of which the first is a nearly fixed minimum time of rather more than 2 seconds for observing the call signals, plugging into the calling line and connecting her telephone; while the other is the wait imposed while the operator serves other calls, which increases with increasing load. The inclination of the curve of observations therefore tends to the horizontal towards the left. In the case of the curve of chance plays the constant factor for physical work is not present.

Fig. 4 was plotted from a large number of similar chance plays, for an assumed handling time of 5 seconds per call. It shows the relation between subscribers' waiting time and different loads per hour per operator for a team of three operators to whom the calls originating by chance are distributed as equably as possible, the mechanism being assumed to pass the call to the operator's telephone as soon as it is free. The charts indicate that a high grade of service can be attained consistently with a high load upon each operator, by providing for connecting any call originating amongst two or three thousand lines with any of six or more operators. To perform such a distribution requires seeking switches of large switching capacity.

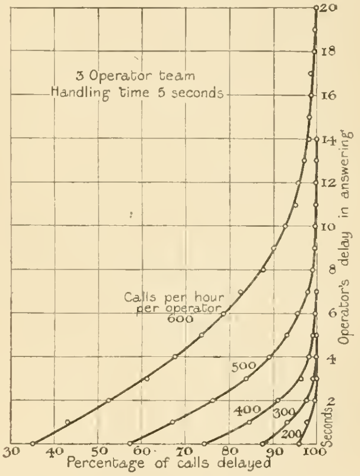

FIG. 4.—RELATION BETWEEN BUSY-HOUR LOAD AND SUBSCRIBER'S WAITING TIME.

The author then gives a detailed account of a semi-automatic equipment in France.

In this installation, in order that the excess calls passed to positions may not be delayed unduly or kept waiting before an operator engaged on a troublesome call, two special features are employed known as "timed distribution" and "helping out" respectively. The "timed distribution" consists in maintaining the busy test of the operator's position for a measured time after the passing of each call to her telephone, and increasing this measured time progressively for second and third calls passed to the position in quick succession. When a call is passed to an operator's position the position is made busy for three seconds, which period together with the time required by the mechanism itself to seize and pass to the telephone another call cover the average handling time for the call. After the arrival of a first call, therefore, immediately succeeding calls must pass to other positions. During normal loads some position usually will be idle to take the call. A call arriving while all positions are busy will be taken by a finder of some position, but in such a case the timing device will maintain the busy condition for five seconds instead of three; for that period directing other excess calls to other positions. Provision is made for the arrival of a third order of calls, though such calls are highly improbable. The busy periods can be adjusted.

The office in question is the centre of an important toll traffic which is provided for in the usual manual toll and recording positions. The switching of calls from lines demanding toll connections and of calls for lines of the automatic equipment are preformed by machine switches. A call originating for a toll line is disposed of by the operator by pressing a special toll key which directs the call at the first group selector into a group of trunks leading to a recording position, where the recording operator notes the numbers of the called and of the calling parties; or by the operation of the dial by the full automatic subscriber which sets the register to a special position and so directs the call to the same group of trunks to recording operators. Provision is made for the automatic prevention of metering calls to the recording operator. Particulars are given of the arrangements adopted.

(*To be concluded.*)

CORRESPONDENCE.

BALANCERS FOR THREE-WIRE CONTINUOUS-CURRENT SYSTEMS.

TO THE EDITORS OF THE ELECTRICIAN.

The writer has been much interested by the article on "Balancers" contributed by Mr. Thomas Carter, beginning in your issue of Jan. 12, as it promises to make available for easy reference information concerning a subject which has not received any clear or sufficient presentation. It would appear, however, that Mr. Carter is somewhat predisposed toward the rotary balancer as the means for maintaining the neutral in its proper place, and other methods, beyond that employing auto-transformers, do not receive much consideration.

It is certainly disconcerting to encounter the reference to the "arrangement proposed by Pilger in the 'Electrical World,' July 20, 1912." This arrangement referred to is one first developed by Mr. James Burke, and incorporated in a great many generators both by his company and that with which the writer is connected. In view of the very considerable number of generators of this type put out each year, covering a range of capacity from 50 kw. to 1,000 kw., it rather grates upon one's sensibilities to see the design included with those classed as obsolete.

A consideration of its vitality would probably admit as direct evidence the testimony of the ultimate consumer who can purchase from the same manufacturer either a two-wire machine with rotary balancer, or a three-wire machine of the "obsolete" design, and who has, since it has been on the market, consistently chosen the three-wire generator.

Mr. Carter apparently believes that the auxiliary winding on the armature, which takes the place of either rotary balancer set or auto-transformers, increases the size of the generator due to the larger slot required. In the absence of any definite knowledge of the design this appears reasonable, but in fact this result does not follow. The outstanding merit of the system beyond the doing away with all external compensating devices lies in the unique property of its balancing winding of not only not continuously absorbing energy corresponding to the excitation losses of the auto-transformer or the free running losses of the balancer, but working in parallel with the main armature winding and actually *reducing* the generator losses by its presence. In actual designs the slot size is [illegible] at all or is increased in depth alone from 5 to 10 per cent., which has no effect upon the machine dimensions. [illegible] for 1,000 kw. generators, which [illegible] unbalanced current of 2,000 amperes, for [illegible] like 500 would be required [illegible] rotary balancer. It thus appears that on further acquaintance the "inherent disadvantage" which has frightened Mr. Carter away [illegible] turn out to be absolutely [illegible].

[illegible] with of this and the static balancer systems is the impossibility of exactly preserving the equality of voltage on the two sides of the three-wire circuits. It appears in actual practice, however, that with the normal three-wire generator giving only about $\frac{3}{4}$ per cent. voltage variation from the mean with an unbalance of 10 per cent. of rated full load current, and about $1\frac{1}{2}$ per cent. variation even with 25 per cent. unbalance, this disadvantage is more theoretical than real.

I do not wish to criticise the rotating balancer or deny that there are many instances where its use is thoroughly justified, but as I have been intimately connected with the design and operation of both the balancer and the self-contained three-wire generator, and have witnessed the balancer being pushed aside by the machine of only "historic interest," I feel that Mr. Carter would be interested in knowing of developments across the way and would be glad to do them full justice.

Ampere, U.S.A., Feb. 8. GEORGE WILLIAMSON.

At the end of the fourth paragraph there is an evident omission, and we take it that the author means £500. We have submitted a proof of this letter to Mr. Carter, from whom we have received the following reply.

TO THE EDITORS OF THE ELECTRICIAN.

"Where ignorance is bliss, 'tis folly to be wise;" but this is a case where ignorance is not bliss, and it would be folly not to profit by the enlightenment contained in Mr. Williamson's letter. My article on "Balancers" was written from the point of view of my own experience, and I referred particularly to rotary balancers and static balancers, because these appear to be the devices most commonly employed in this country for the purpose of balancing. In looking up the history of the subject, in order to make the statement reasonably complete, I came across a reference to Pilger's article in the "Electrical World," July 20, 1912. Unfortunately, I was unable to see a full copy of the article, and so could not do more than briefly refer to the arrangement there described; and, as I did not know of any extended use of it in this country, I somewhat rashly included it amongst machines of more or less historical interest. One lives; and if one also learns, there is hope for one's soul. I therefore thank Mr. Williamson for drawing attention to my inaccurate description of the arrangement in which he is interested, and for the information he has given as to its extended use "across the way." Back numbers of the "Electrical World" are very difficult to buy in this country; should they be more plentiful in America, and should Mr. Williamson by any chance be able to get hold of a copy of the issue in question, or anything else containing a description of the machine, and send it across to me, he would be doing me a favour I should be glad in any way to repay. I trust he will not think my suggestion exceeds what one stranger may ask of another.

If I have any preference for the rotary balancer it is because, as my article shows in its later stages, that type is more flexible in many respects than any other; it is less costly in its connections than the three-wire dynamo with a static balancer, which involves additional full-sized cables between the dynamo and the switchboard, as compared with a two-wire machine, when it has to operate in parallel with others; and there is an inevitable under-compounding of the system with a three-wire dynamo, as Mr. Williamson agrees, which can be fully avoided when a rotary balancer is used. The last-named point is certainly not usually of importance: I had a case last month where a static balancer was used, and where the variation from the correct voltage was only $1\frac{1}{4}$ per cent. on each side, with an out of balance of $33\frac{1}{3}$ per cent. of the total current of a 250 kw. generator. But the additional cables are very often a real difficulty, and largely offset the reduced price of the static balancer arrangement. I assume (though, "in the absence of any definite knowledge of the design," this may not be entirely safe) that Mr. Williamson's arrangement involves the same external main and equalising connections to the switchboard as are required for a dynamo using an external static balancer. At the same time, to use a homely proverb, the proof of the pudding is in the eating thereof; and Mr. Williamson's statement that in his experience the self-contained three-wire dynamo is preferred to the two-wire type with a rotary balancer is very significant.

I would thank Mr. Williamson for his kind reference to the probable usefulness of my article, and would again express my obligation to him for so materially adding to the information it contains.

Newcastle-upon-Tyne. March 14. THOMAS CARTER.

A DECIMAL MONEY SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

I stated in my article in your issue of Jan. 26 the reasons why I believe that the pound must be the basis of a decimal money system in this country. But there is something else to be said, and to which I direct the attention of those who advocate the florin or the shilling as the basis. It is this. It does not appear to be possible that the British people will consent to alter the position of the pound, to write and calculate and think in florins or shillings, to alter their ways of keeping their accounts, drawing out their bills or cheques and doing everything in which money beyond extremely small amounts is involved. The opposition to such changes would be overwhelming. I think that this must surely be plain to almost every reader of THE ELECTRICIAN. Consequently, unless the advocates of the florin or the shilling system would prefer the existing system to the pound decimal system, it would appear that they ought to support the only thing practicable and possible. Moreover, some of your correspondents seem to be in favour of the introduction of the words "cent" and "mil." This also would cause a certain amount of opposition. I pointed out in the article referred to that there is no need whatever to do away with the old names of penny, halfpenny and farthing, but every reason why they should be retained. If a British Government would make 25 pennies to the florin the pound decimal system would be at once in operation. But, of course, it would be necessary to have coins more suitable than our present ones for such a system, and these could be brought into use gradually.

London, March 20. JOHN JOHNSTON.

TO THE EDITORS OF THE ELECTRICIAN.

It would appear desirable that any proposed decimal system should retain existing coins, and as far as practicable their relative values. A simple method of conversion would be to make the half-sovereign the unit, and during the transition period call it the new pound, designated by $\overset{N}{\pounds 1}$; also divide the shilling into 10 pence. Then a sovereign = $\overset{N}{\pounds 2}$; half a sovereign = $\overset{N}{\pounds 1}$ = 10 shillings = 100 pence = 200 halfpence = 400 farthings. Or, in terms of the $\overset{N}{\pounds 1}$, we have 2, 1, 0·1, 0·01, 0·005 and 0·0025 respectively. The rule for converting would simply be: multiply the amount in sovereigns by two and add one if the amount in shillings exceeds nine. Thus,

£3 17s. 9¼d. becomes $\overset{N}{\pounds 7{\cdot}7925}$.

A suitable opportunity for introducing a decimal system and giving the public an incentive in using it, presents itself in an issue of Premium bonds. The fixed rate of interest may be expressed as 2·7025 per cent., and the various prizes in attractive amounts, and thus stimulate a desire to thoroughly understand the decimal system.

London, March 17. A. DITTMAR.

PHYSICAL SOCIETY.

A meeting was held on Friday, March 9th, at the Imperial College of Science, Prof. C. V. BOYS, F.R.S., President, in the Chair.

A Paper, entitled

"To Measure the Pressure in a High Vacuum by Observations of Logarithmic Decrement,"

by Dr. P. E. SHAW, B.A., D.Sc., was taken as read in the absence of the author.

In experiments on the Newtonian Constant ("Phil. Trans.," May, 1916) the author used a torsion balance in a vacuum which varied in different cases from 1·5 mm. to 0·00001 mm. pressure. Before sealing the vessel the pressure was determined by a McLeod gauge. Values of the pressure after sealing off were deduced, in the case of the higher vacua, from observations of the damping of the torsion system.

The formula employed is due to the late Prof. Poynting, and can be expressed in the form

$$P = 35{\cdot}6 \frac{I}{saT}\lambda,$$

where I = moment of inertia of suspended system, s = area of surface (supposed plane) which is experiencing the resistance, a = mean distance of plane from centre of rotation, T = period of oscillation, and λ = the observed logarithmic decrement.

A table and curve are given showing the relation between P and λ.

A Paper on

"A Diffraction Colour Box,"

was read by Mr. A. W. CLAYDEN, M.A.

The apparatus consists essentially of a very simple concave grating spectroscope, of which the slit and grating are situated at opposite diameters of a circle, the spectrum being formed on the arc of this circle. Two independent arms carry fittings on which may be placed either telescope eyepieces or small electric lamps. With the slit of the instrument illuminated by a suitable source, the eyepieces can be set so that any two desired wave-lengths are in the centres of their respective fields of view. The eyepieces are then replaced by the small lamps (the filaments coinciding with the previous positions of the crosslines), and the grating is observed with a small telescope pointed towards the widened slit: the whole of its surface is seen to be illuminated with a mixture of the two colours on which the eyepieces were originally set.

The "concave grating" employed consists of a Thorpe replica of a Rowland plane grating of 14,475 lines to the inch, mounted with its ruled surface in contact with the surface of a concave mirror of 4 ft. focal length. This forms an admirable substitute for the more expensive concave grating.

The author prefers to state results in terms of the number of oscillations per unit of time.

Observations showed that the smallest change of wave-length which could be recognised by the eye as a change of colour was greater than that which corresponded to a change of period of 10^{12} vibrations per second, or to a change of one vibration more or less in $1/10^{12}$ second.

Mr. TROTTER asked how the minimum difference of wave-length detectable as colour difference compared with the values obtained by Dr. Edridge-Green.

Mr. T. SMITH said that experiments on the minimum colour difference which the eye could detect were valueless unless the exact conditions under which the experiments were made were stated. For example, the comparison of two colours side by side is materially affected by the presence of a black space between them. In Dr. Edridge-Green's experiments the conditions were not good. The experiments were made somewhat as follows: While viewing the extreme red end of the spectrum, a shutter is brought down towards the red so as to cut off everything above the region to which the observer would give one distinguishing name such as deep red. A second shutter was then brought up from the red end to cut off the first patch, and the first shutter moved along the spectrum until the boundary of the next "monochromatic" patch was located. By this means the whole spectrum was divided up into about 25 monochromatic patches. It is not difficult to repeat these observations, but if they are compared with measurements made in another way entirely different results are obtained. Lord Rayleigh was able, for instance, to distinguish between the colour of the two sodium lines. He had two spectra, one above the other, the upper one being inverted, so that D_1 and D_2 of one spectrum coincided with D_2 and D_1 of the other. Colour comparisons should always be made from simultaneous observations of the two colours.

Prof. C. V. BOYS said he would like to emphasise Mr. Smith's remarks about the effect of varying conditions on the visual estimates of colour. In the colours of soap films, for instance, this difficulty is met with. Where the thickness is nearly zero the colour is black. As the thickness increases the colours of the first order are successively encountered. Between the blue and yellow there is a tint which can only be described as a bad white. He had long been puzzled as to what this colour was, but had eventually discovered a method of overcoming the deceptive influence of the adjacent colours. Usually these films are traversed by long thin folds. The thickness of the folded film is everywhere three times that of the adjacent unfolded film. Points can be found where this doubtful region between the blue and yellow, occurring on the triple film, can be directly contrasted with the first order white in the adjacent single film. It is then seen to be a very good green. A point which had surprised him in connection with Mr. Clayden's apparatus was that the plane grating, which could not be in actual contact with the mirror except at its edges, nevertheless behaved as if it were in good optical contact.

Dr. W. ECCLES pointed out that the minimum colour difference estimated by Mr. Clayden to be perceptible to the eye, if expressed in the same way as an interval in music, works out as about 1·0013. The tone difference just perceptible to the trained musical ear has been stated to be one seven-hundredth of an octave, which works out as 1·001. It is interesting to observe that the sensitiveness of the eye to pitch differences is, like its sensitiveness to inflow of energy, of the same order as that of the ear.

Mr. Clayden, in reply, said that in making his experiments on the minimum difference of wave-length required to produce a noticeable change of colour he had arranged matters so that by using a reversing or non-reversing eyepiece in the observing telescope one or other colour was uppermost in the field of view. The difference in wave-length was then reduced until it was impossible to say which was which. By this method he could detect a difference of two vibrations per $1/10^{12}$ sec., but at the red and violet ends of the spectrum the detectable difference greatly increased. With regard to the President's last remarks, he had himself been very agreeably surprised to find that the performance of the grating was so satisfactory.

An arrangement for showing by projection on a screen the coloured fringes exhibited when a Thorpe grating is laid with its ruled face against a plane mirror was shown by Mr. A. W. Clayden.

The light from a small lantern is incident in an approximately parallel beam on the interface of the grating and mirror, which are held together in a wooden framework supported on a stand. The position of the grating-mirror combination is adjusted so that the central reflected beam or any one of the diffracted beams is returned just alongside the lantern. The beam passes through a projection lens which focuses the fringes on a distant screen. The fringes thus obtained are very bright, and the simplest apparatus and adjustments suffice for their production.

Dr. R. S. Willows mentioned that Fellows had informed him that these fringes had been described by Barus in the "Philosophical Magazine" (July, 1910, and July, 1911). He understood that they had also been exhibited by Rheinberg at the Optical Convention in 1910. Mr. Clayden's method of exhibiting them by projection would, he thought, be distinctly useful to teachers.

An apparatus for studying the effect of Hertzian Waves on the Heart was exhibited by Prof. W. M. Coleman.

A simple pendulum, consisting of a cylindrical brass bob terminating in a pointed wire coaxial with the bob, hangs by a piece of string above one of the terminals of an induction coil, so that in its lowest position the point of the bob is within sparking distance of the terminal and vertically above it. The bob is connected by a piece of flexible wire to the other terminal of the coil. When the pendulum is set oscillating there is a shower of sparks every time the bob passes its lowest position. The frequency of intermittence can be varied by altering the length of the suspension. By adjusting the period of the pendulum nearly to the time of a heart beat any possible effect on the rate of the beating may be observed. The condensed discharge from two Leyden jars is employed.

LEGAL INTELLIGENCE.

British Thomson-Houston Co. (Ltd.) v. Duram (Ltd.)

On Tuesday the Court of Appeal (the Master of the Rolls and Lords Justices Warrington and Scrutton) delivered their reserved judgment in the appeal of plaintiffs from a judgment of Mr. Justice Astbury. The Court affirmed the decision of the court below, holding that plaintiffs' patent was invalid for want of subject matter.

Alien Enemy Patents.

[illegible] the Pa[illegible] Vermehr Machinery Co. applied for a licence [illegible] patents Nos. 3,666 and 10,374 of 1914 (granted to Dr. Geo. Orn[illegible]) [illegible] to the use of chlorine gas for purifying water.

[illegible] Mr. A. E. Wurts, and they were a British company, [illegible] £10,000, established by Mr. Vermehr in 1907, and turned [illegible] company in May, 1913. They had a working [illegible] with Messrs. [illegible] & [illegible]. Before the war applicants had a [illegible] in Germany. A German named Deutsch, who owned [illegible] a director of the English company. After the [illegible] from the directorate and his 8,000 [illegible] transferred by the Public Trustee to a Mr. Sn[illegible]den. They [illegible]. In the early days of the war the [illegible] supplied to the troops was effected by bleaching [illegible] not used. The patented chlorine gas [illegible] small quantity of water with the gas, [illegible] it was broken down, was [illegible] it perfectly innocuous. The [illegible] part of the equipment of [illegible] of the War Office and it [illegible] that they should supply [illegible] with chlorine gas. The [illegible] Water Softener Co. of America, [illegible] paid £900 for apparatus for two filters. Then applicants [illegible] the Electro Bleaching Gas Co., of New York [illegible]. The War Office were pressing for a [illegible], and applicants proposed now to give it. The apparatus was made under the specifications of Dr. Geo. Ornstein, and applicants wanted a licence to make it here. Various firms would supply them with parts, and those would be assembled at their works, where the apparatus would be built up and completed. In the apparatus water ran down through an absorption tower, and the chlorine gas from a cylinder was introduced at the bottom of the tower and flowed upwards, meeting the water. The water took up a certain pre-determined quantity of the chlorine gas, and the water so charged with the chlorine gas was then introduced in the main body of the water. Chlorine in its free state was a very powerful sterilising agent or antiseptic, as little as 0·1 to 0·4 parts of chlorine per million parts of water being sufficient substantially to sterilise most river or lake water, provided the chlorine was uniformly distributed through the water before it had time to disappear as free chlorine. This invention for using chlorine gas was one of great importance at present. There was a means for automatically varying the rate of supply of the gas. There was a regulation that all water supplied to the troops, irrespective of its source of supply, must be sterilised as well as filtered. At present the Government were paying a considerable sum for the apparatus. The grant of a licence would give them it at a cheap rate, and applicants said that competition would keep down the prices, and they did not mind how many similar licences were granted. As to royalty, they asked that they should not be put in a worse position than the Paterson Engineering Co., who had already applied. It might be that after the war it would be possible to use the apparatus in connection with the water supplies of cities. There was a large installation for dealing with the water supply of Toronto, Canada, where they had a serious outbreak of typhoid fever two or three years ago, and the whole of the supply was now being dealt with by filters manufactured by the applicant company.

After hearing Mr. Vermehr's evidence, Mr. Temple Franks said he thought there was no doubt that, in the circumstance, a licence should be recomended on the same terms as to the previous applicant.

H. S. Barrett v. Enfield Electric Cable Mfg. Co. (Ltd.)

Last week this case came before Mr. Justice Ridley. Plaintiff, an architect, sought to recover from defendants £115 10s., fees for professional work done, the main portion being in connection with the preparation of plans for a new factory at Brimsdown. The defence was that a verbal agreement was made between plaintiff and Lord Grimston (acting on behalf of defendants) by which plaintiff was to prepare the plans at his own risk. If the work was afterwards carried out, plaintiff was to be paid for his services and if not (as did happen) he was to receive nothing.

In the result defendants agreed to submit to judgment for £105 (including £10 10s. paid into Court), with costs.

Australian Metal Co.—In the Chancery Division last week Mr. Justice Younger ordered this Company to be wound up. The petition was brought under Sec. 1 (7) of the Trading with the Enemy Act.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

February 12, 1917.

2,092 Thompson. Electric generating apparatus.
2,093 Thompson. Wireless telegraph apparatus.
2,098 Reyrolle, Coates & Mirrey. Frames or casings of alternating current electric apparatus.
2,103 James. Electro-magnetic brake.
2,106 Morgan. Testing magnetos, &c.
2,109 Maschinenfabr.-Oerlikon. Securing insulator to base-plate. (12/2/16, Switzerland.)

February 13, 1917.

2,133 Waller. Supporting shades or reflectors on electric lamps, &c.
2,1[illegible]7 Bentley & Scott. Electric driven cranes, &c.
2,1[illegible]8 Allgemeine Elek. Ges. Continuous-current measuring apparatus. (24/6/14, Germany.)
2,15[illegible] H[illegible]tik. Wireless telegraphy and telephony.
2,161 Baker & Kl[illegible]yne. Insulation of electric machinery.
2,162 B[illegible]ry. Electric heater.

February 14, 1917.

2,17[illegible] Williams. Electric torch.
2,191 R[illegible]way. Automatic [illegible] breakers.
2,1[illegible] H[illegible]ik. Wireless telegraphy and telephony.
2,214 B[illegible]n. Continuous-current dynamo-electric machines.
2,21[illegible] B[illegible]. Electric speed indicators. (2[illegible]/2/16, Germany.)
2,2[illegible] K[illegible]enberg. Metal fellows with electrically welded flanges.

February 15, 1917.

2,2[illegible] B.T.-H. Co. (G. E. Co.). Electric [illegible].
2,2[illegible] B. T.-H. Co. & Pollock. Dynamo-electric machines.
2,2[illegible]0 G[illegible]-Adam, Ha[illegible] & Lucas. Electric signalling [illegible] lamp.
2,281 Salm[illegible]n. Mounting [illegible] in magnet[illegible].
2,2[illegible] B[illegible]kham & Daw[illegible]. Electric signalling systems.
2,2[illegible] [illegible] T[illegible] Co. & M[illegible]. Telegraph apparatus.

February 16, 1917.

[illegible] [illegible] M[illegible] Co., Clark & [illegible]. Electric switch.
[illegible] B[illegible] & Callender's Cable Co. [illegible] and [illegible] (for electric) junction boxes.
[illegible] R[illegible]. Tapping [illegible] signalling systems.
[illegible] [illegible] & Zw[illegible]. [illegible] electric wires, &c.

February 17, 1917.

[illegible] Exide. Accumulator [illegible].
[illegible] B. T.-H. Co. & Young. Magneto-electric machines.
[illegible] A[illegible]man. Multi-cell battery.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Priority of Government Orders. The Minister of Munitions recently issued an Order giving instructions as to the priority to be given by manufacturers and others engaged in certain trades (which include "electricity and gas services," and "rubber trades and manufacture") to orders for Government work.

Class A, which takes precedence of Classes B and C, includes Government war contracts, placed by the British Government Departments or by Allied Governments with the consent of the Admiralty, War Office or Ministry of Munitions; work on contracts or orders certified by either of those Departments to be war or munitions work; and work which the Minister of Munitions has directed to be treated on an equality with war work.

Class B, which takes precedence of Class C, includes work or material wholly required for repairs to existing industrial machinery (but not the replacement of old machinery by new) wherever essential to maintain continuity of operation in the United Kingdom; the maintenance of reasonable stocks of materials or articles necessary as component parts of work or goods to be carried out or supplied under any orders or contracts to be executed under Class A or Class B; export orders, certified in writing by the Board of Trade, the Admiralty, the War Office, or the Minister of Munitions to be of sufficient national importance to be specially approved tor export to approved destinations and as to which the Minister of Munitions or other Government Department controlling the necessary materials has certified that such materials can be spared; contracts or orders certified in writing by the Admiralty, the War Office, or the Minister of Munitions as necessary for the efficient conduct of the War; contracts or orders certified in writing by the Director-General of National Service to be of sufficient importance in the national interest to be placed in Class B and as to which the Minister of Munitions or other Government Department controlling the necessary materials has certified that such materials can be spared.

For Class C, which comprises all work not comprised in Classes A or B no certificate may be issued.

The consent of the Departments will usually be given through the Commission Internationale de Ravitaillement (the International Commission), India House, Kingsway, W.C.2, to whom application should be made for such consent.

The schedule of trades is set out in an advertisement on another page.

* * * *

Trade After the War. At the annual conference of the Association of Chambers of Commerce on Tuesday, the President of the Board of Trade (Sir Albert Stanley) delivered an important speech on trade problems after the war, and he outlined various proposals for assisting trade and commerce, including the following:—

Railways.—It was necessary that this country should continue to enjoy an unparalleled degree of facilities for railway transport during the war.

Parallel Routes.—It had been suggested that a good deal might be done on the commercial side in the diminution of parallel routes covered by so many business undertakings, and if the business world could take that matter from the Board of Trade and formulate a scheme it would be a good thing for the country.

Coal Mines.—At an early date he would be able to make an announcement showing how it was proposed to deal with the control of this essential commodity. Much less coal must be burned in the country trom now onwards.

Iron Ore.—We had to mine a great deal more iron ore than in the past. Some of the men in coal mines could be released for that particular object.

Post War Problems.—He intended to establish an organisation to deal with these problems.

Trade Banks.—Steps had been taken to establish the British Trade Corporation, which would be given a charter, and whose principal object would be to facilitate and establish a Trade Credit Bank, connected with the existing banks, for developing British trade abroad.

Electricity Supply, &c.—Sir Albert also referred to the importance of the development of the generation of electricity, the co-ordination of the great transport facilities of the country, and a reform of the patent laws.

Commercial Intelligence.—The Board had arranged for a great development of their commercial and trade intelligence department in the City, and an extension of the system of trade commissioners in various parts of the Empire. They were going to increase the commissioners from four to 16. Some would be stationed in India and the Crown colonies, so that the whole Empire would be covered by our representatives.

* * * *

Electric Cooking in Munitions Canteens. On another page of this issue we publish an illustrated description of an electric cooking installation which comprises "Tricity" apparatus and which has been in successful operation for some time in a canteen attached to a large munition works in the north of London. There may seem to be little significance in the employment of electrical energy for cooking purposes in munition works, but as a fact the electrical method is being more and more selected on economical grounds in preference to coal and gas. Quite apart from considerations of cleanliness, convenience, safety and compactness, the electric kitchen saves money in the roasting of meat to a degree which is considered in some quarters almost exaggerated. We hope that every advantage will be taken of what is undoubtedly a great opportunity by electric cooking manufacturers of urging the economic claims of their particular method. The subject is really one of national interest and therefore of concern to the Food Controller. Perhaps it will be brought to his notice by way of the increasing number of electric kitchens which are becoming a feature of munition works, Y.M.C.A. refreshment depots and similar establishments concerned with catering on a large scale. In justice to the electric method every credit should be given to it in this time of national need.

* * * *

Excess Profits Duty. The Treasury give notice that after 40 days from March 13 they will make a regulation.

That the Commissioners of Inland Revenue shall have power in any case, with effect from the commencement of the Finance (No. 2) Act, 1915, to allow modification of the provisions of the fourth schedule to the Act owing to depreciation through effluxion of time of any capital employed in the trade or business and which is expended upon and consists of patent rights so far as such depreciation is not effected by goodwill arising from the user of or interest in such patent rights.

* * * *

Federation of British Industries. Mr. F. Dudley Docker, C.B., who presided at the recent meeting of the Federation of British Industries, said that the membership now consisted of 269 firms and individuals and 50 associations, with 18 applicants awaiting election. He gave an outline of the aims and objects of the Federation.

Mr. Docker said that one of the principal objects for which the Federation had been formed was to command the attention of the Government when framing industrial legislation. In a conversation he recently had with Mr. Wallenberg, president of the Swedish Federation of Industries, he was told that in Sweden they had had for six years a similar Federation to ours, and that no action was taken by the Swedish Government which might affect industry without previous consultation with the Federation. They had got one association, and one association only, for the purpose of being recognised by the Government, and so it must be with us. There could only be one federation to deal with the Government, a federation that would be able to command recognition and respect, and that body must be their Federation. Trade associations could render valuable aid, and for that reason, if for no other, it must be the constant endeavour of the Federation to strengthen them in every way; but for the purpose of dealing with the Government they must have one big federation with a constructive policy. They were engaged upon a great experiment, an experiment upon which the whole future prosperity of the country might depend, but they could not carry it on with their hands tied. They must be free to develop, perhaps into a federation of associations, perhaps into some other type of organisation. Their principles and objects could be stated in a few words: "United action by the manufacturers of the country through a national federation for the development of the industry of the country." If they tried to lay down a fixed programme of policy before they had included in their membership all the manufacturing interests of the country they could not become a national federation; they should only be a federation of persons who happened to agree with that programme. If they adopted an immutable form of constitution they should lose the chance of learning from their mistakes, and in an experiment so novel as the attempt to secure united action by British manufacturers they were bound to make many mistakes. "We must get together first and we must learn to consult each other before we take action, and to modify our own individual wishes and views so as to conform to the common good; when we have done this we can take vigorous and united action, and from this consultation and action we can develop a constitution and a policy based upon a practical experience of our requirements." He was pleased to say that arrangements had been made with other bodies formed with objects not dissimilar to those of the Federation, to be affiliated with the Federation, notably the Employers' Parliamentary Association, by which the various district branches of that Association would become branches of the Federation. The British Manufacturers' Association, which was a body composed chiefly of smaller manufacturers, but with objects very similar to the Federation, had co-operated with the Federation by joining as an association. The British Empire Producers' Association were also working to a certain extent in conjunction with the Federation, there being a joint committee of the two bodies; and arrangements had been made with the Engineering Employers' Federation for their co-operation.

Relations With Labour.—Mr. Docker said they would have an opportunity of considering some resolutions on economic policy which were recommended for their approval. One of those resolutions had a reference to organised labour. The question of their relations with labour called for all the patience, tact and consideration they could command. Having referred to the resolutions passed at the recent conferences between representatives of the employers and trade unions, he said that it the Federation did nothing else to bring Capital and Labour together that would be an achievement to be proud of. It would be necessary to speak plainly to labour in future, not to be afraid to ask what they wanted, and not to be afraid to give what they ought to give for fear of something more being demanded. The welfare of the Empire was essentially dependent upon the existence of a satisfactory understanding between employers and employed.

Trade Bank.—The earlier of the resolutions which would be submitted for approval referred to matters relating to British trade generally. He thought that to a very great extent the whole framework of their commercial organisations would have to be reconstructed. Excessive competition must be eliminated if they were to face the competition of the big foreign combines with any hope of success, especially in overseas markets. Coupled with that problem must also be that of finance. The Board of Trade Departmental Committee on Financial Facilities for Trade had recommended that a trade bank should be established. If that bank was formed it should be largely supported by manufacturers with their own money, in order that they might have their share of control and ensure that the bank was used for the benefit of British industry. The alliance between organised finance and organised industry was marvellously advanced in Germany before the war. He had seen it stated that the Deutsche Bank was interested in over 1,000 industrial companies, and another bank, founded by an electrical company for the purpose of financing electrical undertakings, was extending its operations to iron and steel work, engineering and chemical works. What the manufacturers of Germany could do our manufacturers could do better.

Organised Education.—Another matter which the Federation might well consider was the problem of organised education. He would like to see the Federation surrounded with honorary scientific members. The value which would accrue to the Federation by the attendance of the scientists at its meetings, giving the benefit of their advice, would be far-reaching. Then again—and in that he thought the Federation could do a great deal—there were their universities, which should be supported far more than they had been in the past for the furtherance of industry.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 10, 1917, *to* March 16, 1917.

IMPORTS.

[illegible] U.S.A.: Wire and cable, £241; elec. carbons, £190; telegraph material, £11; elec. machinery, £2,382; unenumerated £11,935. *Japan:* Unenumerated, £3,585. [illegible]: Elec. carbons, £2,507; unenumerated £429. *Switzerland:* Elec. machinery, £1[illegible]; unenumerated, £1,246. *Holland:* Elec. glow lamps, £9,842; unenumerated, £3,1[illegible]6. *Italy:* Wire and cable £11.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £54; unenumerated, £264. *Melbourne:* Elec. machinery, £1,346; wire and cable, £81; unenumerated, £1,221. *Sydney:* Elec. machinery, £1,585; elec. lamps, 3,000 n.o.; unenumerated, £395. *Wellington:* Wire and cable, £258; unenumerated, £62. *Adelaide:* Elec. machinery, £848. *Christchurch:* Wire and cable, £29; unenumerated, £35. *Brisbane:* Unenumerated, £169. *Hobart:* Unenumerated, £32. *Perth:* Elec. machinery, £104; unenumerated, £96. [illegible]: Unenumerated £18.

To Africa.—*Cape Town:* Unenumerated, £539. *Port Elizabeth:* Elec. machinery, [illegible] unenumerated, £167. *Durban:* Elec. machinery, £671; wire and cable, £497; [illegible] unenumerated £148. *Delagoa Bay:* Unenumerated, £20. *East London:* Elec. machinery, £[illegible]; unenumerated £114. *Beira:* Unenumerated, £307. *Mombasa:* Unenumerated, £[illegible]. [illegible]: Unenumerated £86.

E[illegible] *Port Sudan:* Unenumerated £17. *Alexandria:* Telegraph material, £140; [illegible] £73. *Suez:* Submarine telegraph material, £13,620; unenumerated, £17.

[illegible] China and Straits Settlements.—*Bombay:* Wire and cable [illegible] *Calcutta:* Elec. machinery, £980; [illegible] £74; unenumerated £68. *Singapore:* Unenumerated, £135. [illegible] *Madras:* Unenumerated [illegible]. [illegible]: Wire and cable, £230. [illegible] £11; unenumerated [illegible]. [illegible] Unenumerated £65. *Shanghai:* [illegible] £459. [illegible] £381 [illegible] £923. *Santiago:* [illegible]

[illegible] America.—*Buenos Ayres:* Unenumerated [illegible] [illegible] Wire and cable, £3[illegible]0. [illegible] unenumerated, [illegible] *Tunis:* Elec. machinery [illegible] £142, unenumerated [illegible]

FOREIGN GOODS (duty paid and free).

[illegible]

IN TRANSIT.

[illegible]

Note.—The [illegible] number of items in these official returns under the heading "unenumerated" relate to what is described as [illegible] and electrical material.

EDUCATIONAL.

Scientific Research.—The education estimates for education, science and art for the year 1917-18 amount to £21,412,175, a net increase of £764,787 over 1916-17.

The increase is mainly due to a new grant of £1,000,000 in aid of scientific and industrial research. This sum will be paid to the account of the Imperial Trust for the encouragement of scientific and industrial research, and grants will be made by the directions of the Privy Council Committee over an agreed period to approved trade associations. Provision is also made for the distribution by the same Committee, on the recommendation of the Advisory Council on scientific and industrial research, of grants totalling £24,000 in aid of investigations carried out by learned and scientific societies, and £6,000 to students and others engaged in research.

Technical Education.—Bristol Education Committee, after consultation with representatives of engineering firms, have decided to open immediately after the Midsummer vacation a Junior Technical School for boys who intend to enter the engineering trades, and they have appointed Mr. Wm. Hall, B.Sc., of Leicester, as headmaster of the school.

BUSINESS NOTICES.

Mr. Wm. V. Wakefield has assigned to Mr. Cecil F. H. Foster his share as a limited partner in the business hitherto carried on by them as the Coventry Magneto Repairing Co., 9A, Fleet-street, Coventry. Debts by Mr. Foster, who continues the business.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of April 2. *Further particulars are set out in an advertisement.*

Patent Development.—The proprietors of patents Nos. 8,195/09, 21,534/05, 30,082/13, 9,964/10 and 5,545/12, relating to "Electric accumulators with alkaline electrolyte," desire to dispose of same or to grant licences thereunder. Inquiries to Svenska Ackumulator Aktiebolaget Jungner, Stockholm, Sweden.

Agency Wanted.—A Russian electrical engineer, with good State and municipal connection, seeks the sole representation for Russia of manufacturers of turbo-generators and other electrical plant and machinery, &c. Communications to M. A. Kraminsky, Kamenoostrowsky, Prospect 29, Petrograd.

Plant Wanted.—One or two second-hand motors (30 H.P. to 50 H.P.) are advertised for. Quotations to Commanding Royal Engineers, Weymouth.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the meeting of creditors of G. T. Harrap, consulting engineer, &c., 5, Budge-row, London, E.C., last week, the liabilities were put at £3,314 and assets at £97.

The Anchor Electric Co. (Ltd.) is being wound up voluntarily, and Mr. T. R. Rankin, Anchor Electric Works, Chadwell Heath, Essex, has been appointed liquidator. Claims to Mr. Rankin by March 26. A meeting of creditors will take place at 5, Lincoln's Inn Fields, London, W.C., on March 30.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barnsley.—Owing to the abnormal demand for electrical energy for power the Corporation have applied for sanction to a further loan of £1,000 for extensions of the electric supply undertaking.

Halifax.—The Corporation have applied to the L. G. Board for sanction to a loan of £10,000 for the installation of a new boiler, economiser, &c., at the electricity works.

Islington (London).—The London County Council have sanctioned the borrowing by the Borough Council of £5,141 for electricity purposes.

A sum of £1,821 is for mains, repayable within 25 years; £1,573 for transformers, within 15 years; £1,681 for house services, within 12 years; and £60 for meters, within 10 years. Sanction to borrow £159 for a site was refused.

London County Council.—On Tuesday the Council authorised tenders being obtained from selected firms for the provision of cables and switchgear in connection with the supply of additional power from the Greenwich station to the Woolwich area.

Loughborough.—The L.G. Board have sanctioned loans for extensions of electric generating plant, &c., without holding a local inquiry. Sanction has been given to borrow £19,925 for plant, boiler, &c. (to be repaid in 15 years), for £5,000 on structural alterations (to be repaid in

30 years), but 25 years is allowed for repaying £1,275 for cables. The Board deducted £1,025 with respect of the debt outstanding on plant to be superseded, so the £1,025 will have to be met out of current revenue. In the report of the electrical engineer, the time of repayment was put at 17 years, but the equated period sanctioned works out at 18·4 years.

The Electricity Committee had ordered a boiler and an underfeed stoker, but the other plant will be ordered by an Emergency Sub-Committee.

Mexborough.—It is proposed to carry out extensions of the electricity undertaking at an estimated cost of £10,000.

Motherwell.—A report on the proposed extension of the electricity supply works is under consideration by a sub-committee of the Electricity Committee.

Rotherham.—At a special meeting of the Corporation on Friday last proposals were submitted for the erection of new electricity works.

The question was raised on the minutes of the Council in Committee, which recommended that the Town Clerk be instructed to apply to the L. G. Board for sanction to borrow £400,000 for the erection and equipment of a new station; also that the Electric Light and Tramways Committee be authorised to accept tenders and enter into contracts for the erection of same.

A special report by the electrical engineer (Mr. E. Cross) emphasised the immediate need for extensions, and stated that the ultimate demand which was likely to be made upon the department was about 60 million units per annum; and he recommended that they should commence at once to erect a new station of a capacity from 20,000 kw. to 30,000. The estimated cost of a station of 20,000 kw. capacity was about £400,000. They had indications that the various Government departments recognised that the new power extensions were very essential; and the fact that the department was in such an excellent financial position was a strong argument in favour of manufacturers obtaining power instead of generating from private plants. The estimated demand was over 16,000 kw., which would yield a revenue of over £200,000.

The Town Clerk reported that he had had further interviews with the various heads of departments, and it could be stated that they fully approved of the proposals and would give entire backing to the scheme being pushed through with the greatest possible expedition.

Swansea.—The cost of the cable and material required to give a supply of energy to the new pumping station of the waterworks department at Cwmbwrla is estimated at £1,200, of which the waterworks department are to pay 7 per cent. per annum, or 20 per cent. of capital outlay by way of payment for current consumed.

The Waterworks Department is to be charged 1⅛d. per unit, but this figure will vary according to a sliding scale depending on the load factor.

The turbines at the generating station are to be thoroughly overhauled during the forthcoming summer. The new offices of the Tramways Co. at their depot at St. Helens are to be connected up with the distribution mains.

The Engineer is to interview the Ministry of Munitions regarding the new plant to be installed at the generating station.

Swindon.—The Council have authorised the purchase of a rotary converter, switchgear, &c., at a cost of £3,200 for giving a supply of electrical energy to a factory by means of an overhead cable.

GENERAL.

Ammanford.—The proprietor of the local electric supply works (Mr. Wm. Herbert) offers to dispose of same to the local Council for £125,000. The matter has been referred to the Roads Committee and the clerk has been instructed to consult the L.G. Board.

Belfast.—The report of Sir John Snell on the present position of the electric supply undertaking is under consideration of the Electricity Sub-committee of the Tramways and Electricity Committee.

The following synopsis of Sir John Snell's report has been issued: As new generating machinery cannot be obtained this year, and almost certainly not in time for the winter of 1918, it will be necessary to utilise the present plant for the coming two winters. An additional pair of connecting cables should be provided between the 'bus bars of No. 1 and No. 2 house, at a cost of £500, in time for the coming winter, and the switch panel at present on order completed. When the alterations are effected, enabling proper use to be made of the overload capacity of the turbines at present in the station, the Committee will be able to meet the demands of another day such as Dec. 15 last with some margin of output possible in the plant actually in operation, and with plant in reserve to the amount of 3,400 kw. Under the circumstances, the Committee may take the small risk of supplying the applications for general demand now deferred for further consideration, and accept such further applications for lighting and small general supply as they arise.

Sir John Snell does not approve of extension of the generating plant in the present station, but he is strongly of opinion that the Committee should proceed to complete all their plans for the future development, and begin by obtaining expert assistance in choosing sites for sub-stations, having regard to the present positions of mains and feeders, to avoid extravagant expenditure in copper, and to provide at the same time for the probable developments of local demand and the proper distributon of same. The plans and specification of all building and machinery required for sub-stations and for the first instalment of the new station at Hamilton-road should be completed in order to be ready to place contracts at once upon the arrival of a favourable opportunity after the conclusion of the war, and if possible have same ready for the late spring of 1919. At a convenient opportunity, not necesarily in present circumstances, the ampere-hour meters at present in use should be substituted by integrating watt meters, in order to remove completely the human element, with its personal equation and probable error in estimating and averaging the pressure during the 24 hour period. The present steam plant is sufficient to meet the present requirements and the additions already indicated and to provide a reserve. He also urges that the greatest skill and attention should be given to the maintenance in the most perfect condition of all the plant, and that the Committee should be prepared to spend freely any money deemed necessary for such maintenance.

Electricity Supply Charges.—It is reported that some electricity supply undertakers, in view of the early introduction of the Summer-time Act, and owing to the very high prices of coal, &c., are contemplating the revision of their charges for electrical energy.

At Heston and Isleworth the Council are recommended to increase their charges to all consumers by a further 12½ per cent., making a total increase of 25 per cent. on pre-war prices.

York Electricity and Tramways Committee has increased the charges to private consumers for electrical energy for light and power by 10 per cent. as from April 1.

Accrington Electricity Committee have also decided to increase their charges. The rate for lighting is to be increased from 4·8d. to 5d. and that for heating from 1·2d. to 1·3d. per unit. Current for power is to be increased by 10 per cent. Consumers who pay on the rateable value tariffs will have their charges increased from 6d. to 7d., all being subject to 2½ per cent. discount.

Birkenhead Corporation is increasing the charges for current through prepayment meters from 5d. to 5¼d. per unit inside and from 6d. to 6¼d. outside the borough, while the charge for current for lighting through ordinary meters is being increased 5 per cent., as from April 1.

Horsham Council has decided to discontinue as from 31st inst. the maximum demand rates for electric current for private electric lighting and power and heating; and a flat rate of 6d. per unit will be charged for all current supplied for lighting (except places of worship and the Fire Station, which will be supplied at the present rates of 5d. and 4d. per unit respectively) and for power and heating 2d. per unit.

At Worcester, occupiers of warehouses, factories, public buildings, shops, &c., now supplied on the m.d. system, and all consumers on 4½d. flat rate, are to pay a flat rate of 5d. after 26th inst., and the special increase of 10 per cent. is to continue to apply to the classes of consumers above mentioned and also to consumers on the rateable value system.

Cambridge Electric Supply Co. is increasing its charges by 20 per cent.

Fulham (London) Electricity Committee recommend an increase of 5 per cent. in the Council's charges for current.

Sleaford Council is increasing the charges by ¼d. per unit for power and ½d. for lighting and heating.

Taunton Council is increasing its charges for current from the end of the March quarter by 8½ per cent., making the total increase on pre-war rates 33⅓ per cent.

Exeter.—The Council have increased the salary of the chief assistant electrical engineer from £180 to £200 per annum, that of the station superintendent from £165 to £185 and that of the chief clerk from £160 to £180.

Hull.—The Council are recommended to re-organise the administration of the electric supply branch of the tramways department.

It is proposed to cease all further capital expenditure on generating plant on the Osborne-street power station, as it has been recognised by the Chairman, Deputy-Chairman and Electrical Engineer of the tramways department that to continue the policy of two stations would be uneconomical and contrary to the general interests of the city. It is therefore proposed to abolish the plant at Osborne-street by a gradual process, and if the proposal be adopted the electricity department will supply the whole of the requirements of the tramways during such hours, as the plant of the electricity department would otherwise be on light load. The heavy load at Sculcoates-lane station is between 9 a.m. and 5 p.m. on week-days, with the exception of Saturday when it is from 9 a.m. to mid-day. With this object in view the tramways department will install converting machinery in Osborne-street to convert the 3-phase 6,600-volt alternating current, and in order to supply this the electricity department will complete their Central Hull extra-high-tension loop. Delivery is expected shortly of a 5,000 kw. turbo-alternator and boiler plant, which will increase the capacity of the Sculcoates-lane station from 10,000 kw. to 15,000 kw.

Leyland.—The Urban Council has authorised the erection of overhead electric cables for supplying electrical energy from the Leyland & Birmingham Rubber Co., to the works of Leyland Motors (Ltd.)

Manchester.—The Gas Committee, which has for some years past given £50,000 per annum for relief of rates, has decided to make no contribution next year.

The Committee's contribution in relief of city rates from 1888 to 1916 has been £1,404,066. Next year a deficit is expected on the year's working owing to the lighting restrictions, the higher prices paid for coal and other commodities, war bonuses, increased wages and income tax.

The Workmen Committee recommend that the war bonus of 6s. 6d. per week be given every adult in the service of the Corporation receiving less than £300 a year.

Poplar (London).—The Electricity Committee has approved the sale of two 500 kw. "Willans" reciprocating sets at £2,500. The sale of the sets necessitates provision of a new converter, and the Electrical Engineer has been authorised to accept a tender, subject to sanction being obtained from the Government.

Interconnection of the Council's undertaking with that of Hackney Council has been completed and has materially assisted in reducing the pressure on Poplar undertaking in meeting the pressing needs of Stepney.

For the quarter ended Dec. 31 last, the units sold amounted to 6,231,591, an increase of 218,590 over the corresponding period of 1915. The net income from sale of current increased by £2,561 and working expenses by £3,378, the gross profit being £817 less. The net profit from April 1 to Dec. 31 is £7,519 compared with £8,503. The advance in price of current of 10 per cent. on power and public lighting charges produced £4,953 and but for this advance the net profit would have been reduced to £2,565.

St. Pancras. Instructions have been given to remove the Babcock boilers at the destructor yard when the new Niclausse boiler has been installed.

The Finance Committee report that they are assured that the profit on the electricity department for the year ended the 31st inst. will be upwards of £10,000.

Sheffield.—The estimates were considered by the Council last week.

The chairman of the Finance Committee (Ald. Hobson) reviewed the financial position. He said there was an increase of £63,000 in the debt on the electric supply department, but the reproductive debt was now 67 per cent. of the whole. The estimated capital expenditure for the ensuing year included £144,251 for the electricity undertaking. Further, it was estimated that on electric supply account £210,949 would be spent during the three months ending March 25 next. The total amount that he expected to have to provide for the department during the coming year was £305,000, in addition to the £105,000 deferred, but that would by no means end the expenditure on the department. In addition to the capital expenditure mentioned in the estimates they were committed to about £90,000 for the purchase of land, &c. They had only one department contributing to the rates (the tramways), and he hoped that the frugal policy which they were pursuing in the electric light department would some day make that business also a very handsome contributor to the rates, but that time was not yet. The revenue from electric supply, which in 1914 was £127,921, was estimated to be £525,250 next year. That was an extraordinary increase, but it did not necessarily mean increased profits, owing to the extra cost of labour and materials and the abnormal wear and tear of existing plant. The contribution from the tramways department would only be £17,715 next year, against £36,225 this year.

Ald. MARSH pointed out that they must all realise that the electric supply department would have to do more work in the future than before the war, as so many electric furnaces had been built and had to use electric power. Then many of them used the power in their mills and in twist drill works, and the demand was greater than ever before. They hoped after the war to take some of the alien trade, and there was bound to be a great call for electric power in the city.

The estimates were passed.

The report of the Development Committee recommending the appointment of an executive officer to deal with the industrial development of the city, &c., was also approved.

Southend-on-Sea.—Further consumers will not be connected up to the electricity works until provision has been made for putting down additional machinery at the conclusion of the war to meet the increased demand.

West London Bulk Supply Scheme.—At the last meeting of Barnes Urban Council the electrical engineer (Mr. C. S. Davidson) reported having attended a conference at Ealing with regard to the supply of electricity in bulk in the western area of Greater London.

It was stated that Ealing Borough Council were in favour of laying down on co-operative lines a large bulk supply power house, such power house to be situated on the banks of the river, and to be of such capacity as would enable it to deal with the non peak supplies for the whole of the western area. The Ealing sub-committee is to ask all the neighbouring authorities to meet at Hammersmith to consider the proposals, with a view to instructing the engineers to prepare a draft scheme.

[illegible] unable to obtain quotations for coal, and also to the [illegible] of [illegible] supplies, Mr. Davidson has been instructed [illegible] of using coke for raising steam.

TRACTION NOTES.

Electric Vehicles.—In his recent presidential address to the Institution of Municipal Engineers, Mr. Edward Whitwell, engineer and surveyor to [illegible] Urban Council, said he was convinced that mechanical traction had more than justified its being preferred to other forms of traction and should be much more general than it was. [illegible] about to change from the old system to the new should be careful in selecting the type of vehicle which best suited the [illegible] and should not be influenced by first cost when considering the [illegible]. To those who had [illegible] electric vehicle [illegible], with the later improvements, [illegible] rival to the best known other forms of traction. The initial cost of an electric vehicle was higher than that of the other forms, and the available speed was low, though the latter would be found ample and quite sufficient having regard to public safety, while at the same time quite equal to legal limits. Its running costs were found to be lower; it was noiseless; it withstood the strain of starts and stopped better; had fewer moving and wearing parts; was quick in acceleration without the sudden jars on gears, &c., while in control and maintenance it possessed none of the difficulties of the petrol engine. While he did not wish to dogmatise, he ventured the opinion that the traction vehicle of the future was more likely to have electrical power by reason of its being cleaner, less noisy and more simple to maintain than any other; and there was every probability that it would be equally cheap. Its only rival would be the petrol engine, which, owing to the war, had increased in efficiency by leaps and bounds. The steam tractor would in all likelihood soon be a relic of the past.

Glasgow.—As the result of a collision between two tramcars at Glasgow Cross on Saturday night one car was derailed and knocked down a section box, causing the car to be electrically charged.

It is stated that passengers were unable to leave until they were helped off the car by officials with rubber gloves. Four passengers suffered from shock and one was detained in the infirmary.

Halifax.—Two lady tramway inspectors have commenced duty on the tramway system.

London County Council.—Two additional grinding machines are to be provided at the central car repair depot at a cost of about £400.

A supplemental estimate of expenditure on maintenance account of £2,100, submitted by the Finance Committee in respect of additional war allowance to minor officials in the tramways department, was approved. The Highways Committee was authorised to grant, as from and including the pay week ended Jan. 3, 1917, until the declaration of peace, a war allowance of from 2s. 6d. to 7s. a week to any minor official on the temporary operative staff in the tramways department whose wages (together with such allowance) will not exceed 80s. a week.

The applications of leading cable hands, switchboard attendants and greasers and cleaners at sub-stations, and the electrical attendant at Belvedere-road depot for increased wages were referred to the Electrical Conciliation Board.

The cost of the additional grants to those members of the staff of the tramways department to whom the conciliation boards scheme does not apply is estimated at £2,350 for the current year.

London-Watford Electric Railway.—Some delay has occurred in connection with the opening of the L. & N.W. electric line to Watford, and it will be about two weeks before it will be ready for traffic.

Southend-on-Sea.—Owing to the shortage of male tram drivers, arrangements have been made for the instruction of women drivers.

Previously no payment was made to drivers during their period of instruction, but in future all drivers while being instructed are to receive wages at the rate of 3d. per hour during a period not exceeding 14 days, and subject to the condition that they continue in the Corporation's service upon becoming qualified to drive. The wages of women drivers are fixed at 6d. an hour. A woman inspector is to be appointed to supervise all female conductors and drivers; she must be from 40 to 45 years of age, and her wages are fixed at 30s. per week.

LIGHTING & POWER NOTES.

Bacup.—The Electricity Committee is considering an application for a supply of electric current to Height Barn Mill.

Electric Smelting in America.—The American Smelting & Refining Co. reports that in 1916 the company did a record business.

The directors have specially appropriated for enlargement, extension and miscellaneous purposes $9,136,559. The completion this summer of the construction programme will increase the company's electrolytic copper capacity to 1,300,000,000 lb. annually.

Hydro-Electric Power in Italy.—A Royal Decree was recently issued introducing reforms in the legislation respecting the use of water power of Italy.

It is thought desirable to develop water power to better advantage and so make up for the lack of coal and other fuel which has to be imported. A Supreme Council for Public Waters has now been established to deal with all matters connected with the development of water power in Italy. Its chief duties will be to draw up a list of all public waters; to examine and verify existing rights; and to discuss and decide on schemes submitted for concessions to develop and apply public waters for motive power. At the inaugural meeting of the Council, the Minister of Public Works outlined the principles contained in the Decree and said existing interests would have to be considered by the Council when granting concessions, but it was hoped to reconcile the interests of the present owners and concessionaires with the greater need of the State, and by the substitution of improved machinery for that at present in use, to create a vast network of water power distribution. The Decree has not yet received the sanction of the Parliament, but the Government have decided to make it operative at once.

Water Power in the Caucasus.—In a recent report to the Baku Engineers' Society by M. A. M. Essen it was stated that the hydrotechnical section of water control in the Caucasus had collected particulars of 147 Caucasian rivers.

These rivers represented 2,000 sq. km. of water surface, and the area was divided into four regions—Black Sea, Kuria, Araksin and the rivers of the Caspian shore. The water power of these regions are estimated to be equal to 2,500,000, 1,000,000, 700,000 and 400,000 H.P. respectively, or a total of 4,600,000 H.P. for all the Caucasus. In the Northern Caucasus 3,600,000 H.P. is available.

TELEGRAPH AND TELEPHONE NOTES.

Guernsey State Telephone Department.—The accounts for the year ended Dec. 31, 1916, show net profit £396 (compared with £540 in the previous year).

Revenue was £7,564 (against £7,511). The number of subscribers' lines increased from 1,786 to 1,824, and the total number of lines from 2,231 to 2,277. The total number of calls was 1,436,153 (against 1,590,492.)

Radio-Telegraph Notes.—On Jan. 12 last the Swedish Post and Telegraph department, in conjunction with the Ministry of Marine, issued a decree prohibiting the use of radio-telegraph installations in any of the Swedish islands.

The French Government is erecting a radio-telegraph station at Guadeloupe.

The Nederlandsche Telegraaf Maatschappij (Radio Holland) has been formed at Amsterdam for the installation of radio-telegraph apparatus on steamships and the merchant marine of Holland.

MISCELLANEOUS NOTES.

New Naval Rating.—The Admiralty has established a new continuous service rating of electrical artificer, 5th class, with the relative rating of leading seaman and pay of 3s. a day.

Trading With the Enemy.—The "London Gazette" of March 16 contains additions to the statutory list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include: *Brazil*—Casa Edison (Figner Friedrich) (Rio de Janeiro); *Netherlands*—Algemeene Maatschappy N.V. (Amsterdam); *Spain*—Industria Electrica (Calle Banquillo 28 Madrid, and Barcelona).

Customs Duties.—The Brazilian Budget Law for 1917 (No. 3,213) fixes, *inter alia*, the following rates of import duty for goods imported into Brazil:

Electrodes and iron sheets coated with tin or lead, 8 per cent. *ad val.*; plain uncovered wire, in cables or cords, for electrical purposes, 800 reis per kilog. (30 per cent.)

TENDERS INVITED.

Cooling Towers.

The Electricity Committee of Hull Corporation invite tenders for the cooling towers required in connection with the extensions of plant at their Sculcoates-lane generating works. Forms of tender and specifications from the City Treasurer, Mr. T. G. Milner, and tenders addressed to the chairman of the Electricity Committee, Guildhall, Hull, are to be in by noon, April 12. *See an advertisement.*

Turbo-alternators, Transformers and Condensing Plant.

Glasgow.—The Corporation of Glasgow invites tenders returnable April 5 for Turbo-alternators (15,000 kw.), transformers and condensing plant for their new generating station at Dalmarnock. Particulars from W. W. Lackie, Chief Engineer and Manager, 75, Waterloo-street, Glasgow.

Warrington Electricity and Tramways Committee require tenders by noon April 11, for supply of one 3,000 kw. turbo-alternator and surface condensing plant. Specifications from Borough Electrical Engineer.

Manchester Electricity Committee require tenders by 10 a.m. April 3 for the supply and erection of a turbo-alternator and condensing plant at their Stuart-street station. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Arc Lamp Carbons.

St. Pancras (London) Borough Council invite tenders for the supply of arc lamp carbons, delivery to be made as required. Specifications from the Electricity Department, Offices 57, Pratt-street, N.W., and tenders to town clerk, Mr. C. H. F. Barrett, by noon of April 12.

Storage Battery, Switchgear, &c.

Aberdare Urban Council require tenders for a battery of accumulators, with charging booster, switchgear, copper rods and cable. Communications to the General Manager of the electricity department.

Electrical Stores.

Dundee Corporation require tenders by 9 a.m. March 28 for 12 months' supply of meters and electrical and general stores to their electricity department. Specifications from the Electricity Dept. Offices, Dudhope, Crescent-road, Dundee.

Tenders are required by March 30 for six months' supply of electric fittings, oils, &c., to the Midlothian and Peebles District Asylum, Rosslynlee. Forms of tender from the Clerk and Treasurer, 19, Heriot-row, Edinburgh.

Synchronous Condensers.

The Toronto Electric Commissioners invite tenders for synchronous condensers of 5,000, 7,500 or 10,000 k.v.a. capacity for operating on their hydro-electric system, 25 cycle, three-phase. Alternatives are required for 2,200 and 13,000 volt machines. Specifications and particulars may be obtained from the general manager, Mr. H. H. Couzens, 226-8, Yonge-street, Toronto, and tenders, addressed to the Chairman of the Toronto Electric Commissioners, are to be in by March 28.

C. C. Generators, Switchboard, &c. (Extension of Time).

The Australian Commonwealth, Department of Defence (Navy Office), require tenders for the supply of 3 separately direct-coupled continuous current generators, with spares and accessories; a 13-panel main switchboard and fittings: and a balancer, motors and control gear, required for the Flinders Naval Base, Victoria. The time for receipt of tenders has been extended to April 2. Specifications from the Director of Navy Contracts, Melbourne.

TENDERS RECEIVED AND ACCEPTED.

Poplar (London).—The Council has accepted a tender at £745 for a "Bessemer" petrol wagon for the Electricity Department.

Swansea.—The Council has accepted the tender of Mather & Platt (at £681 10s.) for electric pumping plant for the Waterworks Committee.

Condensing Plant.—The Mirrlees Watson Co. have received orders for 69 sets of condensers, practically all for War service work, aggregating approximately 1,400,000 lbs. steam duty per hour.

Erith.—The Council have accepted the tender of Hadfields, Ltd., for the supply of 60 wheel tyres at £285.

Loughborough.—The Council have placed an order with Messrs. Babcock & Wilcox for a boiler, at £2,600, and an underfeed stoker, at £574.

Government Contracts.—The following contracts were placed by the British Government Departments during February:—

War Office.—Callender's Cable & Construction Co., W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works & St. Helens Cable & Rubber Co., electric cable and wire; Premier Accumulator Co., electric cells; Barton & Sons, Credenda Conduits Co., Eureka Conduits & Fittings Co., General Electric Co., I. Griffiths & Sons, Oriental Tube Co. & Simplex Conduits (Ltd.), conduits and fittings; Bruce Peebles & Co., motor converters; Edison Swan Electric Co., Johnson & Phillips and G. Roe & Sons, electric light fittings; Aster Engineering Co., W. H. Dorman & Co., R. A. Lister & Co., A. Lyon and Wrench & Petters (Ltd.), generating sets and parts; Siemens Bros. Dynamo Works, generators and dynamos; British Insulated & Helsby Cables, wire rope and copper cord; British Ever-Ready Co. and Efandem Co., electric torches and parts; Foote & Milne, electric lighting at Hilsea; Edmundson's Electricity Corporation, electric lighting at Montrose; C. Cooper & Co., extensions to electric lighting at Northolt; T. Clarke & Co., telephones at Sandhurst.

India Office.—Lancashire Dynamo Co., alternators; Siemens Bros. & Co., switches.

H. M. Office of Works.—Johnson & Phillips, electric lighting plant at Bramley.

Post Office.—Automatic Telephone Mfg. Co., telegraph apparatus and telephones; Gent & Co., telephones; W. T. Glover & Co., India Rubber Gutta Percha & Telegraph Works Co., Johnson & Phillips, Telegraph Construction & Maintenance Co., Union Cable Co., and Western Electric Co., telegraph cables; Siemens Bros. & Co., dry cells; North British Rubber Co., telephone mouthpieces; British Insulated & Helsby Cables, instrument cords, distribution plugs, and copper binding and strand wire; Bullers (Ltd.), stay-rods and insulator spindles; T. Bolton & Sons and Shropshire Iron Co., copper strand wire.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Charing Cross, West End & City Electricity Supply Co. (Ltd.)

The annual ordinary general meeting was held on March 15, under the presidency of Mr WILLIAM FRANCIS FLADGATE, M.V.O.

The SECRETARY (Mr. Cecil G. Stanesby, F.C.I.S.) having read the notice convening the meeting and the auditors' reports,

The CHAIRMAN, after a feeling reference to the death of Mr. Richard Chadwick, who was a director of the company for 22 years, said: We have now entered the third year of the war period, and, therefore, we are in a position to compare a whole war year with a whole war year. There is nothing in the accounts to call for any serious comment, and, therefore, I pass at once to the results. I do not think I need point out to you the extreme difficulty under which the business has been carried on during the last few years. It has taxed the ingenuity and the work of all the members of our staff, and particularly of our engineer-in-chief, Mr. Kingston, and of our secretary, Mr. Stanesby, and I cannot too highly appreciate and I cannot ask you too highly to appreciate the work which has been done by those two gentlemen and by all the staff. The result shows how excellent their work has been, and without careful co-ordinated work between the two important branches of this company—the secretarial and the engineering—it would have been impossible to have arrived at the satisfactory position shown by the accounts now before you. I think that those accounts are satisfactory, because, notwithstanding the difficulties under which we are working, the net revenue in the West End has increased by £2,700, and the total amount of the net revenue which is available to deal with is £71,640; and this, gentlemen, is arrived at after spending no less than £10,000 on repairs and maintenance of our stations in the West End during the year. We bring in from the year 1915 the balance of £18,043, and we have earned interest to the extent of £3,234. That gives us a total of £92,919 to deal with, out of which we have paid the debenture interest, amounting to £17,829, and we have set apart for depreciation £22,000. We have then a surplus of net revenue of £53,090. Out of that we pay the Preference dividend of £18,000; we propose to recommend you to pay a dividend on the Ordinary shares of the company at the rate of 5 per cent.—the same rate as last year—which absorbs £20,000, and to carry forward £15,090. We have set aside the full amount of our depreciation, we have spent a large sum on repairing and maintaining our plant, we have paid our dividend at the same rate, and the only difference between this year and last year is that, whereas last year we carried forward £18,000, we carry forward now £15,090. The expenditure of £4,900 on capital account is a very productive item, as it is on the erection of buildings in Short's-gardens, which are already let at proper and fair rentals. I think that the results of the working of the City undertaking may be described as equally satisfactory. Our net revenue increased by £1,788, compared with that of the preceding year. The net available balance is £65,554, to which we have to add £18,000 brought forward, giving a total of £83,554, out of which we have paid the debenture interest, amounting to £29,815, which leaves an available amount of £53,738. This provides the Preference dividend of £18,000, and gives us a balance out of which we propose to put £17,738 to general reserve, and to carry forward £18,000—the same as in 1915. On the City undertaking we have also spent £15,000 in keeping our plant in an efficient state. Having regard to the form of the Provisional Order, we are advised that no depreciation fund at the present moment is necessary, and as we do not divide our profits, but simply pay the dividend on the Preference shares and carry the rest to general reserve, it seems to me immaterial whether there is a depreciation fund or not. The balance on general reserve account is no less than £101,562. Your Board are [illegible] of the result at which they have arrived, and having [illegible] through [illegible] trying times since the outbreak of the war, [illegible] great nervousness for the future. They quite [illegible] the task set before them and the employés of the company [illegible] one, but they believe honestly that there [illegible] of your company doing otherwise than passing [illegible] period and emerging from it stronger than ever. With reference to the general position of the industry, of course, [illegible] nothing in the way of an amalgamation [illegible] of the companies is possible. We have, however, [illegible] of which I have the [illegible] to be the Chairman, been able to secure [illegible] profits standard [illegible] per cent. I am glad to say that we were able [illegible] part of our committee, [illegible] on the part of the whole of the London [illegible] that the London companies [illegible] in the future. No fewer than 118 [illegible] with the [illegible]. Of these, I regret to say, [illegible] to their country, and two [illegible] wounded, but I trust [illegible] recover. We have the [illegible], Mr. Lanton, has been given the Military Cross, and I have no doubt that all our employés with the Colours are serving their country as loyally as our chief engineer, our Secretary, and the members of their staffs have been serving us. I now beg to move that the report and accounts be adopted.

The MANAGING DIRECTOR (Mr. John M. Gatti) seconded, and the resolution was carried unanimously. The dividends recommended were declared. Mr. Rocco Gatti and Lieut.-Col. J. D. Laurie, the retiring directors, were then re-elected, and Messrs. O. R. Johnson & Son, the retiring auditors, were re-appointed.

Kensington & Knightsbridge Electric Lighting Co. (Ltd.)

The ordinary general meeting was held on the 15th inst., Col. R. CROMPTON, C.B., presiding.

The SECRETARY (Mr. G. S. Britton) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, during 1914, 1915 and 1916, there has been a progressive falling off in the number of units sold, but this took place chiefly during the first two years of the war, and towards the close of 1916 there were signs that the reduction of output had fallen to a lower figure, and there is now an upward tendency. The returns from our big generating station at Wood-lane show that there is an actual increase this month in the units sold as compared with last year—14 per cent., in fact. Owing to the revision of our discounts for certain of the lower-priced units sold to the shops and special customers, the average price that we received slightly increased for the year 1915, but in 1916, although from this revision we no doubt received slightly increased prices for the lighting units sold, this was more than cancelled by the increasing quantity of the low-priced units sold for power, heating and cooking. The reduction of our money takings is therefore due to several causes, and must be shared between them. These are lighting restrictions, Summer Time Act, the early closing of shops, and very largely from the increase in the number of houses which have become unoccupied during the year owing to the owners moving into smaller houses; this decrease in the unoccupied houses previously served by us has risen from 233 houses in 1913 to 451 houses in 1916, and there is no doubt that our district has suffered more than in this respect any of the London districts, probably owing to the very large proportion of large-sized houses in the Queensgate district. We consequently found the adjustments in price made in 1915 and 1916 were insufficient, and the Board were compelled to give notice of a rise in price all round of 10 per cent. as and from Jan. 1, 1917. A great deal has been done during the year to economise in material, labour and in management expenses, and I think that the result may be considered satisfactory. As to coal, for instance, the price of which per ton has gone up since 1911 from 11s. 8d. to the average price paid this year of 21s. 6½d. per ton, which is really an increase of 80 per cent. We have, by unremitting attention to perfecting our generating plant and by running only the most efficient of our generating sets, actually reduced the quantity of coal used so that the total cost of coal even at the high price has only gone up 19 per cent. Again I may supplement this by pointing out how war even affects the quality of the coal. The pressure on labour at the collieries is so great that the coal comes to us very imperfectly cleaned. Two or three years ago it had a certain evaporative efficiency, but now, the same coal, owing to the quantity of practically incombustible material that comes with it to London, is certainly 20 to 30 per cent. less efficient in evaporative value. Again, in spite of the increased cost of living having forced us in fairness to our workmen to increase their wages, by improved arrangements, the total sum paid for labour of all classes has gone down, so that the cost for material and labour has only gone up to 13 per cent. The other items chargeable are for rates and taxes, which owing to our success in the re-assessment shows a reduction; management, stationery, law expenses and insurance show increases. Summarising these results the total cost of producing our output, apart from depreciation, has gone up from £41,600 to £42,700—roughly £1,100 only. I have taken the depreciation item by itself owing to many causes—one being that the sum that we have accumulated, as shown in our renewal and reserve fund, is so considerable that we have thought it better to considerably reduce the amount put to this fund during the year from £7,260 last year to £3,885 this year. In this way our total sum, including depreciation, reaches £46,580, against £48,852 last year, enabling us to show a balance profit of £21,474 as against £22,625. I think that, on the whole, our results are very creditable to the managing director, Mr. Miller, to the staff at Wood lane and to our large staff here. I now move that the report and accounts for 1916 be received and adopted.

The motion was seconded by Mr. C. C. WYLLIE, and after the chairman had replied to some questions by Mr. K. Hedges, the motion was carried unanimously. The interim dividend of 2½ per cent. paid for the half year ended June 30 was approved and a further dividend of 3½ per cent. for the half year ended Dec. 31 last was declared. Mr. C. C. Wyllie, the retiring director, was re-elected a director, and Messrs. Price, Waterhouse & Co. were re-appointed auditors for the ensuing year.

South London Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on Tuesday, Mr. J. ATHERTON, chairman of the company, presiding.

The SECRETARY (Mr. Herbert H. Boyer) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: The total receipts have increased from £54,782 in 1915 to £59,037 (or 7·8 per cent.), and £28,388 has been carried to net revenue account, against £27,229 in 1915. The principal increases on the expenditure side have been for coal £3,226, and local rates £546, under the revised quinquennial assessment, but economies in other directions have been effected, with the result that the total expenditure has only been increased by £3,096, or a little over 11 per cent. The addition of 9 per cent. to the charge for supply to our consumers has partly neutralised the increased costs. Our contracts for coal supplies during the present year have been made at an even higher cost, but we hope that by continued economy it may not be necessary to further increase our charges for supply. After providing for debenture interest and preference dividend, allocating £7,000 to depreciation fund, and making other necessary provisions, there remains £16,053, out of which we recommend the same dividend as previously on the ordinary share capital—namely, 5 per cent. for the year—carrying forward £3,053, against £3,010 brought into the accounts. These results are gratifying, as not only has our revenue from lighting supply been again decreased by the more stringent restrictions, but the Summer Time Act was in full effect for more than four months of the year, and naturally caused a further diminution in the output for this purpose. On the other hand, the supply of energy for power purposes has increased by over half a million units, our power consumers taking about 75 per cent. of the whole output. No less than 60 employés have already joined H.M. Forces, representing 40 per cent. of the total number employed, and no less than 70 per cent. of those of military age. Their places have, in several instances, been temporarily filled by women, and in other instances by men invalided out of the service or unfit for military duties of any kind. It is with great regret I have to announce that two of our most promising employés were killed in the naval action off Jutland, and several others have been from time to time wounded, but I am pleased to say these have made good recoveries. The share and loan capital is the same as in the previous year, and expenditure on this account has been on a very moderate scale, only such as was vitally necessary in the interests of the undertaking having been made, the principal additions being for mains £2,297, included in which is the cost of additional services to connect new consumers to the supply. £7,000 has been allocated to depreciation from last year's revenue, and as £573 has been expended in sundry small renewals to plant and machinery, a reserve on balance of over £61,926 remains to the credit of this account. With regard to the connections made to the mains last year, an even better result was achieved than in the previous year, the equivalent of 26,481 35-watt lamps, or 927 kw., having been connected, and the units sold increased by 380,217. The gross profit of the sales department increased from £1,733 to £2,034, the turnover exceeding £10,000; and the central showrooms at Brixton largely contributed to this record result. So far as the current year is concerned, it is with considerable satisfaction I am able to report a record increase in the output of units, which up to the end of last month amounted to 1,879,080, or nearly 20 per cent. above the figure for the corresponding period of 1916. This augurs well, but, of course, the question of the Company's prospects for the whole year is exceedingly difficult to forecast, owing to the very abnormal conditions under which we are working, but with the actual figures before us of what has been accomplished in the first two months of the year, I think we can look forward with a fair amount of confidence to the results of the present year. This growth in the demand has for some time past engaged our serious attention, it being necessary to look many months ahead, so that our power house may be capable, with a due amount of reserve plant, of efficiently providing for the ever-increasing load. Faced as we are with the fact that machinery and plant is almost unobtainable, consideration was given to the alternative of obtaining our excess requirements over and above the economical capacity of the present generating plant from another source of supply, and accordingly negotiations for a supply of energy in bulk were opened last summer with our neighbours, the County of London Electric Supply Company (Ltd.), and have continued during the past few months, and I am now pleased to tell you that they have been concluded, and a seven years' agreement on favourable terms has been entered into with that Company. This bulk supply is to be available in the late autumn of this year, and will initially be for 1,500 kw., capable of extension as and when such a course may be necessary, and will link up the two large generating stations of the County Company with our power house. Not only will ever more economical operation be promoted, but in the event of a breakdown or damage to the plant in our power house, there will always be this additional supply available thus ensuring to our present and prospective consumers a continuity of supply not to be obtained when only one power house is connected to the system, and this will prove to be a considerable asset when negotiating for supply to important factories and other premises. Further, your Company will be relieved of very considerable capital expenditure which would have been necessary were additional generating plant to have been installed in our power house, the result being that our surplus funds, which are invested in the new 5 per cent. War Loan and other British Government securities, will still be available for the extension from time to time as may become necessary of the feeders and mains of the distribution system requisite to supply any additional demand that may be made upon our system. The work of connecting the two companies' systems will be actively taken in hand as soon as certain official consents have been obtained I now propose that the report and accounts be adopted.

The resolution was seconded by Mr. J. M. HENDERSON and adopted.

The recommended dividends were declared. The retiring directors (Mr. J. M. Henderson, M.P., and Mr. J. B. Braithwaite) were re-elected, and the auditors, Messrs. Price, Waterhouse & Co., were re-appointed.

ABERDEEN SUBURBAN TRAMWAYS CO.—The chairman (Mr. J. Mearns) stated at the recent meeting that there had been a considerable increase in revenue. The profit for the past half-year (£1,595) was the largest they had made in any winter half-year and but for increased wages and cost of maintenance, &c., the results would have been better. At present they were actively engaged in overhauling their rolling stock and looking after their permanent way with a view of meeting the summer traffic effectually.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The profit for 1916, after estimating excess profits duty ansd contingencies is £56,450, and with £6,774 from last year the total is £63,224. Deducting directors' fees (£2,450), depreciation on patents, goodwill, buildings, plant and machinery (£10,000), amounts written off underwriting commission on shares (£4,000) and off preliminary expenses (£2,000) and the dividend on the preference shares (£12,000), there is an available balance of £32,774 2s. 5d. The directors recommend payment of a dividend on the ordinary shares at the rate of 5 per cent. (less tax) for the year (£18,000), carrying forward £14,774 2s. 5d. Throughout the year the works have been employed day and night almost entirely on Government work and other manufactures have been of a character of National importance. No orders have been taken for new Post Office public exchanges, the department having necessarily to curtail work of this description. The exchanges at Portsmouth, Paisley and Blackburn were, however, completed and put into use during the year and continue to give satisfaction. Several smaller exchanges for works have also been completed and one for a public institution.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—Mr. H. B. Renwick presided over the meeting on the 14th inst. and in moving the adoption of the report and accounts said that during the past year the dominating factors were dear coal, higher working expenses and other war burdens. The receipts from sale of current and meter rentals were £63,543, an increase of £1,039 over 1915. Interests and dividends were less and income tax was higher. They had received a reduced amount from the Richmond Co., owing to special and particular reasons. The working expenses had increased by £2,677, the cost of coal and other fuel accounting for more than half that figure. Management salaries and wages also showed an increase, due mainly—as in the case of engineers' salaries and wages—to the bonuses and allowances paid to men on service. The result was that only £35,215. 7s. 5d. was carried to net revenue account, against £38,684, but it was proposed to pay the same dividend on the ordinary shares as last year (6 per cent. for the year), leaving £2,265 to be carried forward. The results were as favourable as the shareholders had any reasonable ground to expect, having regard to the fact that the revenue for the year had been charged with all war expenses and burdens, while the lighting restrictions had been more onerous than ever, and in addition the Summer Time Act had materially reduced the lighting load during the time it was in force. The company had well maintained its position from a commercial development point of view, but that was due to the increased demand for heating, which helped to compensate for the drop in lighting. The applications received during the year showed an increase of 910 kw., compared with 885 kw. for 1915, and 568 consumers had been added, making a total of 8,663 consumers, while, in spite of the lighting restrictions, slightly more units had been sold than in 1915, but that was due to the increase in the heating load, to which the company must look in future to balance the losses in lighting. The business of the trading department continued to grow in volume and the profits to increase proportionately, but that was due more to the growth of demand for auxiliary uses than to lighting. Up to the 6th inst. a greater number of consumers had been secured than in the corresponding period of 1916, while the units supplied also showed a marked improvement, and it was to be hoped that that rate of progress would continue throughout the year. Further increases in station costs and working expenses were in store for them. They had 119 men on active service, of whom two had been lost and six wounded.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—The gross receipts for 1916 were £555,907, and working and general expenses and renewals £450,447. With balance brought forward, the net revenue was £110,515. Of this interest and dividends absorb £57,754, and it is proposed to pay a final dividend on the ordinary shares at rate of 7 per cent. per annum (less tax), making 6 per cent. for the year, and to add to reserve for contingencies and renewals £30,000, leaving £9,635 to be carried forward.

At the meeting on Monday the chairman (Mr. S. White) said the gross receipts of the tramways department were £251,596, an increase of £6,241. They had not raised their fares, although expenses had greatly increased. They were paying 6 per cent. for the year, compared with 5 per cent. in 1915. In regard to the Corporation's option to purchase the tramways, no further development had taken place, except that the Corporation obtained an order from the Board of Trade extending to Oct. 31, 1917, the time within which their option must be exercised.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The profit for the year 1916, after making provision for estimated liability for excess profits duties to date, amounts to £300,466 and with £160,096 brought forward the total is £460,563. Deducting directors' and debenture trustees' fees, &c. (£5,915), interest on first debenture stock (£22,500) and on second debenture stock (£10,000), the dividend on the preference shares to Dec. 31 (£30,000) and the interim dividend on the ordinary shares to June 30, 1916 (£25,000), the disposable balance is £367,148. The directors have appropriated £25,000 to depreciation on buildings, plant, machinery, &c., £20,000 to special depreciation on plant and machinery, £70,000 has been transferred to reserve account, £8,500 to special reserve account and £5,000 to first mortgage debenture stock redemption account, leaving available for dividend a balance of £238,648. The directors recommend payment of a further dividend of 10s. per share on the ordinary shares, making with the interim dividend already paid a total of 15 per cent. for the year ended Dec. 31, 1916, together with a bonus of 5 per cent., which will absorb £75,000, carrying forward to next account, after making provision for estimated liability for excess profits duties, a balance of £163,647 10s. 1d. The directors are pleased to report that the business during the past year has been well maintained.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—Mr. W. M. Crowe, who presided over the annual meeting last week, stated that the balance sheet was a good one. They were engaged upon important work which had proved satisfactory. The profit on trading was £69,813; that was a large increase over last year, and was a record for the company. The net profit was £47,145, and with £6,615 brought forward the available balance was £53,761. It was proposed to pay 6 per cent. on the preference shares (£5,999. 8s.) and 8 per cent. (tax free) on the ordinary shares, requiring £8,000. 16s.—that is, the same dividend as they had paid for some years back. A sum of £9,000 was placed to reserve and £5,000 to reserve account for extra depreciation. The £13,963 for depreciation was calculated on exactly the same lines as in former years, when things were normal. Therefore, £5,000 has been included for extra wear and tear to which their plant and machinery had been subjected through working day and night. They proposed to carry forward £25,761. 9s., subject to the munitions levy and the excess profits duty.

The report and accounts were adopted.

BRUCE PEEBLES & CO. (LTD.)—At the meeting on Friday the chairman (Mr. F. E. Andrews) said the past year's turnover was the largest in any similar period, £18,920 compared with £7,096 and £3,892 for the two previous years. After much uphill work their balance-sheet had been gradually and steadily put into a fairly healthy condition, but the mortgage and unsecured debentures would fall for repayment in July, 1918, and the capital account would have to be reorganised.

GATESHEAD & DISTRICT TRAMWAYS CO.—The total revenue for the year 1916 amounted to £77,333. After deducting all expenses chargeable to revenue (including £3,000 for renewals) the balance is £35,136. With £4,240 brought forward the total is £39,376. The directors recommend the appropriation of £7,500 to special reserve, £5,560 to reserve and £2,539. 13s. 9d. to sinking fund for redemption of mortgages. The year's dividends on the 6 per cent. preference shares required £756. 12s. and on the 5 per cent. preference shares £6,000. A dividend of 12s. per share was recommended on the ordinary shares (£8,100) and also a bonus of 8s. per share on the ordinary shares (£5,400), leaving to be carried forward £3,579. 9s. 4d. The expenditure chargeable to the tramway capital account during the year amounted to £107. 8s. 10d., making the entire capital outlay in and upon the tramway undertaking £339,094. 11s. 9d.

GUERNSEY RAILWAY CO. (LTD.)—At the recent meeting it was reported that the net profit for 1916 (including £472 brought forward, writing off £841 for depreciation, paying debentures interest (£360) and placing £500 to general reserve, was £1,712. After providing the preference dividend (£467) the directors recommended payment of an ordinary dividend of 5 per cent. (£792), carrying forward £455.

MIRRLEES, WATSON CO. (LTD.)—The accounts for 1916 show a credit balance, after providing for depreciation, &c., of £30,695, and with [illegible] brought forward, the amount available is £34,161. The directors recommend that £9,700 be applied in payment of a dividend of 10 per cent. (less tax), and that £17,500 be transferred to general reserve, leaving £6,900 to be carried forward.

NORTH METROPOLITAN ELECTRIC POWER DISTRIBUTION CO. (LTD.) At the meeting last week it was reported that the revenue for the year 1916 (£22,094) showed an increase of £1,098 over that of 1915. The balance from the local revenue accounts amounted to £3,650. After adding sundry receipts and £588 brought forward and deducting all expenses chargeable to revenue (including a provision of £750 for renewals) there remained £861 10s. The directors recommend that £750 should be appropriated to reserve and £111 10s. carried forward. The capital expenditure during the year amounted to £2,041 12s., of which £1,767 [illegible] was in respect of extensions of mains and installations upon consumers' premises. The number of units sold was 1,905,490, which, compared with 1,681,112 in 1915, showed an increase of 13 per cent.

PARA ELECTRIC RAILWAYS AND LIGHTING CO. (LTD.)—The gross receipts for year to Nov. 30, 1916, were £271,691 (against £213,483 in 1915), but the working expenses increased from £115,309 to £123,403, net [illegible] in Para being £148,288 (against £128,171), but there must be deducted £42,[illegible], the loss incurred on exchange. After deducting that sum and London expenses, the balance is £100,675, compared with £90,7[illegible]. [illegible] revenue in milreis during the past year [illegible]. With £2,362 for interest and transfer [illegible] and £18,[illegible] brought forward, the total is £121,972. Debenture interest and sinking fund required £38,[illegible], and interim preference dividend [illegible], and the directors recommend a dividend of 6 per cent. on the ordinary shares (less tax), leaving £2[illegible],672 to be carried forward.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—During the past year [illegible] connected to the company's system the equivalent of 765 30 [illegible], making a total of 1[illegible]2,842. The number of units supplied during the year was 618,019, and the profit was £714. 17s. 4d. After paying bank interest and placing £500 to depreciation account, the credit balance £1,602 is to be carried forward.

SIMPLEX CONDUITS (LTD.)—The directors report that they are unable to submit a balance-sheet for 1916 until the necessary adjustments have been agreed with the Ministry of Munitions in respect of the munitions levy. They consider the results to be satisfactory, and recommend a dividend of 10 per cent., together with a bonus of 10 per cent., both tax free. Last year 15 per cent. was paid.

STEWARTS & LLOYDS (LTD.)—After setting aside £100,000 for depreciation and paying 6 per cent. on preference and 10 per cent. on preferred ordinary shares, the directors recommend a dividend of 2s. on deferred shares, together with a bonus of 6d. per share. £60,000 is placed to general reserve, £20,000 to employees' benefit reserve and £110,000 is carried forward.

TYNESIDE ELECTRICAL DEVELOPMENT CO. (LTD.)—The report for the year ended Jan. 31 states that the credit balance, after making the appropriation from general reserve and including £3,654 brought forward, is £7,089. Out of this the directors have transferred to general reserve £3,283, and recommend a dividend at rate of 6 per cent. per annum on the preferred ordinary shares (of this an interim dividend was paid in August last amounting to £999) and a dividend of 10 per cent. on the deferred ordinary shares, leaving £933 to be carried forward. The Electro-Flex Steel Co. (Ltd.) went into liquidation, and the property has been sold to the Tyne Electric Steel Foundries (Ltd.). No dividend on the company's holding of shares in the Electro-Flex Steel Co. will be received, and their book value (£8,782) has been written off.

TYNESIDE TRAMWAYS & TRAMROADS CO.—Dr. J. T. Merz, who presided at the recent meeting, said that their receipts had been very considerably more than they were in the corresponding half-year of 1915, and they were able to make up the deficiency in the dividend and bring it up to the former figure of 3 per cent.

WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS (LTD.)—Mr. F. S. Newall stated at the recent meeting that the past year's capital expenditure had been £37,737 on extensions at Weardale and Grangetown. As an intermediary between coalowners and ironmasters and the electrical distributing companies, they had done good service in utilising waste gases, especially in view of the price of coal. They proposed to erect a new station at Horden to take gas from coke ovens about to be erected there.

CITY NOTES.

MEMORANDA.—(March 20).—Consols, 54¼. Consols Pay Day, April 4. Stocks and Shares Ticket Day, March 28. Pay Day, March 29. Price of Silver, 35$\frac{15}{16}$d.

DOULTON & CO. (LTD.)—A dividend of 5 per cent. (less tax) has been declared on the preference shares for the year ended Dec. 31, 1915.

EDISON SWAN UNITED ELECTRIC CO. (LTD.)—At meetings of holders of A and B shares last week the scheme of arrangement submitted by the directors was approved.

HADFIELDS LIMITED.—The directors recommend, in addition to the interim dividend of 1s. per share, a further dividend of 4s. per ordinary share, making the same rate as last year, together with a bonus of 1s. per share, all tax free.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Subject to audit, the directors recommend a final dividend on the ordinary shares of 10 per cent. (less tax), making 15 per cent. for the year and also a bonus of 10s. per share, less tax.

IRON TRADES EMPLOYERS' INSURANCE CO.—Mr. John Dewrance, chairman of Babcock & Wilcox, has been appointed a director of this company.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—The accounts for 1916 show, after providing for the preference dividend and placing £2,000 to renewal fund, a credit balance of £338 to be carried forward. It is proposed to transfer £1,500 from general reserve to renewal fund account.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The directors recommend a dividend of 2 per cent. actual for the past half-year.

SCOTTISH TUBE CO. (LTD.).—The directors recommend payment of a dividend of 5 per cent. on the cumulative-preference shares for the six months ended Dec. 31, 1916, and also a dividend of 5 per cent. and 6d. per share bonus on the ordinary shares for the year 1916.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER CO.—This company is inviting applications for 50,000 7 per cent. redeemable cumulative preference shares of £1 each at par.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—It is proposed to issue £700,000 5 per cent. three year Notes in order to replace £700,000 4½ per cent. notes which fall due on April 30.

VERITYS (LTD.)—A dividend of 7 per cent. per annum has been declared on the preferred ordinary shares for the half year ended Dec. 31, making 7 per cent. for the year, compared with 6 per cent. in the previous year. A sum of £1,517 is carried forward.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO. (LTD.)—At a special meeting of preference shareholders the scheme dealing with the arrears of preference dividend was confirmed.

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NOTICE.—GOOD FRIDAY WEEK.

"THE ELECTRICIAN" will be published on THURSDAY next instead of on Friday. Communications intended for that issue must reach the Offices not later than WEDNESDAY MORNING'S POST.

Alterations to existing Advertisements and Copy for new Advertisements must reach the Publisher as much earlier as possible, but not later than TUESDAY MORNING. Official Announcements and "Small" Advertisements must be sent in not later than noon on WEDNESDAY.

NOTES.

The Board of Trade and Electric Power.

An important step has been taken by the President of the Board of Trade in appointing a committee to consider and report upon what steps should be taken to secure a cheap supply of electric power in the United Kingdom. Further particulars and the names of those serving upon the Committee are given in a note which appears in another column, so that we need not repeat them here. Suffice it to say that, although the Committee is a fairly strong one, we think it might have been further strengthened by including a few more engineers concerned essentially with electricity supply. We take it that the Committee is the outcome of the Board of Trade Committee which is considering electrical trade after the War, as we note that there are three members serving on both Committees, and that the importance of providing a cheap supply of electric power became so apparent as to lead to the formation of this new Committee. It is to be hoped that the whole position will be carefully investigated. When we look back upon the history of the supply industry we find that the lack of progress is due primarily to the five following causes:

1. Defective legislation, some of which, even if adequate some 20 years ago, is entirely unsuitable for the present day.

2. Compulsory purchase of private undertakings without adequate compensation.

3. Municipal policy in favouring the development of small undertakings and the maintenance of municipal boundaries, coupled with distrust of private enterprise.

4. Lack of co-operation between undertakings which should be interlinked.

5. High cost and uncertainty of Parliamentary procedure.

◆

It will be necessary for the Committee to consider not merely the claims of one section of the community as against another, but the claims of electricity supply as a whole and the benefits accruing to the nation as a whole through a really cheap supply of electric power. It should not be possible for small undertakings to be run by municipalities, or by private enterprise either for that matter, if electric power can be obtained from larger concerns at an equally low cost. Nor should it be possible for the Board of Trade (of all departments) to block the progress of a power company as was recently done in the case of the Bill promoted by the Yorkshire Electric Power Co., because some of its clauses were in conflict with established practice and with an antiquated Act of Parliament which was passed when merely electric light was being developed and when electric power was virtually unknown. The Committee has an unusual opportunity of doing a great national work, and we hope that the opportunity will not be lost.

◆

"Opportunities" for Technical Teachers.

In a recent address at Oxford, Mr. H. A. L. Fisher, Minister of Education, is reported to have said that teaching offered a wonderful variety of interest measured by the variety of human characters, human dispositions, and human intellects with which the teacher was brought into contact. New openings, said Mr. Fisher, were unfolding themselves to teachers. It was becoming more and more the practice to give them seats on local authorities and to ask them to serve on committees. We are of the opinion that those whose misfortune it is to work under an average local education authority will consider it a doubtful compliment to be asked to serve on the committee, and we have yet to learn that a wonderful variety of interest, measured by the characters, dispositions and intellects of his students, is going to help the teacher to live decently. Before the war it was with the utmost difficulty that technical teachers could make both ends meet on the very low "salaries" they received. Under war conditions it is well-nigh an impossibility for them to pay their way. With a full knowledge of the facts, and ardently as we believe in and support technical education, our advice to those who desire to become teachers is that in all likelihood they would do very much better for themselves by engaging in other work. With conditions as they were before 1914, the workhouse was the only prospect before the majority of the technical teachers of Great Britain. The man who, after several years at college and a like period in the works, spends 20 to 30 years in teaching is worthy of a better fate.

Women's Work in Engineering.

On the 26th inst., a small exhibition was opened by the Ministry of Munitions at the Royal Colonial Institute (and will remain open until to-morrow) to demonstrate what is being done by women in engineering, optical and chemical work under the scheme of dilution of labour which was initiated by the Ministry some time ago. We think that every engineer who looks round the exhibits must be struck with the remarkable skill displayed by the women. The work includes screw gauges of high accuracy and various examples of work requiring great skill. Having regard to the fact that mechanical work has always been looked upon as essentially men's work, and that the women by whom these exhibits were turned out have only been at this occupation for, say, 12 months, the achievements are remarkable. A man who had just served his apprenticeship for five years in engineering shops would no doubt have a much wider general knowledge, but the chance is that he would be unable to turn out work of the character shown at this exhibition. The explanation is no doubt to be found in various causes. First of all a high degree of skill can be obtained much more readily on repetition work than on work of a varied character. This, however, does not account for everything. Another reason is that the women have not been subject to trade union ideas or hard and fast rules that have arisen during the past century. Lastly, and probably this is the most important, is the fact that these women have been *taught*, whereas the apprentice receives very little teaching. He has to pick up what he can, and, therefore, he is correspondingly less useful. One effect of women's work will, we think, be to prove that the college workshop is not an altogether useless adjunct, and that men should be taught something of their trades in such workshops before passing into the shops where they waste a great deal of time because other men are not willing to teach them. In other words, our methods must be revised.

Electric Grab Buckets.

Elsewhere will be found an illustrated description of an electrically-operated single-rope clam-shell bucket, which, though of comparatively recent origin, is said to be meeting with a considerable measure of success. An important advantage is that the grab may be operated on any crane which is of sufficient capacity to lift the load. To place the motor near to its work is the obvious thing to do, and given a suitable machine there should be a very wide field for an electric grab. An inspection of the drawings shows that care has been taken with the design so as to obtain robust construction. A slipping-clutch is interposed between the motor and the barrel in order to prevent overloading the motor in case the spades encounter too high a resistance. The grab is operated by a simple form of controller having forward and reverse running positions. The [illegible]-wire flexible conductor is mounted on a spring-controlled drum arranged in much the same manner as the spring drums [illegible] taking charge of the cable required for operating [illegible].

* * *

I.E.E. Wiring Rules.—In view of the great demand by the [illegible] stranded wires, the Council have decided [illegible] the period of the war the use of single-strand con[illegible] No. [illegible] S.W.G.

Control by Sound.—At Lady Drogheda's Aircraft Exhibition at [illegible] Gallery [illegible] to be seen an interesting model [illegible] in which the control is effected by sound. Electric circuits are worked by a telephone diaphragm, and this is tuned by [illegible] so as to respond to any [illegible]. On sounding the note the electric apparatus [illegible] the diaphragm acting as a relay, and by [illegible] a sufficient number of times [illegible] into operation.

Board of Trade Committee on Electric Power.—The President of the Board of Trade has appointed a Committee to consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of power for their development. The Committee is constituted as follows:—

The Right Hon. F. Huth Jackson (chairman), Mr. H. Booth, Mr. James Devonshire, Mr. James Falconer, M.P., Mr. G. H. Hume, Mr. John Kemp, Mr. H. H. Law, M.Inst.C.E., Mr. C. H. Merz, Sir Charles Parsons, K.C.B., Sir John Snell, M.Inst.C.E., Ald. C. F. Spencer, and Mr. A. J. Walter, K.C.

The Secretary of the Committee is Mr. M. J. Collins, to whom all communications on the work of the Committee should be addressed at the Board of Trade, 7, Whitehall-gardens, London, S.W.1.

Heat Treatment of Steel Forgings.—At a meeting of the Institution of Mechanical Engineers, held on the 16th inst., two Papers on the above subject were read by Mr. H. H. Ashdown and Sir William Beardmore respectively.

In these Papers it is pointed out that annealing temperatures and the amount of work done on the material often differ between wide limits, which are sometimes responsible for subsequent defects ascribed to "fatigue." Inequalities in structure due to variety in heat treatment are illustrated by several micro-photographs. In annealing or quenching a temperature of 843°C. need never be exceeded. Unduly high temperatures, besides leading to coarse structure, are expensive, in view of the cost of heating large masses of metal.

Other matters discussed in the Papers include the proper methods of using pyrometers and the respective fields for sand, oil and water quenching. As regards research, it is remarked that a gap still exists between the works and the laboratory, and investigations are often undertaken on an insufficient scale.

Speaking in the discussion on the two Papers on the heat treatment of steel at the Institution of Mechanical Engineers on Friday, Sir Robert Hadfield, F.R.S., said that even the very best gas-fired or coal-fired furnaces did not enable steel makers to get the uniform temperatures that were absolutely necessary for them. Steel was a most delicate material, far more delicate than most people imagined, and he hoped that before long we should have some form of electrically heated furnace for the purpose. There was no doubt whatever that with an electrically heated furnace it was possible to get more uniform control over variations in temperature, and he believed that the electric furnace was coming. Considerable attention was being given to this matter in America, and he hoped we should not be behind in this country. One direction in which this end might be the more easily attained was in the production of cheaper electric power. He hoped to live to see the day when we should have large furnaces—not laboratory furnaces—heated electrically, because in that way it would be possible to get a more uniform quality of steel simply because the crystals of the steel could be controlled in a better manner.

OBITUARY.

John S. Raworth.—We regret to record the death of Mr. John S. Raworth, who has been associated with the electric lighting and electric traction industries from their inception, and who during the whole period has played a conspicuous part in most of their great developments. It is nearly 40 years since he put up the first installation of electric lighting in Manchester, and until the last two or three years he has been prominently identified with the practical application of electricity in nearly all its branches. Mr. Raworth had an important advantage over many who did pioneer work in electricity in that he was already a trained mechanic. As apprentice and draughtsman he laid a wide foundation for his future career in the shops and drawing offices of Messrs. R. & W. Hawthorn, of Newcastle-upon-Tyne, and of Messrs. Wren & Hopkinson, of Manchester, with the result that when he began to design electric machines he attacked the problems before him from the point of view of the mechanical engineer, and not that of the electrician. Indeed, it is as an engineer that Mr. Raworth won his reputation rather than as a discoverer of new principles.

In the late seventies and early eighties Mr. Raworth was resident in Lancashire as the representative of Messrs. Siemens Brothers. For some time he devoted himself mainly to ship lighting, first with arc lamps and later on the incandescent system. When he commenced he found nothing ready to hand except dynamos, lamps and wires. High-speed engines, fittings, switches and switchboards, castings and the like were non-existent, and he had to evolve types and patterns, most of which have persisted and now form the basis of three or four distinct trades. It must be remembered that interior electric lighting first grew into a system on steamships; it was received with open arms there at a time when it had made no progress on shore. Its immediate adoption, although gratifying, involved the creation of more than one new industry, and in this Mr. Raworth played the leading part. He undertook installations on the steamships "City of Berlin," "City of Rome," "Arizona," "Alaska," "Orient," "Austral," "Aurania," "Britannic" and various other vessels of the more important passenger lines, and to-day it is possible to trace the influence of his early work in every electric plant on board ship. For some time he ran a small central station at Manchester, distributing current in the immediate neighbourhood. Most of the important electric installations erected in that city in those days were done under his superintendence, and it is worth while to recall that he put up the first electrically worked hoist. In 1886 Mr. Raworth settled in the metropolis, having accepted a leading position with the Brush Electrical Engineering Co., at that time known by an earlier and more cumbrous title. This was a period of transition and of trouble for all electrical engineers, and the Brush Company had their share. Nevertheless, much good work was done, and very rapidly the entire responsibility for the engineering department fell into Mr. Raworth's hands. After the passage of the 1888 Electric Lighting Act, several important enterprises were entrusted to him, among them being the supply stations of the City of London Electric Lighting Co., of the Leicester Corporation, also at Huddersfield, Hanley, Bournemouth and elsewhere. Many of these represented thousands of horse-power, and were wholly or in great part designed by Mr. Raworth. When he joined the Brush Company in 1886 a 50 H.P. dynamo was about the limit of their capacity, but when he left in 1896 a 1,000 H.P. combined plant, including both engine and generator, was an ordinary order for them, their works at Loughborough having in the meantime been designed, erected and equipped under Mr. Raworth's superintendence. When the Loughborough works were complete Mr. Raworth exchanged the position of chief engineer for a seat on the board, and commenced practice in Westminster as a consultant. He was already technical adviser to several important electrical undertakings, among which was the British Electric Traction Co., and it was to the subject of traction that he was most strongly drawn. Although lighting and power schemes claimed much of his attention, his interest became more and more diverted towards tramways, until he eventually undertook the technical directorship of the British Electric Traction Co. Mr. Raworth was a prolific inventor. At shareholders' meetings he formed an ideal chairman, securing confidence and disarming opposition by his frank dealing and his evident knowledge. Mr. Raworth had been in failing health for two or three years. He leaves a widow and two sons and two daughters.

ARTHUR BROOKER.—We regret to record the death of Mr. Arthur Brooker, which occurred on Friday last.

Mr. Brooker was general manager of the Automatic Telephone Mfg. Co., and was formerly engaged in the Engineer-in-Chief's Department of the General Post Office. His name is familiar to our readers as joint author with Sir Wm. Slingo and Mr. T. Wall of "Electrical Engineering."

DEATHS ON ACTIVE SERVICE.—The following deaths in action or of wounds are reported:—

Capt. Norman C. Lowson, M.C., R.E., who died on March 6 of wounds received on the same day, was 24 years of age. He was a graduate in engineering of Glasgow University, and the only son of Major James Lowson (of Messrs. W. C. Martin & Co.), a past chairman of the Scottish Section of the I.E.E.

Sec.-Lieut. H. G. Downes, R.E., who has been killed, was 23 years of age, and prior to receiving his commission was trained in the Northampton Polytechnic engineering school.

PERSONAL.

On Tuesday last at the Engineers' Club, Manchester, a presentation of a handsome silver cigarette case was made to Mr. C. C. Atchison by the members of the Lancashire & Cheshire Municipal Electrical Engineers, as a token of appreciation of his services for 15 years as Borough Electrical Engineer at Rochdale. Mr. J. A. Robertson, borough electrical engineer of Salford, made the presentation and remarked with regret that Mr. Atchison had relinquished his post on grounds of ill-health.

Mr. T. H. Ward has been appointed acting superintendent of stores of the Midland Railway Co., in succession to Major L. Sandwith, resigned.

Mr. B. J. Grigsby, A.M.I.E.E., who has been associated with the Benjamin Electric (Ltd.) since 1908 (being a managing director until December last when he resigned to return to the United States), has been elected a director and is now vice-president and general manager of the Anderson Electric Specialty Co., 562-564, W. Van Buren-street, Chicago, U.S.A.

Mr. Billington, locomotive superintendent of the L.B. & S.C. Railway Co., has been appointed by the War Office to an important post, with the rank of lieut.-colonel in the Royal Engineers.

Mr. Herbert Willett, who has been in the service of the Edison Swan Electric Co. for 25 years, has been called up, and joined the Forces on the 22nd inst.

Mr. C. W. Salt, borough electrical engineer, Torquay, has been promoted to Lieutenant.

Prof. W. D. Ripper, D.Eng., D.Sc., M.I.C.E., vice-chancellor of Sheffield University and professor of engineering, and Coun. Evans, chairman of the Sheffield Electric Supply Committee, have been added to the Commission of the Peace for Sheffield.

APPOINTMENTS VACANT AND FILLED.

London County Council invite applications for the position of electrical engineer in the tramways department, at a salary ranging from £1,200 to £1,500 a year. Applications on official form to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., must be returned by 1 p.m. April 23.

London County Council also require an operation superintendent (£500 to £700 per annum) and a development superintendent (£500 to £800) for the traffic branch of their tramways department. Applications by April 23 for the former, and May 7 for the latter appointment.

An additional lecturer and demonstrator will shortly be required in the engineering department of the Borough Polytechnic Institute, Borough-road, London, S.E. 1. Salary £160 to £180 per annum.

Station, mains and shift engineers for a.c. and d.c. work are required for aerodromes and hutted camps. Applications to the Chief Engineer, Southern Command, 12, Wilton-road, Salisbury.

Mr. S. L. Rambotham has been appointed an Assistant Electrical Engineer of the Indian Public Works Department, and posted to the Eastern Bengal Railway.

Mr. E. C. Pope, of Watford, has been appointed charge engineer at Erith.

INSTITUTIONS AND SOCIETIES.

Junior Institution of Engineers and Engineering Students.—In January the Council of the Junior Institution of Engineers passed a resolution having reference to extending the advantages of membership to apprentices at approved works and students of such technical schools and colleges as may be approved by the Council.

The proposal is that such students would be admitted at a reduced subscription, be permitted to attend all meetings and visits, and, by means of the existing J.I.E. "Engineers' Register," would be assisted in obtaining employment in engineering works.

Royal Institution.—After Easter Prof. Sir J. J. Thomson will give a course of six lectures on "The Electrical Properties of Gases." The Friday Evening Discourses will begin on April 20, and will be given, amongst others, by Prof. John Joly on "Radio-active Haloes"; Prof. Frederick Soddy on "The Complexity of the Chemical Elements"; and Prof. Sir J. J. Thomson on "Industrial Applications of Electrons."

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 30th (to-day).

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, W. Discourse on "Recent Developments of Molecular Physics," by Prof. J. H. Jeans, F.R.S.

TUESDAY, April 3rd.

MANCHESTER LOCAL SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At the Engineers' Club, 17, Albert-square, Manchester. Annual General Meeting. A Lecture will be delivered by Prof. E. Wilson.

SCOTTISH LOCAL SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. At 207, Bath-street, Glasgow. Paper on "Some Points in Connection with Engineering Specifications," by Mr. J. Shepherd.

THE RONTGEN SOCIETY.

8.15 p.m. At the Cancer Hospital, Fulham Road, S.W. Discussion on "The Future of the British X-Ray Industry," opened by Mr. Geoffrey Pearce.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the week:—

Officer for the Week.—Platoon Commander Watkins.

Next for Duty.—Platoon Commander Hughes-Hallett.

SPECIAL NOTICE.—The Commandant congratulates the Corps on now having received official recognition. He trusts that *every member* will make it convenient to attend at Headquarters on Monday, April 2nd, between 6 and 7 for medical examination and attestation.

Monday, April 2nd.—Technical for Platoon No. 9 at Regency-street. Squad and platoon drill, Platoon No. 10. Signalling class. Recruits' drill, 6.30 to 8. Medical Examination, 6.

Wednesday, April 4th.—Instructional class, 6.15. Platoon drill, Platoon No. 1.

Thursday, April 5th, to Monday, April 9th.—Headquarters closed during Easter training at Esher. Special orders will be sent to each volunteer who has sent in his name.

Muskctry.—For all companies, see notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.).

A NEW METHOD OF MEASURING RESISTIVITY OF MOLTEN METALS.*

BY E. F. NORTHRUP AND R. G. SHERWOOD.

Summary.—The authors describe a new method of measuring resistivity of molten materials. The study of electrical resistivities of metals and especially alloys in the solid and liquid phases, now give useful data which cannot conveniently be obtained from cooling curves. Such measurements should be made at temperatures above 1,100°C.-1,200°C., and a special apparatus, termed a "resistometer," is devised for the purpose. It consists essentially of two quartz or porcelain tubes, into which tungsten leads are taken, enclosed in a large graphite tube. This instrument is lowered into the material to be tested. Measurements are made with an alternating current, a special form of galvanometer and bridge being used. Some curves are presented showing variations in resistivity of bismuth-tin alloys at various temperatures.

The results of an experimental investigation of the electrical conductivity of molten metals and alloys, commenced in 1911, have been described in a series of Papers,† of which five, relating to metallic conduction, have appeared in the "Journal" of the Franklin Institute.

To obtain accurate data from which curves may be drawn that give the relation between resistivity and temperature over a wide range of temperatures, it was found necessary to devise entirely new methods of producing the required temperature and, also, entirely new methods for measuring the resistivities of materials when in the molten state. Several different methods were developed and used in measuring the resistivities of metals and alloys.

Cooling Curves and Resistivity Curves.—Importance has long been attached to a study of certain physical characteristics of the metals and alloys by tracing their heating and cooling curves, especially through changes in state. Melting and freezing point determinations are made in this way, and data for equilibrium diagrams have been taken largely from such curves. The same and additional information may be obtained, with nearly equal facility and with greater exactness, by tracing, not the progress of cooling of an element, alloy, or compound, but the change in resistivity of the material with change in the temperature when this is slowly raised or lowered. The methods which have been perfected for measuring the resistivity of molten materials have enabled us in certain cases to measure simultaneously the resistivities of two metals, under identical temperature conditions, to a temperature as high as 1,680°C. When, however, the temperature much exceeds 1,000°C. difficulties are encountered from the formation of new chemical equilibria and the contamination of the sample being measured. Below this temperature difficulties of this character do not arise to any serious extent.

It seems certain that data on electrical resistance or electrical resistivity of a metal, and more especially of an alloy in the solid, [illegible] and liquid phases, will yield new and valuable information which cannot be obtained from cooling curves or from any of the other methods now employed to study the physical characteristics of alloys.

The following description of methods of measurement relates to some results obtained by the methods described, for alloys of tin and bismuth.

Requirements to be met.—If measurements of resistivity are to be carried higher than 1,100°C. or 1,200°C., a wire wound furnace is unsuitable and it becomes necessary to employ a type of furnace developed by the first-named writer for this particular class of work. When, however, a study of the alloys is under consideration it is generally unnecessary and it is often impossible (on account of [illegible] of a metal) to take observations above a temperature of 1,000°C. In this case a vertical type furnace, made by [illegible] tube with nichrome wire or ribbon, meets [illegible]. In what follows we shall confine ourselves to a [illegible] of measurements of resistivities which can be made [illegible].

Temperatures may be measured with either a resistance thermometer or with a thermocouple, the calibration of which is effected [illegible] than the calibration of other devices by checking it against the [illegible] points of common metals.

To obtain the value of the resistivity of a molten material, it is very desirable to employ a device which will give this result by direct insertion of the device into a considerable mass of the molten material, contained in a crucible. The instrument devised for this purpose is termed a "resistometer." It consists essentially of two quartz tubes or special porcelain tubes, which are enclosed in a large graphite tube, and are firmly cemented into a small square block of stone. Leads of tungsten wire are led into the quartz or porcelain tubes, and enable the current and P.D. applied to any material, poured when molten into the graphite tube, to be measured, and hence also the resistance of the material. The resistometer is lowered into a specially designed chamber by which it is heated, the temperature being observed by an adjacent thermocouple, which should be as close to the material studied as is practicable. By this means the arrangement can be conveniently calibrated.

It is desirable to make the readings of resistivity directly in microhms per centimetre cube. A null-method requires the use of a Kelvin double-bridge. The measuring current must be an alternating one. All difficulties arising from parasitic E.M.F.s and currents are thus avoided. An alternating-current galvanometer which possesses new features and fills every requirement was designed especially for this work.

In measuring the resistance of molten materials, connections or electrodes must be used which shall serve both for current and potential terminals. Tungsten wire, and in many cases molybdenum wire, has proved entirely satisfactory for this purpose at the temperatures used, because neither tungsten nor molybdenum fuses or appreciably alloys with any molten metal not belonging to the iron group.

To obtain the results directly in microhms per centimetre cube it is necessary to so design the resistometer that its constant may be obtained readily. This is accomplished by inserting it in pure mercury, which serves as a standard of resistivity. When the constant of the resistometer has been obtained thus, the values of the bridge ratio-coils may be then so chosen that the bridge-readings, when multiplied by a power of ten, are in michrohms per centimetre cube. For this reason the ratio-values of two ratio-arms should be adjustable.

Two modifications of the resistometer were used, the first serving chiefly for testing precious metals or alloys, where only small quantities are available for experiment, the second, a more robust type, being used in tracing the resistivity of the baser metals and alloys.

As previously stated the large E.M.F.s of a parasitic character which are developed in the resistometer, when this is immersed in a molten metal or alloy, preclude the use of direct current for the measuring current and, therefore, a direct-current galvanometer. Both 60-cycle and 25-cycle alternating current were used. The latter is to be preferred, as it is then of less importance, when high precision is required, that the ratio-coils in the Kelvin double-bridge should be freed from capacity or inductance. The alternating-current galvanometer designed for the work completely fulfils the following requirements for a satisfactory instrument: The sensibility of the instrument is fully equal to the sensibility of a good D'Arsonval galvanometer of prescribed type. The sensibility of the alternating-current galvanometer is not a constant quantity as with a direct-current instrument, but may be varied to any degree within wide limits by simply changing the value of the alternating current passed through its magnetising coils. As the damping of the system varies with the square of the field strength, this latter is chosen of such value, by adjusting the current through the magnetising coils, that the system after deflection returns aperiodically to zero with the particular resistance in circuit with the swinging coil which is in use. With such an adjustment of field strength, the sensibility of the galvanometer should equal that of the direct current instrument referred to above. The aperiodic time of swing of the galvanometer should not exceed two or three seconds, and this requirement makes it necessary to use a narrow light coil for the swinging system.

When the alternating current galvanometer is in use the swinging system is necessarily on closed circuit, and, as this latter hangs in a field in which the magnetic flux is alternating, currents are induced in the swinging coil circuit. It is essential that these induced currents should not cause the system to seek a position of stable equilibrium other than that at which it comes to rest when no currents are flowing. This requirement has been fully met by the special shape which has been given the pole pieces of the laminated galvanometer magnet. It has never been found necessary to make any phase adjustments of any of the currents.

The magnetising coils, two in number, may be joined in series or parallel combination. They are always connected *in series* with the main circuit of the Kelvin double bridge, and hence must be able to carry without heating and without too strongly mag netising the magnet, a current which is at least as large as the current passed through the bridge. It is inadvisable to cut down the current through the magnetising coils, which are highly inductive, by means of a shunt. The bridge, however, being non-inductive, may be shunted to any extent. Hence it follows that the current through the magnetising coils required to energise the field-magnet may be chosen much larger than, but never less than the current which is passed through the bridge.

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* Abstract of a paper in the "Journal" of the Franklin Institute.

† [illegible] Electrochem. Soc., Vol. XX, 1911; also [illegible], 1911; Metallurgical and Chemical Engineering, June, 1912, [illegible], 1913, [illegible], 1914, [illegible], 1914, March, 1914, May, 1914, March, 1915; "Journal" of the Franklin Institute, February, 1913, [illegible], 1914, March, 1914, July, 1914, March, 1915, and "High [illegible] of Metallic Conduction," June, 1915.

In the galvanometer the fixed iron core-piece between the pole-faces, which is generally used with direct-current instruments, is omitted. The pole-faces are hollowed out so that the coil swings in a hollow cylinder. This construction is used for the reason that when the coil is on short circuit, it will tend to set itself in the weakest part of the field. The shape which has been given the pole-pieces makes the position of stable equilibrium for the system that which corresponds to zero reading on the scale.

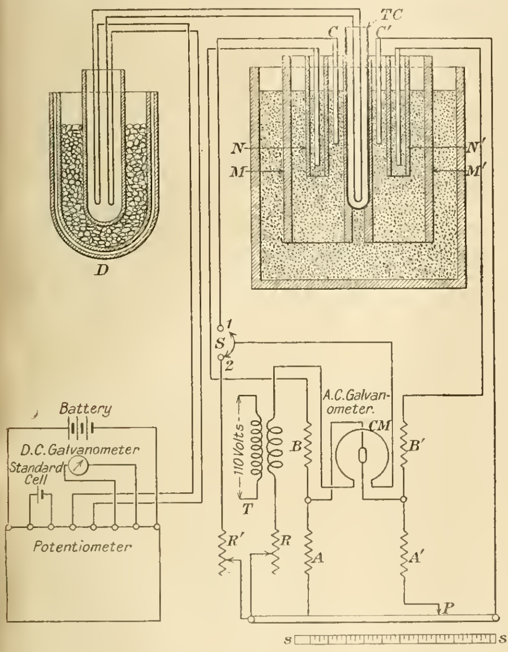

Fig. 1.

It is very much more convenient for work of this class to employ a type of Kelvin double-bridge in which a balance is obtained by varying the position of the potential-points on a low-resistance standard than one in which a balance is obtained by varying the ratio-coils and using a fixed low-resistance standard.

The electrical circuits employed and the manner of including the resistometer type I in these circuits are shown diagrammatically in Fig. 1. The resistometer itself is shown with its lateral dimensions greatly exaggerated for the sake of clearness. The source of current is the secondary of a step-down transformeer *T*. *S* is a switch which when in position 2 cuts the resistometer and Kelvin double-bridge out of circuit and puts the magnetising coils, *CM*, of the galvanometer in circuit with the transformer-secondary and the two resistances, *R′* and *R*. When the switch *S* is in position 1 the resistance *R′* is cut out of circuit and the resistometer and Kelvin double-bridge are thrown into circuit with the source of current. The switch *S* is so constructed that neither contact 1 or 2 is broken before the other is made. This is necessary to prevent a sudden small deflection of the galvanometer which would result if the current through its magnetising coils were momentarily stopped. The resistance *R′* is given such a value that the total resistance in circuit with the secondary of the transformer is the same whether the switch *S* is in position 1 or in position 2. The object in being able by means of the switch *S* to throw the bridge and resistometer out of circuit is, that by so doing the zero position of the galvanometer may be located. Resistances *A* and *A′* are fixed ratio-coils, generally chosen 1,000 ohms each. Resistances *B* and *B′* are ratio-coils which can be varied. They are chosen of such a value that the settings of the slider *P*, as read on the scale *SS′*, shall indicate the resistivity of the sample, when multiplied by some power of ten, in microhms per centimetre cube.

The thermocouple, *TC*, is located in the bath of molten material so that its hot junction is midway between the bottom ends of the two potential-tubes, *N N′* and the two current-tubes *M M′*. Its cold junction is located in the Dewar flask *D*, filled with cracked ice, and the terminals of copper wire which lead from the cold junction are joined to the potentiometer as shown in Fig. 1. The arrangement of the circuit is subject to several modifications when the alternative form of resistometer is used.

An extremely important line of high-temperature investigation is an inquiry into the linear increase in resistance of pure metals when carried to a very high temperature. By simultaneously tracing the increase in resistance of two different metals when subjected to identical temperature conditions, it is possible to ascertain, by studying different pairs of metals taken in different combinations, whether or not they all increase in resistance linearly.

It has been found that both tin and lead increased linearly in resistance when molten up to about 1,575°C. The method is most convenient for direct comparison to a very high temperature of the rate of increase in resistance of two molten metals or alloys. If this comparison were to be made of various pairs of metals chosen in different combinations *it would firmly establish an extension, to a high temperature, of the temperature-scale on a basis new and quite as reproducible as the gas-scale.*

Either form of resistometer may be used as a pyrometer up to 1,600°C. to 1,700°C.

The theory of the method of adjusting the ratio-coils in a Kelvin double-bridge so that the readings on the variable low-resistance standard when multiplied by a power of ten will be in microhms per centimetre cube has been given by the first-named writer in a former paper.* The calibration of the resistometer and the adjustment of the ratio coils, however, may be determined experimentally and simultaneously without any calculation, in the simplest manner possible, as follows:—

A container of the same dimensions as the one destined to contain the sample is filled with pure mercury. The resistometer is placed in this mercury, the temperature of which is accurately taken with a mercury thermometer. The two ratio-coils *A A′* (Fig. 1) are given some arbitrary value, say 1,000 ohms. A setting is then made on the variable low-resistance standard which when multiplied by some power of ten is equal to the specific resistance of the mercury in ohms when at the temperature recorded. A balance of the bridge is then

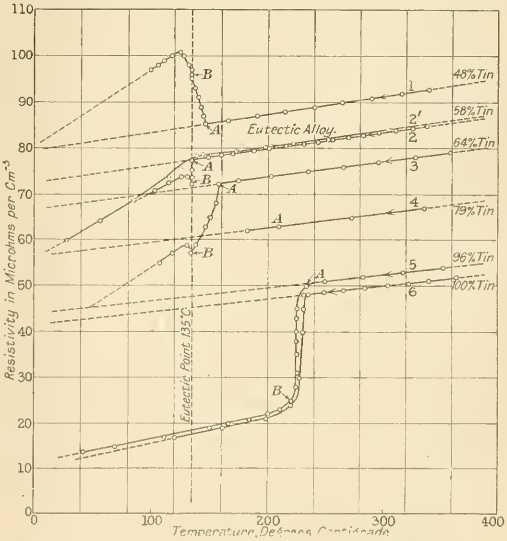

Fig. 2.—Resistivity Temperature Curves for Bi + Sn Alloys through Change of State. Per cent. Concentration Given in Atomic per cent. Curves 1, 2, 3, 4, 5 and 6 taken while Slowly Cooling; Curve 2′ taken while Slowly Heating.

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* "Resistivity of Copper in Temperature Range 20°C. to 1,450°C," "Journal" of the Franklin Institute, January, 1914, pp. 9-11.

effected by the simultaneous adjustment of the ratio-coils B B'. The readings of the bridge when multiplied by the proper power of ten will now give the resistivity of the mercury in microhms per centimetre cube.

By making these adjustments the resistivities of the samples studied are determined without any calculation whatever, and the result is that it is actually simpler to measure the resistivity of molten brass, for example, at 800°C. than to determine the resistivity of a rod of metal at room temperature. When the resistometer-tubes are made of Marquardt porcelain the temperature, given a suitable furnace, can be carried to 1,600°C. or 1,700°C., and it follows that, when one is supplied with the equipment which has been described, the resistivities of molten metals can be determined with the greatest ease, simplicity and accuracy at even this high temperature.

A common characteristic shown by all the resistivity-curves, obtain both for the pure metals and the alloys, is their linear character in the molten state. Moreover, it is interesting to note that the slope dR/dT for all the curves of the Bi-Sn alloys in the molten state is approximately constant. The phenomenon of under-cooling is clearly shown in the case of bismuth and tin on one of the curves not here reproduced. So far as we are informed, this is the first time that the phenomenon of undercooling has been made to reveal itself on a temperature-resistivity curve when tracing this for a metal or alloy passing from the molten to the solid state.

The chief interest in the results obtained, however, is connected with the curves obtained for the alloys of bismuth and tin given in Fig. 2. Attention is directed to the following features:—

1. The linear portion of the curves gives the resistivity-temperature relation of the alloy when this exists as a homogeneous liquid-solution. When cooling has reached the point designated by the letter A on all the curves, there suddenly takes place a separating out of a mixed crystal. Between the points A and B on the curves the alloy consists of this mixed-crystal and a liquid-solution, the latter, however, gradually disappearing while the mixed-crystal increases in amount until the point B on the curves is reached. Here the last trace of liquid solution disappears and at the same instant the single mixed-crystal immediately begins to separate into two conjugate mixed-crystals. This is shown sharply on the curves. The remaining portion of the curve gives the resistivity of the alloy while the two mixed-crystals gradually change their relative composition, as the cooling progresses. The temperature at which the last trace of the liquid solution disappears and the two mixed-crystal formation begins is, for this class of alloy, always at the definite fixed-temperature called the "Eutectic Point." The reason why curve 5 does not exhibit this common characteristic is to be explained by the fact that the proportion of the constituents is such that, after the point B is reached, the single mixed-crystal remains as an unsaturated solid-solution of bismuth in tin, for the lowest temperature recorded. Hence there is no breaking up of the alloy into the two conjugate solid-solutions or mixed-crystals above referred to. In the case of the curve for the eutectic alloy the points A and B are at the same temperature, since, by definition of the eutectic, the homogeneous liquid solution at its freezing point does not pass into a single mixed-crystal, as do the other alloys, but passes immediately into two conjugate mixed-crystals. The character of the curve for the eutectic brings out this point well.

2. The heating curve for the eutectic alloy, curve 2′, is interesting, since it apparently shows that the mixture represented by the proportions of this alloy are the proper proportions to "wipe out," so to speak, the abrupt break exhibited by all the other curves, as well as by the pure metals themselves. Heating-curves for these latter have been taken, but, since they differ only slightly from the cooling curves given and seem to be of no special interest, they have not been included. The phenomenon above mentioned, associated as it is with the alloy having the lowest freezing-temperature, rather [illegible] out of a definite relation existing between the molecular condition or arrangement which causes a lowering of the freezing point of the alloy and the molecular condition or arrangement [illegible] to change the resistance of the alloy.

3. When consideration is taken of the fact that the liquid phase of a metal or alloy possesses no crystalline structure, at least in the sense here referred to, and is homogeneous throughout, it is logical to conclude that a systematic study of the electrical resistivity of various metals and alloys in their liquid phases might yield some very interesting and important information and furnish thereby a real basis for the comparison of this property with other properties of the metals or alloys. In this connection it is interesting to note that a linear relation exists between the resistivity of the various alloys of bismuth and tin and the percentage of gramme atoms of each constituent forming the alloy. Whether such a relation or some other simple relation holds true for alloys of other metals is, however, a matter of more or less speculation.

AN ELECTRIC GRAB-BUCKET.

The motor-operated single-rope clam-shell bucket shown in Fig. 1 has a wide sphere of usefulness wherever bulk material is to be handled. It is now being used in connection with travelling cranes, mono-rail hoists, derricks, locomotive cranes, inclined boom unloaders and steelworks cranes. An important advantage is that it may be operated by *any* crane of capacity sufficient to lift the loaded bucket.

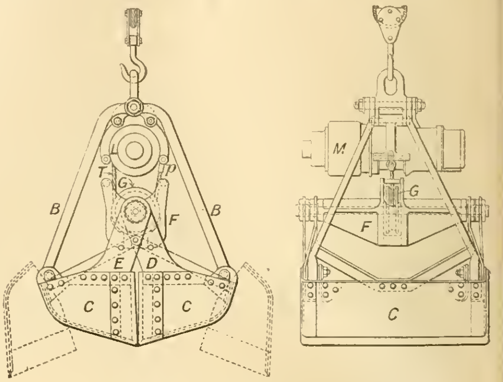

Fig. 1.—Hayward Electric Grab-Bucket.

The two sections of the bucket are opened and closed by a winding-rope wound on a drum actuated through a friction-clutch and gearing from an electric motor carried in the grab frame, and controlled from a distant point. As will be seen from Fig. 1, the bucket sections C C are pivoted to links B, and are connected by arms D, E to a weighted member F carrying a sheave G. The opening and closing rope T is attached to a fixed point p and passes round the sheave G to a drum O mounted in a frame L which carries the motor and gearing. The motor M, Fig. 2, actuates a pinion Q which transmits motion to the part R of the drum through two sun-and-planet gears in series. Interposed between the part R and the drum proper is an adjustable slipping-clutch S of the Weston type. An electro-mechanical brake H, also of the Weston type, is provided on the extended motor spindle.

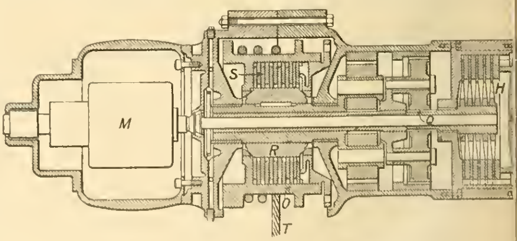

Fig. 2.—Arrangement of Driving Mechanism.

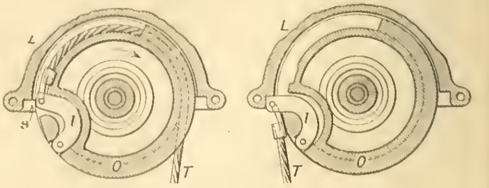

Fig. 3

Fig. 3 shows the end of the rope T connected to a curved link, which is pivoted in a recess in the drum. As the grab opens, the rope T is entirely unwound from the drum, whereupon the pull on the rope projects the link l to engage a shoulder, s, formed in the frame L, thus stopping the opening motion. In case the edges of the bucket come together or are held apart by some obstruction, rotation of the motor can continue by reason of the slipping-clutch. This eliminates the necessity of limit-switches or circuit-breakers, makes the bucket practically fool-proof in the hands of the ordinary crane operator, and greatly simplifies the construction.

A simple form of controller is used for opening and closing the bucket, and a weatherproof conductor cable is provided to connect the controller to the bucket. When the bucket is fitted to an electric crane the controller is usually housed in the operator's cage, but it may be located in any convenient position.

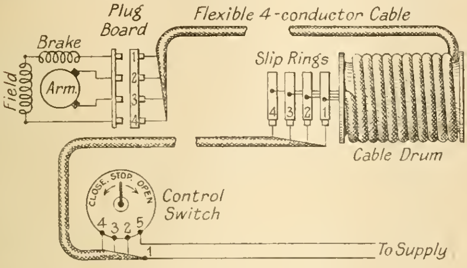

FIG. 4.—DIAGRAM OF CONNECTIONS.

In cases where the service is such as to require a long conductor cable, the latter may be kept off the ground and clear of obstructions by means of a reel, Fig. 4, which automatically pays out and coils it up as required. This reel operates upon the principle of the ordinary roller-blind, the rotative power being furnished by a set of compound springs enclosed within the drum. A number of mica-insulated collector rings are attached to one end of the drum, and each ring is arranged with binding screws for the attachment of the cable. When not in use, the drum is held stationary by means of a plunger lock. An arrangement of ratchet and pawl on one end of the shaft permits a quick adjustment of the tension on the springs, and also provides against any possible damage to the springs in case the drum should run away backwards in the event of the cable breaking. Flexible cable with any number of conductors may be successfully handled in lengths up to 150 ft.

These ingenious buckets are built in capacities from $\frac{3}{4}$ cubic yd. and upwards. Weights, dimensions and capacities of four sizes are set out in the accompanying table:

Capacity, cubic yards.	Weight in lbs.	Dimensions in inches.				
		A	B	C	D	E
$\frac{3}{4}$	2,300	65	77	49	69	46
1	3,900	76	88	56	79	48
$1\frac{1}{4}$	4,000	88	97	61	89	51
$1\frac{1}{2}$	4,500	88	97	61	89	59

The bucket, which was introduced a short time ago by the Hayward Co., of New York, is now in daily use in foundries, boiler houses, steelworks, industrial plants, on railways and at docks. Those interested in the handling of materials would do well to get into touch with the makers.

PRESSURE HARMONICS IN POLYPHASE SYSTEMS AND WINDINGS.

BY B. HAGUE, B.SC., D.I.C.

(Concluded from page 743.)

Summary.—In this article the properties of pressure harmonics in a polyphase system are first discussed by the use of the well-known theory; after which the effect of the distribution of the armature winding of the alternator (from which the system is derived) on the magnitude of the harmonics is considered. Tables of distribution factors are given for single-layer windings and for double-layer lap windings, forming an extension to similar tables published by Dr. S. P. Smith and Mr. R. S. H. Boulding.

PART II.—THE EFFECT OF WINDING FACTORS ON THE PRESSURES IN SYMMETRICAL POLYPHASE WINDINGS.

The properties of harmonics in symmetrical polyphase systems having been discussed in the previous part of the Paper, we must now examine how the pressure harmonics generated in a winding are affected by the phase-spread and the coil-span. The phase-spread of a winding is the angle subtended in each pole-pitch by the group of coil-sides of a phase. We shall measure it in radians, and according to whether the phase-spread is $1/N$th or $2/N$ths of a pole-pitch, we have the narrow or wide spread. The coil-span we shall also consider to be measured in radians. It is obvious that the span of the coils in a winding should be made as nearly equal to π radians as possible. If for any reason the span is different from a full pitch, we shall take ε to be the angular deviation of the coil-span from π radians.

In the Paper* referred to in the introduction it is shown that the amplitude of the nth harmonic of pressure induced in a circuit of c coils in series is

$$\sum_1^c e_n = 2Tvf_nB_n \cdot 10^{-8} \text{ volts}, \quad . \quad . \quad . \quad . \quad . \quad (16)$$

where $T = gmT_c$ = total turns in a circuit consisting of g groups of m coils per group, each coil having T_c turns; winding factor, f_n = coil-span factor, $f_{\varepsilon,n}$ × distribution factor, $f_{m,n}$ × group factor, $f_{g,n}$; and B_n = amplitude of the nth harmonic in the flux density curve.

Since we are only discussing symmetrical systems, in which a phase is made up of a number of identical circuits in series or parallel, the pressure wave of a phase will have the same shape as that of a circuit—hence we need only find the winding factor, f_n, for a circuit.

I. Single-layer Windings.—(*a*) *Whole Number of Slots per Pole, Q.*—The important case of a single layer winding is the three-phase winding, and it is common practice to use a whole number of slots per pole. Two cases arise, namely, (i.) when the mean coil-span equals a pole-pitch; (ii.) when the mean coil-span is less than a pole-pitch.

(*i.*) *Full-pitch Coils.*—It can be easily verified that in a single-layer winding in which N is odd, the mean coil-span is equal to a pole-pitch. Thus in a 3-phase winding, $m = q_0 = Q/3$. (q_0 being the number of wound slots per pole and phase), successive coils being $\psi = \gamma$ = an angular slot-pitch apart in the field. There is only one group of coils per circuit, and hence the group factor, $f_{g,n} = 1$, since $g = 1$. The angular deviation, ε, of the coil-span from a full pitch of π radians, in the case of full-pitch coils, is clearly zero, and hence the coil-span factor, $f_{\varepsilon,n} = \cos n\varepsilon/2 = 1$. Consequently, the winding factor is in this case equal to the distribution factor, *i.e.*,

$$f_n = f_{m,n} = \frac{\sin nm\psi/2}{m \sin n\psi/2} = \frac{\sin nq_0\gamma/2}{q_0 \sin n\gamma/2} = \frac{\sin n\frac{q_0}{Q}\cdot\frac{\pi}{2}}{q_0 \sin n\frac{1}{Q}\cdot\frac{\pi}{2}} \quad . \quad . \quad (17)$$

since $Q\gamma = \pi$.

Hence when $N = 3$ and $Q = 3q_0$,

$$f_n = \frac{\sin n\frac{\pi}{6}}{q_0 \sin n\frac{1}{Q}\cdot\frac{\pi}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

If x be an odd integer, it is clear that $2Q \pm x$ will also be odd, and will therefore represent possible harmonics. Inserting $n = 2Q \pm x$ in equation 17, we find,

$$f_n = f_{2Q\pm x} = \frac{\sin (2Q\pm x)\frac{q_0}{Q}\cdot\frac{\pi}{2}}{q_0 \sin (2Q\pm x)\frac{1}{Q}\cdot\frac{\pi}{2}} = \frac{\sin \pm x\frac{q_0}{Q}\cdot\frac{\pi}{2}}{q_0 \sin \frac{x}{Q}\cdot\frac{\pi}{2}} = \pm f^x.$$

that is,

$$f_{2Q+x} = f_{2Q-x} = \pm f_x.$$

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* Smith and Boulding, *ibid.*, Equation 16.

Table I.—*Distribution Factors, $f_{d,n}$, for Three-phase Single-layer Windings with Whole Number of Slots per Pole.* ($Q = 3q_0$.)

$q_0 = Q/3$.	2	3	4	5	6	7	8	9	10	Winding uniformly distributed.
Q = slots/pole.	6	9	12	15	18	21	24	27	30	
f_1	**0·966**	**0·960**	**0·958**	**0·957**	**0·957**	**0·957**	**0·956**	**0·955**	**0·955**	**0·955**
f_3	0·707	0·667	0·654	0·646	0·644	0·642	0·641	0·640	0·639	0·636
f_5	0·259	0·217	0·205	0·200	0·197	0·195	0·194	0·194	0·193	0·191
f_7	0·259	—0·177	—0·158	—0·149	0·145	0·143	—0·141	0·140	—0·140	—0·136
f_9	—0·707	—0·333	—0·270	—0·247	—0·236	—0·229	—0·225	0·222	—0·220	—0·212
f_{11}	—**0·966**	—0·177	—0·126	—0·110	0·102	—0·097	—0·095	0·093	—0·092	—0·087
f_{13}	**0·966**	0·217	0·126	0·102	0·092	0·086	0·083	0·081	0·079	0·073
f_{15}	—0·707	0·667	0·270	0·200	0·172	0·158	0·150	0·145	0·141	0·127
f_{17}	—0·259	**0·960**	0·158	0·102	0·084	0·075	0·070	0·066	0·064	0·056
f_{19}	0·259	**0·960**	—0·205	0·110	—0·084	—0·072	—0·066	—0·062	0·060	—0·050
f_{21}	0·707	0·667	0·654	—0·247	—0·172	0·143	—0·127	0·118	—0·112	—0·091
f_{23}	**0·966**	0·217	—**0·958**	—0·149	—0·092	—0·072	—0·063	0·057	—0·054	—0·041
f_{25}	**0·966**	—0·177	—**0·958**	0·200	0·102	0·075	0·063	0·056	0·052	0·038
f_{27}	0·707	—0·333	—0·654	0·646	0·236	0·158	0·127	0·111	0·101	0·071
f_{29}	0·259	0·177	0·205	**0·957**	0·145	0·086	0·066	0·056	0·050	0·033
f_{31}	—0·259	0·217	0·158	**0·957**	—0·197	—0·097	—0·070	—0·057	—0·050	—0·031
f_{33}	—0·707	0·667	0·270	0·646	—0·644	—0·229	—0·150	—0·118	—0·101	—0·058
f_{35}	—**0·966**	**0·960**	0·126	0·200	—**0·957**	—0·143	—0·083	0·062	—0·052	—0·027
f_{37}	—**0·966**	**0·960**	—0·126	—0·149	—**0·957**	0·195	0·095	0·066	0·054	0·026
f_{39}	0·707	0·667	—0·270	—0·247	—0·644	0·642	0·225	0·145	0·112	0·049
f_{41}	0·259	0·217	—0·158	—0·110	—0·197	**0·957**	0·141	0·081	0·060	0·023
f_{43}	0·259	—0·177	0·205	0·102	0·145	**0·957**	—0·194	—0·093	—0·064	—0·022
f_{45}	0·707	—0·333	0·654	0·200	0·236	0·642	—0·641	—0·222	—0·141	—0·042
f_{47}	**0·966**	—0·177	**0·958**	0·102	0·102	0·195	—**0·956**	—0·140	—0·079	—0·020
f_{49}	**0·966**	0·217	**0·958**	—0·110	—0·092	—0·143	—**0·956**	0·194	0·092	0·019
f_{51}	0·707	0·667	0·654	—0·247	—0·172	—0·229	—0·641	0·640	0·220	0·038
f_{53}	0·259	**0·960**	0·205	—0·149	—0·084	—0·097	—0·194	**0·955**	0·140	0·018
f_{55}	—0·259	**0·960**	—0·158	0·200	0·084	0·086	0·141	**0·955**	—0·193	—0·017
f_{57}	0·707	0·667	—0·270	0·646	0·172	0·158	0·225	0·640	—0·639	—0·033
f_{59}	—**0·966**	0·217	—0·126	**0·957**	0·092	0·075	0·095	0·194	—**0·955**	—0·016
f_{61}	—**0·966**	—0·177	0·126	**0·957**	—0·102	—0·072	—0·083	—0·140	—**0·955**	0·016
f_{63}	—0·707	—0·333	0·270	0·646	—0·236	—0·143	—0·150	—0·222	—0·639	0·030
f_{65}	0·259	—0·177	0·158	0·200	—0·145	—0·072	0·070	—0·093	0·193	0·015

The harmonics of the orders $2Q\pm1$ and $2Q\pm3$ are therefore of particular importance because $f_{2Q\pm1}$ and $f_{2Q\pm3}$ have the same high values as f_1 and f_3 respectively, and so enable the spacing and tooth ripples to be pronounced.

The values of the distribution factors for 3-phase windings with a whole number of slots per pole have been calculated from equation 18 and are given in Table I.,* in which the distribution factors of the harmonics of orders $2Q\pm1$, &c., are shown in heavy type.

(*a*) *Short-span Coils.*—When N is even (4 or 6), the mean coil-span of a symmetrical single-layer winding is equal to $(N-1)/N$ times the pole pitch, as can be readily verified. Then we get $\varepsilon = \pi - \frac{N-1}{N}\pi = \pi/N$ and since $N = Q/q_0$,

$$f_{c,n} = \cos n\varepsilon/2 = \cos n\pi/2N = \cos n\frac{q_0}{Q}\cdot\frac{\pi}{2}.$$

The group factor will again be unity, since there is only one group of coils per circuit. Thus for the winding factor we have

$$f_{w,n} = f_{c,n}\cdot f_{d,n} = \cos n\frac{q_0}{Q}\cdot\frac{\pi}{2}\times\frac{\sin n\frac{q_0}{Q}\cdot\frac{\pi}{2}}{q_0\sin n\frac{1}{Q}\cdot\frac{\pi}{2}} = \frac{\sin n\frac{2q_0}{Q}\cdot\frac{\pi}{2}}{2q_0\sin n\frac{1}{Q}\cdot\frac{\pi}{2}}$$

$$= \frac{\sin n\frac{\pi}{6}}{2q_0\sin n\frac{1}{Q}\cdot\frac{\pi}{2}},\quad Q/q_0 = 6 \text{ and } N = 6. \quad . \quad . \quad (19)$$

If with a given value of Q and $N = 6$ there are q_0 slots per pole and phase and the mean coil-span $= \pi(N-1)/N = \frac{5}{6}\pi$; then for the same Q and $N = 3$ there will be $2q_0$ slots per pole and phase and the coils will have a mean span of π. Thus f_n in equation 19 for $N = 6$ is the same as f_n in equation 18 for $N = 3$ with the same value of Q. Similarly it can be shown that a symmetrical 4-phase winding has the same winding factor as the hemisymmetrical 2-phase winding with the same number of slots per pole. This is, of course, due to the fact that the symmetrical 6- and 4-phase windings have a coil-span less than a pole-pitch, π, whilst in symmetrical 3-phase and hemisymmetrical 2-phase windings it is equal to π.

Thus, whenever Q is a whole number, whether the coils have a full or a short span, the spacing and tooth ripples will always be pronounced if the flux harmonics of the corresponding orders, $B_{2Q\pm1}$, are appreciable in value. This is a distinguishing and troublesome characteristic of all windings having Q = *an integer*, and is due to the fact that coils under successive pole-pairs occupy like positions in the field and being connected in series any E.M.F.s due to flux harmonics of order $2Q\pm x$ will be additive, accounting for their high winding factors. The remedy lies in making the coils under successive poles occupy different positions in the field, or by making Q fractional so that $2Q\pm x$ shall not represent possible harmonics. The means by which this is carried out are considered below.

(*b*) *Fractional Number of Slots per Pole.*—When Q is a fractional number (other than an integer $+\frac{1}{2}$), $2Q+x$ and $2Q-x$ are not integers, and so do not represent possible harmonics. Interpreted physically this means that the coil-sides occupy different positions in the field, instead of like positions under every pole, so that the winding assumes the character of a uniformly distributed winding in which the winding factor, $f_{m,n}$ = *chord/arc*, decreases as the order of the harmonic increases, as shown in the last column of Table I.

In the case of a machine with three extra empty slots per pole pair, the number of slots per pole, Q = *an integer* $+1/2$. Since the coil spans a whole number of slot pitches, Q_0, the deviation of the mean coil-span from a full pitch will be an odd number of half slot-pitches, since

$$Q\gamma - Q_0\gamma = (Q - Q_0)\gamma = \gamma/2,\ 3\gamma/2,\ 5\gamma/2,\ \&c. = x\gamma/2,$$
$$\text{where } x = 1, 3, 5, \&c.$$

Then the coil-span factor,

$$f_{c,n} = \cos n\varepsilon/2 = \cos n\frac{x\gamma}{2} = \cos n\frac{x}{2Q}\cdot\frac{2}{\pi}.$$

Now $2Q$, being odd, is a possible harmonic, so that for $n = 2Q$,

$$f_{c,2Q} = \cos 2Q\frac{x}{2Q}\cdot\frac{\pi}{2} = \cos x\frac{\pi}{2} = 0.$$

Hence ripples of this order cannot appear in the pressure wave,

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* This Table corresponds with Table III in Smith and Boulding's Paper, *loc. cit.*, p. 26.

Table II.—*Distribution Factors, $f_{m,n}$, for Lap-winding with Diametral Tappings.*

No. of slip-rings.	6 or 4	6	6 or 4	6	6 or 4	6	6 or 4	6	6 or 4	6 or 4
Q=slots/pole.	6	9	12	15	18	21	24	27	30	Winding uniformly distributed.
f_1	**0·644**	**0·640**	**0·639**	**0·638**	**0·638**	**0·638**	**0·637**	**0·637**	**0·637**	**0·637**
f_3	−0·236	−0·222	−0·218	−0·215	−0·215	−0·214	−0·214	0·213	0·213	0·212
f_5	0·173	0·145	0·137	0·133	0·131	0·130	0·129	0·129	0·128	0·127
f_7	−0·173	−0·118	−0·105	−0·099	−0·097	−0·095	−0·094	−0·093	−0·093	−0·091
f_9	0·236	0·111	0·090	0·082	0·079	0·076	0·075	0·074	0·073	0·071
f_{11}	−**0·644**	−0·118	−0·084	−0·073	−0·068	−0·065	−0·063	−0·062	−0·061	−0·058
f_{13}	**0·644**	0·145	0·084	0·068	0·061	0·057	0·055	0·054	0·053	0·049
f_{15}	0·236	−0·222	−0·090	−0·066	−0·057	−0·053	0·050	−0·048	−0·042	−0·042
f_{17}	−0·173	**0·640**	0·106	0·068	0·056	0·050	0·047	0·044	0·043	0·037
f_{19}	0·173	**0·640**	−0·137	−0·073	0·056	−0·048	−0·044	−0·041	−0·040	−0·033
f_{21}	−0·236	−0·222	0·218	0·082	0·057	0·048	0·042	0·039	0·037	0·030
f_{23}	**0·644**	0·145	−**0·639**	−0·099	−0·061	−0·048	−0·042	0·038	−0·036	−0·028
f_{25}	**0·644**	−0·118	−**0·639**	0·133	0·068	0·050	0·042	0·037	0·035	0·025
f_{27}	−0·236	0·111	0·218	−0·215	−0·079	−0·053	−0·042	−0·037	−0·033	−0·024
f_{29}	0·173	−0·118	−0·137	**0·638**	0·096	0·057	0·044	0·037	0·033	0·022
f_{31}	−0·173	0·145	0·106	**0·638**	−0·131	−0·065	−0·047	−0·037	−0·033	−0·020
f_{33}	0·236	−0·222	−0·090	−0·215	0·215	0·076	0·050	0·039	0·033	0·019
f_{35}	−**0·644**	**0·640**	0·084	0·133	−**0·638**	−0·095	−0·055	0·041	−0·035	−0·018
f_{37}	−**0·644**	**0·640**	−0·084	−0·099	−**0·638**	0·130	0·063	0·044	0·042	0·017
f_{39}	0·236	−0·222	0·090	0·082	0·215	−0·214	−0·075	−0·048	−0·037	0·016
f_{41}	−0·173	0·145	−0·106	−0·073	−0·131	**0·638**	0·094	0·054	0·040	0·016
f_{43}	0·173	−0·118	0·137	0·068	0·096	**0·638**	−0·129	−0·064	−0·043	−0·015
f_{45}	−0·236	0·111	−0·218	−0·066	−0·079	−0·214	0·214	0·074	0·047	0·014
f_{47}	**0·644**	−0·118	**0·639**	0·068	0·068	0·130	−**0·637**	−0·093	−0·053	−0·014
f_{49}	**0·644**	0·145	**0·639**	−0·073	−0·061	−0·095	−**0·637**	0·129	0·061	0·013
f_{51}	−0·236	−0·222	−0·218	0·082	0·057	0·076	0·214	−0·213	−0·073	−0·013
f_{53}	0·173	**0·640**	0·137	−0·099	−0·056	−0·065	−0·129	**0·637**	0·093	0·012
f_{55}	−0·173	**0·640**	−0·105	0·133	0·056	0·057	0·094	**0·637**	−0·128	−0·012
f_{57}	0·236	−0·222	0·090	−0·215	−0·057	−0·053	−0·075	−0·213	0·213	0·011
f_{59}	**0·644**	0·145	−0·084	**0·638**	0·061	0·050	0·064	0·129	−**0·637**	−0·010
f_{61}	**0·644**	−0·118	0·084	**0·638**	−0·068	0·048	−0·055	−0·093	−**0·637**	0·010
f_{63}	0·236	0·111	0·090	−0·215	0·079	0·048	0·050	0·074	0·213	−0·010
f_{65}	−0·173	−0·118	0·105	0·133	−0·097	−0·048	−0·047	−0·064	−0·128	0·009

since $f_{\epsilon, 2Q}$ is zero, and the pressure wave in this case, as in the other cases when Q is fractional, cannot contain pronounced spacing or tooth ripples.

It is thus seen that it is advisable to make the number of identical circuits a minimum by making the value of Q fractional, in order that a smooth wave of phase pressure may be obtained.

II. *Double-layer Windings.*—In a double-layer winding with more than two coil-sides per slot, it will be readily appreciated that the phase of the pressure induced in a coil-side depends on the position of the slot in which the coil-side lies rather than on its position in the slot. In other words, when calculating the distribution factor, we need only consider the slot positions; which is equivalent to considering a winding in which the number of slots, S, is equal to the number of coils C. That is, we can replace the winding by an imaginary one in which there are only two coil-sides per slot.

It can be shown * that in any closed winding $S\psi=a \cdot 2\pi$, ψ being the angular displacement in the field between successive coils in the winding; whilst in a symmetrical winding, $S/a=S'=$*an integer*$=2\pi/\psi$, a being the number of identical parts in the winding. Further, to get a symmetrical N-phase system of pressures from the windings, S/aN must be an integer, as will be obvious.

Consequently for a symmetrical N-phase closed lap or wave winding, the distribution factor for the nth harmonic becomes,

$$f_{m,n}=\frac{\sin n\frac{S}{aN}\cdot\frac{\psi}{2}}{\frac{S}{aN}\sin n\frac{\psi}{2}}=\frac{\sin n\frac{\pi}{N}}{\frac{S}{aN}\sin n\frac{a}{S}\pi}. \quad . \quad . \quad (20)$$

This equation can now be applied to the actual cases of three, four or six-phase windings, with diametral or polygon tappings.

(*a*) *Lap Windings.*—In this case $a=p$, if p is the number of pole-pairs in the machine, and, therefore, S/aN must be integers. Full-pitch coils are usually used, and, therefore, $f_{\epsilon,n}=1$. Also, $f_{g,n}=1$, since there is only one group of coils per circuit.

(*i*) *Diametral Loading.*—This is the usual method of loading a rotary converter on the alternating-current side. For a two or three-phase load, $S/a=S/p$ must be divisible by four or six respectively. A pair of diametral tappings places two winding phases in parallel, so that $N=2$; hence, from equation (20),

$$f_{m,n}=\frac{\sin\frac{n\pi}{2}}{\frac{S}{2p}\cdot\sin\frac{np}{S}\pi}=\frac{-(-1)^{\left(\frac{n}{2}+\frac{1}{2}\right)}}{Q\sin\frac{n\pi}{2Q}}.$$

This function is tabulated in Table II. for various values of Q, along with the corresponding numbers of slip-rings.

(*ii.*) *Three-phase Polygon Loading.*—In this case we have $N=3$, and hence, from equation (20),

$$f_{m,n}=\frac{\sin n\frac{\pi}{3}}{\frac{S}{3p}\sin\frac{np}{S}\pi}=\frac{\sin n\frac{\pi}{3}}{\frac{2Q}{3}\sin\frac{n\pi}{2Q}}.$$

This is tabulated in Table III., for $Q=3q_0$=an integer, and shows the interesting result that the third harmonic in a three-phase polygon-loaded winding is zero.

The high values of f_{2Q+1}, when Q=an integer occur in Tables II. and III., as in Table I., thus showing that spacing and tooth ripples may be pronounced in all these windings. If the coil-span be shortened by one slot-pitch, as proposed by Prof. Miles Walker for rotary converter armatures, the figures given in these two tables must be multiplied by

$$f_{\epsilon,n}=\cos n\frac{\gamma}{2}=\cos\frac{n\pi}{2Q},$$

since in this case $\epsilon=\gamma$.

These pronounced ripples may give rise to troubles in commutating machines like rotary converters. They can be nullified by making $2Q$ odd, when there are three slip-rings, for then the coil-span factor is zero, as just shown. When there are four or six slip-rings it is not permissible to suppress the ripples by making a fractional number of slots per pole, since this makes the phases of the lap winding unsymmetrical. Their magnitude, however, can be reduced by increasing the

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* Smith and Boulding, *ibid.*, p. 232.

Table III.—*Distribution Factors, $f_{m,n}$, for Lap-winding with Three-phase Polygon Tappings.* ($Q=3q_0$.)

$q_0=Q/3$.	2	3	4	5	6	7	8	9	10	Winding uniformly distributed.
Q=slots pole.	6	9	12	15	18	21	24	27	30	
f_1	**0·835**	**0·830**	**0·829**	**0·828**	**0·828**	**0·828**	**0·827**	**0·826**	**0·826**	**0·826**
f_3	0	0	0	0	0...	0	0	0	0	0
f_5	−0·224	−0·188	−0·177	−0·173	−0·171	−0·169	−0·168	−0·168	−0·167	−0·165
f_7	0·224	0·153	0·137	0·129	0·126	0·124	0·122	0·121	0·121	0·117
f_9	0	0	0	0	0	0	0	0	0	0
f_{11}	−**0·835**	−0·153	−0·109	−0·095	−0·088	−0·084	−0·082	−0·080	−0·079	−0·075
f_{13}	−**0·835**	0·188	0·109	0·088	0·079	0·075	0·072	0·070	0·068	0·063
f_{15}	0	0	0	0	0	0	0	0	0	0
f_{17}	0·224	−**0·830**	−0·137	−0·088	−0·073	−0·065	−0·060	−0·057	−0·055	−0·408
f_{19}	−0·224	−**0·830**	0·177	0·095	0·073	0·065	0·057	0·054	0·052	0·043
f_{21}	0	0	0	0	0	0	0	0	0	0
f_{23}	**0·835**	0·188	−**0·829**	−0·129	−0·079	−0·062	−0·054	0·049	0·047	−0·035
f_{25}	**0·835**	−0·153	−**0·829**	0·173	0·088	0·065	0·054	0·048	0·045	0·033
f_{27}	0	0	0	0	0	0	0	0	0	0
f_{29}	−0·224	0·153	0·177	−**0·828**	−0·126	−0·075	0·057	−0·048	−0·043	−0·029
f_{31}	0·224	−0·188	−0·137	**0·828**	0·171	0·084	0·060	0·049	0·043	0·026
f_{33}	0	0	0	0	0	0	0	0	0	0
f_{35}	−**0·835**	**0·830**	0·109	0·173	**0·828**	−0·124	−0·072	−0·054	−0·045	−0·023
f_{37}	−**0·835**	**0 830**	−0·109	−0·129	−**0·828**	0·169	0·082	0·057	0·047	0·022
f_{39}	0	0	0	0	0	0	0	0	0	0
f_{41}	0·224	−0·188	0·137	0·095	0·171	−**0·828**	−0·122	−0·070	−0·052	−0·020
f_{43}	0·224	0·153	0·177	−0·088	−0·126	−**0·828**	0·168	0·080	0·055	0·019
f_{45}	0	0	0	0	0	0	0	0	0	0
f_{47}	**0·835**	−0·153	**0·829**	0·088	0·088	0·169	−**0·827**	−0·121	−0·068	−0·017
f_{49}	**0·835**	0·188	**0·829**	−0·095	−0·079	−0·124	−**0·827**	0·168	0·079	0·016
f_{51}	0	0	0	0	0	0	0	0	0	0
f_{53}	0·224	−**0·830**	−0·177	0·129	0·073	0·084	0·168	−**0·826**	−0·121	−0·015
f_{55}	0·224	**0·830**	0·137	−0·173	−0·073	−0·075	−0·122	**0·826**	0·167	0·015
f_{57}	0	0	0	0	0	0	0	0	0	0
f_{59}	−**0·835**	0·188	−0·109	**0·828**	0·079	0·065	0·082	0·168	−**0·826**	−0·014
f_{61}	−**0·835**	0·153	0·109	**0·828**	−0·088	0·062	−0·072	0·121	**0·826**	0·014
f_{63}	0	0	0	0	0	0	0	0	0	0
f_{65}	0·224	0·153	−0·137	−0·173	0·126	0·062	0·060	0·080	0·167	−0·013

value of Q, and they can be entirely suppressed by skewing the slots or pole-shoes, although this construction may be difficult in large machines. Another possible way of suppressing the tooth effects is to displace the poles, so that alternate polar gaps (*i.e.*, gaps between poles) differ by a slot-pitch, which causes the E.M.F.s induced in the two sides of a coil to differ by half a slot-pitch.

(*b*) *Wave Windings.*—In addition to their usage when tapped for phases, wave windings are often employed opened * in order to obtain the narrow phase-spread and a fractional value for Q. If $q=Q/N$ is an integer it is easy to see that we shall obtain the same expression for the distribution factor in this case as we got for a single-layer winding. If, however, q is not an integer, the winding factors for the harmonics will approach in value those of a uniformly distributed winding, as we shall presently show.

(*i.*) *Diametral Loading. Common-wave Winding* ($a=1$).—In the following we shall confine our attention to the case of the common wave winding, in which S is always even with four or six phase polygon loading, *i.e.*, two or three-phase diametral loading. Substituting $N=2$ and $a=1$ in equation (20) $f_{m,n}$ for the diametral pressure becomes:

$$f_{m,n}=\frac{\sin n\frac{\pi}{2}}{\frac{S}{2}\sin n\frac{\pi}{S}}=\frac{-(-1)^{\left(\frac{n}{2}+\frac{1}{2}\right)}}{\frac{S}{2}\sin n\frac{\pi}{S}}.$$

Now, since S is always even, and n is odd, n will never be equal to or a multiple of $\frac{1}{2}S$, and hence, $\sin n\pi/S$ is never zero. If we expand the function in a series it is easy to show that when S is a large number (as is usual), and n is not of the same order of magnitude as S, $f_{m,n}$ is small and nearly equal to the values obtaining for a uniformly distributed winding. Thus, expanding $f_{m,n}$ we have

$$f_{m,n}=\frac{2(-1)^{\left(\frac{n}{2}-\frac{1}{2}\right)}}{S}\left[\frac{S}{n\pi}+\frac{n\pi}{6S}+\frac{7n^3\pi^3}{360S^3}+\frac{31n^5\pi^5}{15{,}120S^5}+\dots\right].$$

Now, if $f_{m,n,u}$ be the value of $f_{m,n}$ in a uniformly distributed winding,

$$f_{m,n,u}=\frac{\sin n\frac{\pi}{2}}{n\frac{\pi}{2}}=\frac{-2(-1)^{\left(\frac{n}{2}+\frac{1}{2}\right)}}{n\pi}.$$

Hence, we can write

$$f_{m,n}=f_{m,n,u}-2(-1)^{\left(\frac{n}{2}+\frac{1}{2}\right)}\left[\frac{n\pi}{6S^2}+\frac{7n^3\pi^3}{360S^4}+\frac{31n^5\pi^5}{15{,}120S^6}+\dots\dots\right]$$

Since the series and $f_{m,n,u}$ change sign together for various values of n, $f_{m,n}$ is in general always $>f_{m,n,u}$, and is nearly equal to it when the sum of the series is small, as is the case when S and n are not of the same order of magnitude. Hence, for practical values, $f_{m,n}$ is not very different from the values for a uniformly distributed winding.

(*ii.*) *Three-phase Polygon Loading, Common-wave Winding* ($a=1$).—In this case we have $N=3$ and $a=1$, $S/3$ being an integer. Hence equation (20) becomes

$$f_{m,n}=\frac{\sin n\frac{\pi}{3}}{\frac{S}{3}\sin n\frac{\pi}{S}}.$$

This is zero when n is a multiple of 3 and not a multiple of S. When n is a multiple of S, $f_{m,n}=\pm 1$, since S is a multiple of 3. Thus, circulating currents of order S can flow in a wave winding arranged for three-phase polygon loading, provided S be odd. For the remaining harmonics we can expand the expression in a series as before

$$f_{m,n}=\frac{3\sin n\frac{\pi}{3}}{S}\left[\frac{S}{n\pi}+\frac{n\pi}{6S}+\frac{7n^3\pi^3}{360S^3}+\frac{31n^5\pi^5}{15{,}120S^5}+\dots\dots\right]$$

$$=\frac{\sin n\frac{\pi}{3}}{n\frac{\pi}{3}}+3\sin n\frac{\pi}{3}\left[\frac{n\pi}{6S^2}+\frac{7n^3\pi^3}{360S^4}+\frac{31n^5\pi^5}{15{,}120S^6}+\dots\dots\right].$$

$$=f_{m,n,u}+3\sin n\frac{\pi}{3}\left[\frac{n\pi}{6S^2}+\frac{7n^3\pi^3}{360S^4}+\frac{31n^5\pi^5}{15{,}120S^6}+\dots\dots\right].$$

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[*] Smith and Boulding, *ibid.* Part II., p. 237.

Hence, except when n is a multiple of 3, $f_{m,n}$ is $>f_{m,n,u}$, and will be nearly equal to it under the same conditions as in (*i.*), so that in practical cases $f_{m,n}$ is nearly equal to the values for a uniformly distributed winding.

In the case of a uniformly distributed double-layer winding the phase-spread can be $\sigma=\pi/N$ or $2\pi/N$ or π, according to the mode of tapping the phases off the winding, so that in this case $f_{m,n}$ becomes

$$f_{m,n}=\frac{\text{chord}}{\text{a.c}}=\frac{\sin n\frac{\sigma}{2}}{n\frac{\sigma}{2}}$$

$$=\frac{\sin\frac{n\pi}{2}}{\frac{n\pi}{2N}}\text{ or }\frac{\sin\frac{n\pi}{2N}}{\frac{n\pi}{N}}\text{ or }\frac{\sin\frac{n\pi}{N}}{\frac{n\pi}{2}}.$$

These are tabulated for $N=3$ in the last columns of Tables I., II. and III. respectively for the purpose of comparison with the other figures in those tables.

Conclusion.

In the first part of this Paper we have discussed the general properties of harmonics in a polyphase system of pressures, whilst in the second part we have determined the effect thereon of the armature winding from which the polyphase system is derived. The purity, or otherwise, of the shape of the pressure wave of an alternator depends on (*i.*) the harmonics present in the flux-density distribution of the machine, and (*ii.*) on the "winding factor," a function of the arrangement of the winding on the armature periphery. The shape of the flux-density curve and the character of the polyphase system required from the winding being known, the tables in Part II. give at once the relative magnitudes of the pressure harmonics present in the E.M.F. wave of the phases, the actual behaviour of these harmonics in the system then following from the theory discussed in Part I., whether the phases of the winding be independent or interlinked.

Concluding, the author wishes to thank Dr. S. P. Smith for his great interest in the work, and to acknowledge that it was at his instigation that the material forming the Paper was gathered together and published. This opportunity might also be taken to mention the kind appreciation of this work shown by Prof. Miles Walker and Mr. C. C. Hawkins whilst it was in preparation for the press.

The work was carried out at the City and Guilds (Engineering) College in the electrical department, under the direction of Prof. T. Mather, F.R.S.

The Electric Drive in Steelworks. According to the "Electric Journal," practically all steelworks in the United States have been fully employed for many months. An indication of the enormous tonnage produced is given by the record of approximately 65,000,000 tons of ore shipped on the Great Lakes, which is 50 per cent. greater than the record for 1915. The steam drive in steel works is becoming the exception rather than the rule; over three-fourths of the works which contracted for equipment during 1916 were for electric drive. On main roll drive there was an increase last year of approximately 200,000 H.P. in the United States, and this involves corresponding increases for auxiliary motor drives of various kinds. One of the large installations was that at the Gary works of the Illinois Steel Co. of a 7,000 H.P. 25 cycle motor for driving a 160 in. plate mill. Electric motors are also rapidly coming into use for reversing mills, a number of equipments having been ordered for maximum ratings of 15,000 H.P. to 18,000 H.P. Practically all new mills are being designed for electrical operation and old mills are being changed over as opportunity offers. The use of central station power is becoming much more common in steel works than heretofore.

VOLTAGE REGULATION OF ROTARY CONVERTERS.

The following is an account of the discussion which took place before the Scottish Section of the Institution of Electrical Engineers on the above subject. An abstract of the Paper appeared in The Electrician of March 9 and 16.

Mr. W. J. Belsey (Glasgow) said he would have liked the author to go more into detail with regard to other methods of obtaining regulation. He suggested that there were such things as split poles.

Mr. Bunting (Edinburgh) remarked that the paper reminded them in a very frank way of the many things which had to be guarded against in the design of rotary converters. The designers would probably want further information on certain points.

Mr. Roer (Edinburgh) thought that in designing these machines they should keep within as small limits as was compatible with the requirements of the service. They had frequently found that machines of a large range could never run to their highest limits, with the result that the customer had to pay for a larger machine, one that was more expensive and not so efficient as if the range had been confined to smaller possible limits. He asked if the author had any difficulty in getting his transformers with big reactance, as some manufacturers of transformers supplied machines with as much as 25 per cent. reactance. In the motor converter, due to the higher reactance which that machine had, at low loads, the wattless current taken at these low loads was considerably smaller than was the case with the corresponding type of rotary converter.

Mr. Page (Glasgow) said he was associated with an undertaking in which there were 97 rotaries carrying 53,000 kw., but only half a dozen of these were motor converters. They had, however, 34 motor generators carrying 24,000 kw. and one motor converter of 1,000 kw. Their specifications for the last two years had hardly varied at all. After hearing Mr. Juhlin's paper they would reconsider the position carefully. They got enough regulation from their reactance-controlled machines although they only asked for 4 per cent. either way. With a fair number of sub-stations dotted over the area he believed 2½ per cent. would meet the average case. With regard to the matter of inter-poles, they were at present exprimenting with a double set of brushes. The one set led through the synchroniser to the lines and the other set led through the inter-pole line, the junction being effected on the line side of the inter-pole windings. They had persevered with high output machines which gave them very satisfactory results. He asked if Mr. Juhlin could explain the excessively high open circuit low-tension voltage sometimes got with a transformer specially built for rotary converter work. This amounted to 600 volts instead of the 370 to 400 volts which one would expect.

Mr. Seddon (Edinburgh) said most engineers were agreed that the synchronous motor was the ideal machine. The simple rotary converter had poor regulation, but its efficiency was high. The motor converter seemed to meet the case. The strong point of the rotary converter was its high efficiency and on this account it would continue to hold its own.

Mr. Whysall (Greenock) had carried out a recent extension on the lines suggested in the Paper. He thought the reactance type of rotary was the most suitable provided the conditions were such that the voltage regualtion came within the range of 15 per cent. The inherent good voltage characteristics of converters are at times rather embarrassing, especially when feeding into a heavy frame or endeavouring to parallel with a direct-current network at nearly full voltage after a shut down. In this connection it had occurred to him that with lower voltage and frequency occurring simultaneously, trouble might be caused due to resonance being set up in the circuit. He asked for some information on this point.

Mr. Hinings (Glasgow) said that one disadvantage of the reactance-controlled rotaries not mentioned by the author was the question as to where the shunt field rheostat should be fixed. If it was fixed adjacent to the alternating-current control panel of the machine for ease of synchronising it was in the wrong place for direct-current regulation, as usually the alternating-current and direct-current control were some distance apart. When two rheostats were fitted, one for the alternating-current and one for the direct-current panel, the length of the field connections of the two rheostats was a possible source of trouble.

Mr. W. B. Hird (Glasgow), in the course of a communication, said he regretted that the author had not made mention of other methods of control than those mentioned in the Paper. Where different ranges of voltage were required the use of two tappings had great and immediate advantages. In certain cases the direct-current booster gave an ideal method of regulation. Another method was the use of a reactance in the line so arranged that the amount of reactance could be varied at will. This would probably be the ideal method in cases where too large a range of the regulation was not required.

Mr. Juhlin in reply emphasised the need for closer co-operation between manufacturer and purchaser. Such co-operation would tend to both cheapen and improve machines. He had limited the scope of the Paper to two machines, partly to keep the Paper within the prescribed limits as regards length, and partly because machines other than the two types mentioned were not much used in this country. He did not agree that the motor converter had all the qualities of the motor generator.

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SPECIAL NOTICE.

The present number of "THE ELECTRICIAN" completes Vol. LXXVIII. The Index to the Volume will be issued (Gratis) on April 13th.

THE HERESY OF THE SMALL STATION.

LAST week an interesting Paper was read by Mr. E. M. LACEY before the Institution of Civil Engineers on "The New Electric Power House at Birchills, Walsall." This power station was described briefly in THE ELECTRICIAN a few months ago, and our readers may remember that when it is fully equipped it is to include three generating sets, each of 4,000 kw. It is a small well-arranged station, built on modern lines. But the point that is most remarkable about this station is its low capital cost; this works out at £6·6 per kilowatt installed. Engineers will admit that this is a remarkable figure, more particularly for a comparatively small station. In the case of large stations low figures of capital cost are to be expected, but even in such cases the cost so far obtained has been considerably higher than the figure just mentioned. For example, Mr. PEARCE estimated the cost of the large new power station for Manchester at £11 per kilowatt. Dr. KLINGENBERG gives the figure of £7 to £7·5 per kilowatt for very large power stations, and the estimated cost has, we believe, been brought down to somewhere in the neighbourhood of £7·5 per kilowatt in this country. Thus a figure of £6·6 per kilowatt for a much smaller station is an achievement that arouses some doubt, and sets one wondering where exactly the saving has been made. One item which undoubtedly leads to such a saving is the use of the combined boiler unit, consisting of a Babcock & Wilcox boiler with superheater, and its own economiser mounted on top, each such unit having its own small chimney shaft with induced draught. This arrangement not only leads to a saving in this part of the equipment, but it also means a considerable narrowing down of the width of the boiler house, with corresponding less cost. There is also a shortening of steam pipes. Further, there is no duplicate coal conveyer, which seems a doubtful economy where the bunker capacity is small, and one not leading to any great saving. The only other item making for cheapness in the present instance is the Reyrolle switchgear, which avoids the necessity of special buildings and the extensive work that becomes a necessity in the case of cellular construction. Lastly, there seems to have been no large expenditure on the site. Whether these items account for the whole of the cheapness we are not clear, but in any case Mr. LACEY is to be congratulated upon the result he has obtained.

Leaving on one side these engineering details, we notice that Mr. LACEY adheres to what we would describe as the heresy of the small station. In other words, he has obtained such good results with the Birchills station that he proceeds to [illegible] the value of the really large generating station. His views are set out in the following quotation:

> [illegible] tendency that a power station of 12,000 kw. to 16,000 kw. [illegible] can be so designed as to produce [illegible] that economy in production due to further [illegible] has frequently been assumed. [illegible] production will decrease to [illegible] the plant [illegible] from [illegible] kw. [illegible] which necessitate the trans[illegible] in order to secure a larger [illegible] would not be sufficient [illegible] transmission system.

At a time when most of us are striving for the centralisation of electricity supply it is disappointing to read a statement of this kind. Mr. LACEY has undoubtedly obtained excellent results, both in capital costs and in running charges, but in doing so he has the advantage of experience gained with larger plants, directly or indirectly. The turbo-generator has become progressively more economical and cheaper as the experience with this size of plant and larger plants has increased. Nevertheless, the labour required for large sets, such as 25,000 kw., is necessarily less for a given output of electrical energy than with smaller sets, and the capital cost similarly is lower per kilowatt. In fact, all the charges must come down to some extent. It may be said that whatever result is achieved by the small station, the large station must in the very nature of things be capable of doing something better. But what is far more important than the charges on account of labour, capital and efficiency is the fact that the load factor of a large station supplying a considerable area can be very much higher than that of a small station, owing to the much greater diversity factor. A load factor of 30 per cent., which is high for a small station, may easily be converted into 60 per cent. in a large station. We recently called attention to some of the load factors obtained in the United States. For example, the Pacific Gas & Electric Co. has a load factor of 60·6 per cent., the Commonwealth Edison Co. of Chicago has a load factor of 43·6 per cent., and there are several companies, presumably having electrochemical works among their consumers, having load factors considerably over 60 per cent. This at once makes an enormous difference in the cost of giving a supply, not merely on account of increased efficiency and reduced labour, but also owing to the fact that the capital expended is used to far greater advantage. If the load factor is raised from 30 to 60 per cent., it is evident that the efficiency of use of capital has been doubled. This in itself is of the greatest possible importance to the electric supply industry.

Further, in due course, the small station must strive to become a large station, but in doing so it may very well be found that the locality which was suitable for a small station is by no means suitable for one that is very much larger. A canal, for instance, may be excellent for the supplying of condensing water to a small station, but for a really large station such a supply would be totally inadequate. Moreover, in passing from the stage of being a small station to being a large one, all the difficulties involved in the discarding of plant that has become too small must be faced. Reserves for depreciation will be found to be much smaller than they should be, and the cost of generation throughout the history of the concern becomes higher than was anticipated. It is useless to take a life of 25 years for plant at the present day in any rapidly developing district.

The advantages to be gained in economising our coal, which is one of our national assets, has been emphasised many times by those associated with the development of large schemes. We gave quite recently the figures estimated by Mr. INSULL on the saving to be effected by centralisation in the United States. In another column we give briefly the views expressed by Dr. KLINGENBERG. Further, if anything is to be done in the carbonisation of coal before it is used for power purposes, this will only become practicable with large power plants. In conclusion, it may be said that the case of the large generating station has been amply proved, and we trust that the engineers of this country will not be so ill advised as to advocate the claims of the small generating station, and thus to put back the hands of the clock in regard to electricity supply in this country.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Large Electric Power Stations: Their Design and Construction.

By Dr. G. KLINGENBERG. (London: Crosby Lockwood & Son.) Pp. xvi.+260. 25s. net.

The name of Dr. Klingenberg is so well known in connection with electric power stations that anything written by him will be read with interest in this country. It will be remembered that shortly before the war Dr. Klingenberg read a Paper before the Institution of Electrical Engineers dealing broadly with the question of electric power supply in London, and in all probability the present work, which is a translation from the German, was in hand at that time. Owing to the war it has been impossible to submit proofs to the author, but they have been carefully revised by an English engineer, and in view of the importance of the subject it has been decided not to delay publication further.

It may be said that the book consists partly of a consideration of the subject and partly of descriptions of stations of which the author was responsible for the design. The stations that are described are the Märkische, and the Brakpan, Simmer Pan, Rosherville, Robinson and Vereenigen stations in South Africa. These descriptions occupy over one-half of the volume. The remainder, which is the part that will be read with most interest, is often somewhat sketchy in character, consisting largely of general observations. Nevertheless such observations show the trend of power station design, and in what follows we shall indicate briefly the author's views.

In the introduction the author touches upon the essential difference between municipal and private enterprise, and points out the limitations imposed upon the former by municipal boundaries. These must disappear if the highest development is to be obtained, and State support will be necessary for this purpose. The author takes the view that the main object of a municipality as regards electricity supply (*i.e.*, an available source at a cheap rate) can be safeguarded equally well by joint ownership, or by entire transfer of legal rights. Emphasis is laid upon the importance of large power stations, and it is calculated that in Germany a saving of more than £2,500,000 per annum could be effected if electrical energy were generated in the most efficient manner. This is a large figure, but the author rightly remarks that it is small in comparison with what it will be when an appreciable industrial supply sets in. An indication is given of the direction in which legislation should move in order to develop electricity supply along right lines. In his brief outline it is interesting to note the author's specific statement that operations of undertakings by the State is not desirable. The State does not possess the necessary organisation, and should, therefore avail itself of experience gained elsewhere. It is, however, suggested that the State should participate. With this exception, the scheme is not unlike what we are considering in various parts of the country at the present time for rendering our methods of electricity supply more efficient, though our tendency is to develop some of our existing large stations rather than erect new ones. At the end of this introduction a number of items are briefly set forth showing the lines along which engineering development should take place.

Chapter I. is concerned with the principles underlying the construction of large electric power stations. After some definitions, graphical methods are given for the determination of power costs, and it is shown that, for the most economical results, the three factors capital expenditure, constant working losses, and operating costs—must be reduced to a minimum (presumably their sum). This consideration may lead to the employment of very economical plant for dealing with the constant part of the load, and uneconomical plant for dealing with the peak. A warning is given against equipping stations with small units of plant to deal with light loads, on the assumption that economy may be secured by so doing. Similarly, the author is averse to generators capable of giving electrical energy in two forms, such as three phase and continuous current. It is preferable to transform in such cases. With regard to auxiliary machinery, the view is taken that it should not be centralised.

Attention is drawn to the waste which so frequently occurs in boiler houses owing to vague ideas, and the important question is discussed of reducing the length of the boiler and increasing the size of the economiser, so as to obtain the best combined result. Such considerations lead up to the design of a unit which is now finding increasing favour, this unit including boiler, economiser and chimney complete. The importance of losses by radiation in steam pipes is emphasised by the statement that 2 per cent. constant loss on a 20 per cent. load factor means 10 per cent. loss of the total coal.

In dealing with oil switches attention is called to the well-known difficulties, but no useful information is given as to how these difficulties are to be overcome. At the end of this chapter some reference is made to architecture, and it is stated that many power station buildings resemble theatres more than anything else. Evidently the German architect is allowed to be more prodigal in this respect than he is in Great Britain.

Chapter II. gives a comparison of the costs of electrical transmission as compared with the cost of coal transport to the neighbourhood where the load is to be supplied, and very interesting curves are given showing that long distance transmission will, as a rule, be more economical than the transport of coal when one has to deal with large outputs and more than 2,500 hours of full use. For shorter distances the superiority of electrical transmission only becomes apparent at a very high load factor. In a particular case of 125 miles transmission with 2,500 hours of full use the conclusion is reached that if the freight of coal delivered at the station is less than 6s. per ton it is cheaper to transport the coal than to transmit the energy.

Chapter III. deals with economy and generating costs. In this connection it is interesting to note some of the data the author adopts. The cost of very large stations with units of 15,000 kw. to 20,000 kw. is taken as £7 to £7. 10s. per kilowatt. The efficiency of a boiler unit at full load, including energy for boiler auxiliaries, is taken as 78 per cent. at such a station. The steam consumption per kilowatt hour of a large generating set at full load, including energy for excitation and condensing plant, is taken as 12·75 lb., giving a thermal efficiency of 21·5 per cent. The total working costs, including coal, supplies, staff, repairs, interest and renewals (the two last combined being put at 12 per cent. on capital) works out at 0·1527d. per kw. hr. at full load. The consumption of thermal units per kilowatt hour is put at 20,500 B.Th.U.; or, with coal of 13,500 B.Th.U., a consumption of 1·518 lb. per kilowatt-hour, but it must be noted that the coal so taken is dry, not as fired. The average annual running cost per effective kilowatt-hour works out at 0·215d. for a utility factor of 0·4, the generating sets being each of 20,000 kw. Tables are given showing the thermal balance, thermal consumption and running costs, and are of interest and value in illustrating the methods adopted.

Chapter V. discusses the calculation of costs and tariffs, and draws attention to the necessity of taking load factor and other conditions into account if true results are to be obtained.

The descriptions of power stations are well illustrated by folding plates, drawings of certain details and photographic reproductions. This part of the volume is not merely descriptive, but includes some information on the problems involved and the results obtained. For example, in the case of the Märkische station (which is only a small station) curves are given showing the variation of coal consumption with output, from observations: also steam consumption, daily costs and economic characteristics. There seems to be a mistake in the last-named diagram, as the thermal consumption per kilowatt-hour at a utility factor of 0·5 appears to be about 10,000 B.Th.U. (an unattained, if not unattainable, figure), whereas the steam consumption is about 16·7 lbs. and the coal consumption is over 2 lbs.

The book is one which English engineers engaged in electricity supply on a large scale should peruse. It is well printed and well got up, but a price of 25s. seems distinctly on the high side.

THE NEW ELECTRIC POWER STATION AT BIRCHILLS, WALSALL.*

BY E. M. LACEY.

The early history of the electricity undertaking of the Walsall Corporation and the original system of generation and transmission are briefly described; also the steps taken by the Corporation since the year 1913 to provide for an efficient supply of electricity in the Walsall area. The conditions determining the size and site of the new power station are stated, and the question of possible land subsidence owing to old colliery workings is dealt with.

Reference is made to the controversies regarding the economy which arises in the production and distribution of electricity by the concentration of plant in power stations of large capacity, and the author expresses his views as to the ultimate limit beyond which no appreciable advantages would accrue by reason of such concentration.

It is claimed that the Walsall power station is by far the lowest in cost per kilowatt of any yet erected in this country, due to special features in the design and type of plant installed, these special features consisting more particularly in the arrangement of the coal-handling and boiler-house plant. The general arrangement of the coal-handling plant is fully described, the main object in the design being to obtain adequate coal storage and at the same time to save the heavy expenditure on constructional work necessary to provide for overhead coal-storage bunkers of large capacity. The boiler house is designed for six self-contained units, each unit consisting of a water-tube boiler with integral superheater, a superimposed economiser, ejector induced draught plant, a steel "Venturi" type chimney and a mechanical chain-grate stoker. Each unit is designed for a high duty evaporation of 30,000 lb. of steam per hour from water entering the economiser at a temperature of 100°F. In an appendix particulars are given of the normal and high-duty tests of a boiler unit of the type adopted, the results showing an overall efficiency of over 88 per cent., based on the net calorific value of the coal.

It is claimed that the Walsall power station is one of the first examples erected in this country for the accommodation of the special type of boiler unit described, and reference is made to the more important features and advantages of the design. A high concentration of steam-raising plant in modern power houses is advocated, and the important bearing which it has upon the general and structural design of modern power houses and its advantages are fully dealt with, as is also the design of boiler necessary to obtain such high concentration.

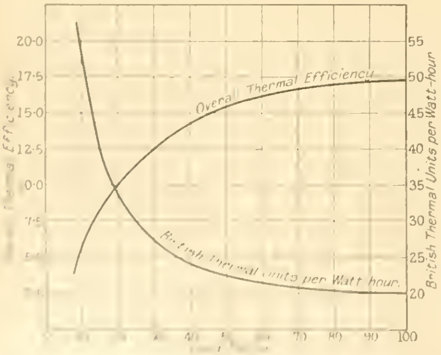

Fig. 1.—Curves showing Effect of the Load-factor on the Overall Thermal Efficiency.

The engine house is arranged to accommodate three 4,000 kw. [illegible], of which two have been erected. The turbines are of the [illegible] impulse type, and work with steam at a pressure of [illegible] lb. per square inch and a temperature [illegible] at the stop valve, the normal speed [illegible] 3,000 revs. per minute. The construction of the turbines is [illegible] and [illegible] to special features, more particularly to the [illegible] for the control of the [illegible] pumps, which, although the rule for [illegible] [illegible]. The alternators are of the [illegible] type, and generate three-phase alternating current at a pressure of 6,600 volts between phases, with a frequency of 50 cycles per minute, the full-load output of each alternator being 5,000 kv.-amperes.

The actual cost of the works under the various contracts is set forth, the figures showing that the cost of a 12,000 kw. station of the design described, at 1914 prices, is approximately £5. 3s. per kilovolt-ampere of plant installed, or £6. 12s. per kilowatt (cos φ=0·8). It is claimed that the economy of the Walsall design represents not less than 30 to 40 per cent., and that not only has this economy been obtained without any sacrifice of efficiency for the sake of cheapness, but this type of station is, in fact, far more economical in operation than stations of more usual design.

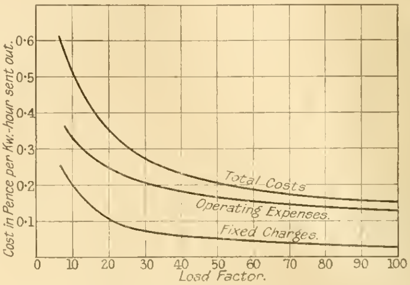

Fig. 2.—Curves showing Effect of Load-factor upon Total Costs of Production.

Fig. 1 shows the thermal efficiency of the station, and Fig. 2 shows estimated running costs. The latter are given in detail in the adjoining table:—

Table.—*Estimate showing the Annual Cost and Cost per Kilowatt-hour on a Station Load Factor of 30 per cent.*

Capital expenditure	£79,237
Life of plant	25 years.
Capacity of plant	12,000 kw.
Maximum load	8,000 kw.
Load factor	30 per cent.
Kilowatt-hours per annum	21,024,000

	Cost per annum.	Cost per Kw.-hr.
Operating expenses:—		
Fuel, 22,800 tons at 12s.	£13,680	0·156d.
Oil, water, waste, &c.	260	0·003d.
Wages	1,560	0·018d.
Repairs and maintenance	2,100	0·024d.
Management	700	0·008d.
Rent, rates and taxes	1,314	0·015d.
	£19,614	0·224d.
Fixed charges:—		
Interest and sinking fund on 5 per cent. tables, £79,237 × 0·07095	£5,622	0·064d.
Insurance	174	0·002d.
Total cost per annum and per unit	£25,410	0·290d.

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* Abstract of a Paper read before the Institution of Civil Engineers.

POSTMASTER-GENERAL'S REPORT.

The annual report of the Postmaster-General for the year ended March 31, 1916, has been issued.

General.

It is stated 68,000 Post Office servants had joined the Colours by Nov. 1, 1916. The whole of the personnel of the Army Post Office has been supplied by the Post Office and a large contribution has been made to the staff of the signal companies (R.E.), to the Naval Signal Units, &c.

The increased telegraph rates produced nearly £200,000 for the period from Nov. 1, 1915, to March 31, 1916, against an estimate of £170,000, but owing to the paper restrictions, &c., the introduction of the new rates for Press telegrams has been postponed until January 1, 1918.

Up to the end of March individual notice of the increased telephone rental had been given to 66 per cent. of the existing flat rate subscribers, and in only 2 per cent. of the cases dealt with was the service given up. 89 per cent. of the subscribers whose replies had been received agreed to continue at the increased rental and 9 per cent. decided to transfer to the measured service. It was calculated that the increase in the trunk call charges would produce £290,000 in a full year and £120,000 in the six remaining months of 1915-16. The actual yield amounted to only £80,000, owing to the reduction in trunk traffic being unexpectedly large. It is difficult at present to gauge the extent to which the fall is due to the increased tariff as distinct from other causes, *e.g.*, the reaction of the war on business, and it may be that trunk traffic will recover when these causes cease to operate. The increase in the charges for calls from Public Call Offices by 1d. was estimated to produce £140,000 per annum. The increased receipts for 1915-16 were estimated at £60,000, but only £10,000 was realised. Advantage was taken of the increase in the flat rates to determine all contracts at obsolete measured and message rates. This will not result in a large increase in revenue, but it will simplify and unify the system of accounting, and will thereby effect considerable economy in clerical work.

Telegraphs and Telephones.

On March 31, 1916, the total mileage of Post Office wires (including spare wires) was 3,264,822 miles, an increase during the year of 192,955 miles or 6·3 per cent. The total mileage is allocated as follows:—Telegraphs 264,480 miles of single wire, telephones 2,843,254 miles, spare 157,088 miles. Of the above 1,022,036 miles of single wire are aerial, 2,229,055 miles are underground and 13,731 miles submarine. The storm at the end of March, 1916, was the worst in the history of the telegraph and telephone services. Gales were preceded and accompanied by heavy falls of snow and freezing rain, which, besides blocking up the roads to a depth of several feet, formed tubes of ice and snow, several inches in diameter, on the wires, thus greatly increasing the surface area upon which wind pressure was exerted. The wind was north-east and the path of greatest violence was along a belt of country bounded on the north by a line from the Humber to Pembroke and on the south by a line from the Wash to the Bristol Channel. Every telegraph and telephone line crossing this belt in a northern and southern direction was blown over and many of the poles and fittings were smashed. In this area 2,150 poles were broken, 6,050 were uprooted, and 33,300 blown over. This involved the re-erection of 41,500 poles, equivalent to 14,000 miles of main pole line, and about 1,500 tons, or more than 17,000 miles, of copper wire were broken into small lengths which had to be collected for re-manufacture. The repair of this damage would have taxed the resources of the Department to the utmost even if the normal engineering staff had been available, but at present about half the staff is serving with the Colours and, in spite of the valuable assistance rendered by the military authorities, the work of repair was unavoidably protracted over many months. Railway telegraph lines also suffered severely and wire and other stores for repair purposes were supplied by the Post Office to some of the railway companies.

War Measures and the Telegraph Service.—The war has continued to make great demands upon the telegraph service. A large number of special circuits have been provided for the War Office, Admiralty and other Government Departments and there has been a constant call for skilled telegraphists for the Army and Navy. The number of telegrams sent on behalf of Government Departments has almost doubled during 1915-16 and special measures have been necessary to cope with this traffic. A few offices have been closed, the attendance for telegraph business at most offices has been curtailed and other measures taken. The number of telegraph offices open on March 31, 1916, was 14,156 (including offices at railway stations, &c.), against 14,222 last year, a decrease of 65. The following table shows the number of telegrams of each class which passed over the Post Office wires during the year, and the corresponding figures for the previous year:—

Class of Telegram.	1914-15.	1915-16.	Increase (+) or Decrease (–).
Ordinary	72,199,000	64,685,000	–7,514,000
Press	4,443,000	3,695,000	– 748,000
Foreign	9,421,000	7,503,000	–1,918,000
Railway and Canal Free ...	1,378,000	1,129,000	– 249,000
Railway Reduced Rate	20,000	17,000	– 3,000
Government Free	3,718,000	7,128,000	+3,410,000
Total	91,179,000	84,157,000	– 7,022,000

Effect of War and of New Tariff.—There has been a large decrease in the number of paid telegrams sent during the year, but the revenue shows a substantial increase chiefly owing to the higher rate of charge. The decrease in the ordinary inland telegraph traffic was 10·4 per cent., but Government telegrams numbered almost twice as many as last year's return. The average length of a Government telegram is almost twice that of an ordinary inland telegram and therefore the traffic passing over the telegraph lines during the year was not substantially less than formerly. The fall in ordinary inland telegrams is no doubt in part due to the increased charge, but other factors, such as the restriction of commercial and social activities, contributed to the falling off. Similar causes resulted in a decrease in the number of Press telegrams of about 17 per cent. compared with last year, and of about 12 per cent. compared with 1913-14. There has been increasing difficulty in providing for the prompt treatment of telegrams by reason of the withdrawal of telegraphists for military service. Additional operators have been trained, telephone transmission has been resorted to where telephone circuits were not being used to their full capacity, and the use of high-speed apparatus has been extended. Referring to the work of the Committee appointed in January, 1914, to consider the various systems of high-speed telegraphy (whose report was recently abstracted in The Electrician), it is stated that the necessity for limiting capital expenditure and the general employment of manufacturers on munition work have caused considerable difficulty in the development of the use of machine telegraphs. A set of Murray multiplex apparatus was ordered early in 1915, but is not yet available for trial. The Murray system is so arranged as to allow eight separate messages to be signalled over one wire by means of transmitters fitted with type keyboards, which can easily be worked by ordinary typists after a short period of training. The messages are received in printed form. The number of Creed re-perforators and printers used on Wheatstone automatic circuits has been considerably increased. By means of this apparatus, telegrams transmitted at a very high rate of speed are received in the form of perforated slips, which can be used either in connection with a mechanical printing apparatus to prepare the telegrams for delivery or for further automatic transmission of the telegrams over Wheatstone circuits. Additional use has also been made of the Baudot multiplex system, by means of which as many as 8, 10, or even 12 messages may be telegraphed simultaneously through the one wire. The messages are printed on tape at the receiving end. Good use has also been made of a set of Western Electric apparatus, which embodies to a considerable extent the features of the Baudot and the Murray systems and allows of eight messages being transmitted simultaneously on one wire. The substitution of telephone apparatus for the Morse sounder at the smaller telegraph offices has been continued thus facilitating the release of skilled telegraphists for service with the Colours. The decline in commercial activity and the restrictions placed upon the use of registered addresses by the Censor have caused a decrease of nearly 4 per cent. in the number of such addresses. 4,451 new addresses were registered and 7,396 addresses were cancelled and the present total is 78,601 against 81,546 last year. During the year about £1,000 has been spent in improving the Coast Communication system by means of which information is furnished to lifeboat authorities of vessels shipwrecked or in distress. The system has been extended to 37 new watch huts provided by the Board of Trade for men who are on the watch for distress signals on parts of the coast not ordinarily under observation by the coastguards. Foreign telegrams show a substantial decrease as compared with last year, partly owing to the fact that last year's figures covered only eight months of war and partly owing to the further curtailment of commerce with Holland, Norway and Switzerland and the cessation of business relations with Belgium. But while the number of telegrams has dropped, the words per telegram has increased.

Wireless Telegraphy.—The prohibition of the private use of wireless telegraphy has been maintained, and effective measures to enforce this prohibition have been taken under the Defence of the Realm Regulations. All existing private stations, except a few required for Government work have been dismantled; and the apparatus has been taken into Post Office custody for the period of the war. The use of the Coast Stations for private radiotelegrams has been suspended until further notice. They are reserved for Government purposes and for the exchange of necessary messages between merchant ships and the owners or agents.

Telephones.—The development of the telephone system in the United Kingdom, in common with other services requiring heavy capital outlay, was seriously retarded during the year ended March 31, 1916, owing both to want of funds and shortage of labour. The efficiency of the service has been well maintained, notwithstanding the release of many of the engineering staff for military service, and the exceptional demands made upon those remaining in connection with war work in this country. New orders for 43,286 telephones were accepted during the year and in addition over 5,000 circuits were provided for the Naval and Military Authorities and the Government Departments. Many more applications for new telephones were received than could possibly be dealt with by the depleted engineering staff. It was decided in September, 1915, to impose a war surcharge, the minimum payment being fixed at £4, on all new telephone services with a view to limit applications to persons and firms urgently in need of that facility. The surcharge has had the effect of reducing the applications by approximately 50 per cent. and it brought in £45,000 in the seven months ended March 31, 1916. Notices to remove 51,680 telephones were received during the year from subscribers giving up the service, compared with 52,584 in 1914-15. The number of telephones owned by the Post Office and in use on March 31, 1916 (exclusive of more than 15,000 provided specially for the temporary use of the Naval and Military Authorities and of Government Departments), numbered 786,991 made up as follows:—

	Exchange Stations.	Private Wire Stations.	Total.
London	249,606	13,529	263,135
Provinces:—			
England and Wales	382,458	23,889	406,347
Scotland	86,063	5,158	91,221
Ireland	23,693	2,595	26,288
United Kingdom	741,820	45,171	786,991

The Post Office maintained in addition 2,236 telephones owned by subscribers. It is estimated that during the year, 776,000,000 effective calls were originated, a decrease of 4·8 per cent. compared with the previous year. The reduction is due firstly to a decrease in the total number of telephones in use, secondly to a general economy in the use of the telephone by existing subscribers, and thirdly to the increase in charges already referred to. The average calling rate dropped from 2·97 calls per telephone per day in 1914-15 to 2·86 in 1915-16. The reduction in inland trunk traffic is not nearly so marked as the reduction in local exchange traffic. This is largely due to the exceptional increase in the number of long distance calls made on behalf of the Naval and Military Authorities and of Government Departments. The total number of inland trunk calls in the year was 40,357,284, or 0·56 per cent. less than in 1914-15. The increase in the charges for trunk calls resulted in a falling off in the use of the trunk service, but for this trunk traffic would have been maintained at the level of the previous year. 71 new exchanges were opened, 46 in England and Wales, 6 in Scotland and 19 in Ireland, and these brought the total number of exchanges open on March 31, 1916, to 3,109. 751 public call offices were opened and 991 were closed chiefly on grounds of public economy. Of the 751 call offices opened, 497 were provided with full trunk facilities, 45 with restricted trunk facilities, and 209 were for local service only.

Development of Trunk System.—During the year the number of exchanges connected directly with the general trunk system was increased by 74; and 126 additional trunk circuits were completed, involving an addition of 31,971 miles of wire (exclusive of spare wires). The improvement of the trunk service by the amalgamation of trunk and local exchanges has been carried a step further, the trunk and local exchanges in 15 more towns having been combined during the year with the result that in only 68 towns are there now separate local and trunk exchanges, compared with 293 at the time of the transfer of the National Telephone Co.'s undertaking in 1912. Owing to financial and other difficulties arising out of the war, not much progress has been possible in the provision of additional trunk lines, but two important underground telephone cables have been completed. The London and Birmingham cable was extended to Liverpool and was opened for public service at the beginning of March last and a new cable between London and Brighton was brought into use in February, 1916. Considerable progress has been made in the acceleration of short distance trunk services, especially between Birmingham and Wolverhampton and Bristol and Bath. It is proposed shortly to introduce a similar service between Glasgow and Edinburgh, Glasgow and Paisley, Birmingham and Coventry, Dudley and Walsall, and between Manchester and Ashton-under-Lyne.

Automatic Exchanges.—Automatic telephone exchanges already installed at the General Post Office (London), Accrington, Chepstow, Darlington, Epsom, Hereford and Newport (Mon.) continue to give a satisfactory service. Difficulties caused by the war have delayed the construction of similar exchanges at Leeds, Grimsby and Stockport. It has, however, been possible to proceed with the work at Portsmouth, and automatic working was introduced there shortly after the close of the financial year.

Continuous Telephone Service, &c.—During the year a continuous telephone service was introduced at 23 exchanges where previously the service had been restricted; and the number of exchanges which are at present without a continuous service has thus been reduced to 334 out of a total of 3,109 exchanges. Continuous service has also been provided temporarily at many rural call offices and small exchanges, to enable the Naval and Military Authorities and the Police to obtain, in addition to telephone communication, direct connection at any hour of the night with important telegraph offices. During the year there was a net addition of 133 stations of rural party lines (farmers' lines), the total number on March 31, 1916, being 2,398. The Anglo-Continental services have been suspended for ordinary commercial traffic since the beginning of the war. The receipts in respect to private telephone lines amounted to £248,078, compared with £263,408.

LEGAL INTELLIGENCE.

British Thomson-Houston Co. (Ltd.) v. Duram (Ltd.)

As stated in our last issue, the Court of Appeal has dismissed plaintiffs' appeal from a judgment in favour of defendants.

Lord Justice Warrington, in his judgment (in which the Master of the Rolls concurred), said the action was brought for infringement of patent No. 21,513 of 1906. Mr. Justice Astbury had held the patent to be invalid for want of subject matter, and from that decision plaintiffs appealed. The first question was to determine what was the true construction of the specification. Tungsten was one of the refractory metals, [illegible] in the form of a finely divided powder, and had a very high melting point, somewhere about 3,000 C. It could only be melted by the employment of the electric current, and the product so obtained was said to be a carbide of the metal, and so hard as to be of no use for [illegible] for which a metal was commonly used. Prior to the date of the patent, however, [illegible] had been suggested, notably by Moissan in [illegible] and in Just and Hanaman's specification in 1904, for obtaining pure tungsten in a solid form. In 1906 there had been no [illegible] of any of those inventions, but plaintiffs' [illegible] assumed that tungsten might be obtained in a solid form, [illegible] the [illegible] of the invention claimed in various ways, and the patentees described one of such ways, treating it as one already known and making no claim to it as an invention of theirs. Working a metal in the technical sense meant altering its shape in such a manner as to produce a spreading or contraction of the actual metallic body. The [illegible] enjoined and included the three well-known processes of hammering, rolling and drawing. The first claim of the specification was in these terms:—"The method of working tungsten which consists in subjecting the metal in a coherent form to the action of heat while it is being operated on or manipulated." Taken by itself that created no [illegible]. The only special feature claimed was subjecting the metal to the action of heat during the operation of working. That special feature was claimed as applicable to every mode of working, including hammering, rolling and drawing. The fight had raged round the words "the metal in a coherent form." Did they mean, as the defendants said, any form of solid metal, however obtained, or were they limited, as plaintiffs contended, to a metal which had assumed a solid form only by reason of the coherence of the particles of which the original powder consisted? Reading the words by themselves, he should feel no difficulty in saying that they included any form of solid tungsten, the only form of the metal to which the process of working could be applied; but it was said that the specification afforded a context with reference to which the words must be read, and that if that was done it would be found that they bore the narrower construction for which plaintiffs' contended. Having read the material portions of plaintiffs' specification, his lordship said that the patentee plainly applied his invention not only to a rod obtained as described, but to one "obtained by any other method which yielded a pure coherent product." He could not see that that meant anything less than pure metal in a solid form as distinct from powder. In his opinion, the context, so far from assisting plaintiffs, tended to show the patentee was dealing with the metal in a condition suitable for working—that was to say, not as a powder—and that they regarded it as perfectly immaterial how that condition was obtained. The claim, therefore, was, in his opinion, simply for the employment of heat during the working operation, whatever it might be, as a means of effectuating or facilitating that operation where the subject of it was tungsten. The patentees condescended to give no definite particulars as to the degree of heat, nor did they lay claim to any special form of apparatus for its application, or any special mode of applying it. The so-called discovery seemed to him to be no discovery at all, for it was proved that it was part of the ordinary routine of a metallurgist, if he had to deal with a metal which could not be worked cold, to use heat to facilitate the operation, it being well known that the action of heat on a metal was to encourage the change of shape, which it was the object of working to produce. He was clearly of opinion that, construed as he thought it ought to be construed, the specification neither described nor claimed an invention which could be the subject matter of a patent, and the patent was, therefore, invalid. It was unnecessary to deal with the question of anticipation or insufficiency of the specification. The appeal failed, and must be dismissed, with costs.

Lord Justice Scrutton also read a judgment dismissing the appeal. He said he agreed with Mr. Justice Astbury's view that there was not sufficient subject matter in claim I. He thought the patent was anticipated by Moissan.

THE ENGINEERS' CLUB ANNUAL DINNER.

On Tuesday evening last the Engineers' Club, Manchester, held its annual general meeting, followed by the annual dinner and smoking concert. At the meeting a hearty vote of thanks was passed and sent to Mr. J. A. Aspinal (Lancashire & Yorkshire Railway), the retiring president, upon his two years' service and keen interest in the club. By a unanimous vote Mr. J. H. Stubbs was elected as president.

At dinner Mr. Stubbs said the membership of the club was now 783, and when it reached 800 there would have to be a waiting list.

The chairman then handed Mr. E. L. Hill, the guest of the evening a copy of a resolution signed by the committee expressing appreciation of his services as hon. secretary.

Mr. W. E. Gower presented Mr. Hill, on behalf of the subscribers, with War Loan to the value of £100, two oil paintings by Byran Cooper, one for Mrs. Hill and one for himself, and also War Loan to the value of £20 for their little daughter "Mollie." Mr. Gower referred in pleasing terms to his long association with Mr. Hill and to the strenuous work which, as honorary secretary, he had done for the Club.

Mr Hill, in reply, said: What do I not owe the Club and my fellow members? I owe almost everything that makes life a pleasure. Happy, congenial and, I hope, useful work, and loyal and true hearted friends. An old proverb ran, "He who would bring back the gold of the Indies must carry the gold of the Indies with him." To my new work, which is interesting and fascinating to an extraordinary degree, I have brought the gold of the Indies—the life and inspiration of our splendid Club. I don't mind confessing that when the Federation of British Industries offered me the position of their secretaryship I was a bit afraid. The man who says he is not afraid of taking on new and unknown duties and responsibilities is either a liar or a fool. The Emperor Charles V. was one day riding with his courtiers and passed the grave of a knight on whose tombstone was written "Here lies a man who never knew fear." "Then," said Charles, "he never snuffed a candle with his fingers." During the last 11 weeks I have had to snuff a good many candles, and I have burnt myself badly, but luckily my carelessness and over-enthusiasm have not put the candle out, and I am glad to realise that the clear bright flame of co-operation and goodwill, which this hateful war has lit, will burn for generations. This is not the time for people to spend money on presentations. In giving us these pictures—painted by my friend Byran Cooper, who is facile princeps in his own line and an artist of whom the Empire may well be proud—you have made sure that we shall see and enjoy them—and think of you—50 times a day. In giving my little daughter and us this glorious amount of War Loan you have highly gratified and complimented us, and you have struck a blow for the victory which is coming surely if slowly.

At the close of the presentation the members wished God-speed to Mr. Longley, who has to join the Colours, and who has been the very able manager of the Club since its inception.

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Manufacture of Electric Lamp Glass.

The Minister of Munitions has made the following order as to the manufacture, purchase and sale of electric lamp glass :—

Manufacture.—(1) No person shall manufacture any electric lamp glass unless the purpose for which such glass is required has been approved. Such approval must be evidenced by one or other of the following, which must be quoted by the ordering firm to the manufacturer, together with the purpose for which the glass is required :—

(*a*) Reference to and number of an Admiralty, War Office or Ministry of Munitions contract for which the glass is necessary ; or

(*b*) A certificate authorising the supply issued on behalf of the Minister of Munitions by the Director of Optical Munitions and Glassware Supply.

(2) Manufacturers of electric lamp glass are required to render to the Director of Optical Munitions and glassware supply at regular intervals full and accurate returns of their manufacture and output of electric lamp glass in accordance with the directions from time to time given by the said Director.

Purchase and Sale Outside U.K.—(3) No person shall buy, sell or deal in any electric lamp glass situated or to be manufactured outside the United Kingdom unless a certificate authorising such purchase, sale or dealing has been issued on behalf of the Minister of Munitions by the Director of Optical Munitions and glassware supply.

(4) For the purpose of the Order electric lamp glass includes all glass intended for use in the manufacture of electric lamps except glass used or intended for use in lamp caps for insulating purposes, but not glass shades and similar accessories.

(5) All applications in reference to the Order should be made to the Director of Optical Munitions and Glassware Supply, Ministry of Munitions of War, 117, Piccadilly, London, W. 1.

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Spelter Dealings.

The Minister of Munitions has also issued an order as to dealings in spelter.

From April all persons are requested to send in the first seven days of each month to the Director of Materials, Ministry of Munitions, Hotel Victoria, W.C.2, monthly returns of the spelter held or controlled by them unless the total stock does not exceed 1 ton. Applications for licences to the Director of Materials (A.M.2.C.), Ministry of Munitions, Hotel Victoria, London, W.C.2, and marked "Spelter Licence."

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Canadian Electrical Energy Export.

In the recent report of the Inland Revenue Department statistics of the generation and export of electrical energy for the past year are given :—

The Canadian Niagara Co. exported 400,521,090 units and 11,178,910 units were used in Canada, and the Electric Development Co. exported 34,652,000 units and sold 395,346,500 units locally. The export and home consumption figures of the other companies were as follows :—

	Export.		Home use.
Ontario	199,135,160	...	616,834,440
Ontario and Minnesota	13,144,070	...	11,789,534
Cedars Rapids Co.	358,753,000	...	56,031,000
Sherbrooke Power Co.	230,820	...	8,605,200
Maine & New Brunswick Co.	3,075,893	...	242,437
Western Canada Co.	11,937,700	...	60,468,020
B.C. Electric Co.	330,626	...	68,470,689

* * * *

Imperial Trade Development.

The final report of the Royal Commission on the Natural Resources, Trade and Legislation of certain portions of His Majesty's Dominions, has been issued and runs to 199 pages.

The Commission state that it is vital that the Empire should, as far as possible, be placed in a position which would enable it to resist any pressure which a foreign Power, or group of Powers, could exercise in time of peace or war in virtue of a control of raw materials and commodities essential to its well-being. They urge that a complete survey should be made of the relation between Empire production and Empire requirements of such materials and commodities, and the Commission have collected preliminary facts and figures for such a survey. In particular, the following lines of investigation are suggested :—The possibility of new sources of supply within the Empire and the possibility of finding substitutes within the Empire, as well as means of preventing waste in existing sources of supply of all minerals. They suggest that the responsibility for such a survey and investigation should be reposed in a new Imperial Development Board.

Transport.—The necessity for cheap, speedy and efficient transport is emphasised, and the use of larger vessels recommended. Larger harbours are required and schemes of improvement should be under the supervision of the proposed new Imperial Development Board. The Port of London Authority is also urged to improve arrangements for the transport of produce from the Dominions by road between the docks and central markets in London.

Cables, &c.—Cheaper cable rates are also an urgent necessity, and it is stated that public opinion in all the Dominions is in favour of State control of the Imperial cables. The Commissioners also recommend the State acquisition of a submarine cable across the Atlantic. A considerable reduction in Press rates is also proposed for the dissemination fully, widely and cheaply of Imperial news.

Among other recommendations is the speeding up of a trade intelligence system with the co-operation of British Consuls. The preparation of Imperial industrial and commercial statistics and periodic inter-Imperial exhibitions are put forward as means of improving commercial practice, as is also the unification of legislation, particularly in regard to patents, trade marks and company law. Regarding the creation of an Imperial Development Board, the Commissioners say :—Existing organisations are inadequate to deal with the scientific development of the resources of the Empire, with the deepening of its harbours on a co-ordinated plan, with the improvement of its small and cable services, the preparation and publication of its statistics, and other matters of joint interest to the Empire as a whole. To remedy these deficiencies we recommend the establishment of an Imperial Development Board. This board, for really effective work, must represent not only the United Kingdom and the self-governing Dominions, but also India, the Crown Colonies and the Protectorates—in other words, it must be concerned with the interests of the whole Empire." Representation of the various parts of the Empire might be on the following lines :—United Kingdom, India, Crown Colonies and Protectorates 7 members, Canada, Australia New Zealand, the Union of South Africa and Newfoundland, one member each, or a total of 12 members.

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Electricity Supply to Government Establishments.

A correspondent, who signs himself "Electric Supply," writes to us, pointing out that the War Office and other Government departments are now taking electric supply in every part of the country for offices, works, hospitals, camps, &c., and electricity undertakings are faced with numerous requests for special terms.

The supply authorities are sometimes rather in a dilemma as to what principle should be applied in view of the argument that the supply is wanted for national purposes, and as such entitled to special consideration. But looked at correctly (our correspondent suggests) the decision is really taken out of their hands by Act of Parliament. In the Electric Lighting Act of 1882 it is enacted that the undertakers shall not "show any undue preference to any local authority, company or person." Corporate bodies or Government departments are, therefore, as clearly debarred from receiving preferential treatment as any private consumer The course laid down is obviously quite clear—namely, that there must not be made to any Government department any reduction from the standard rates beyond that which is warranted by the conditions under which supply is taken (maximum demand, hours of use, &c.), or, in other words, Government departments must be treated on all fours with all other consumers. Of course, where there is a case where a patriotic feeling might naturally come to the fore, say, in the case of hospitals, &c., it is clearly the more advisable course to keep strictly within the Electric Lighting Act, and to give, say, a donation to the hospital or help in any other way quite independently. It amounts to the same thing in the end ; no principle is violated, and no improper precedent formed. Further, if undertakings take this course it would mean consistency of action throughout the industry.

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Newcastle-on-Tyne Electricity Supply.

As will be seen from the reports of the meetings elsewhere, the proposals for the acquisition of shares in the Cleveland & Durham Electric Power (Ltd.) by the Newcastle-upon-Tyne Electric Supply Co. have been adopted.

The Newcastle Co. will give to the shareholders of the Cleveland Co. (1) 18s. fully paid of the preference share capital of the Newcastle Co. in exchange for every £1 of preference share capital of the Cleveland Co., together with 3s. 6d. of funded preference income stock (being amount issued in respect of each preference share) ; (2) 16s. fully paid of the preference share capital of the Newcastle Co. in exchange for every £1 of preference share capital of the Cleveland Co. held without funded preference income stock ; (3) 10s. fully paid of the preference share capital of the Newcastle Co. in exchange for every £1 of ordinary share capital of the Cleveland Co.

The scheme will benefit both companies, and it will place the Newcastle Co., which is the leading and most progressive industrial power company of the country, in a still stronger position to deal with the rapidly increasing demand for electric power in the important Tyneside area.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 17, 1917, *to* March 23, 1917.

IMPORTS.

London.—*U.S.A.:* Wire and cable, £395; elec. machinery, £59; unenumerated, £2,963. *Japan:* Unenumerated, £4,971. *France:* Elec. carbons, £1,344; unenumerated, £290. *Switzerland:* Elec. carbons, £930; elec. machinery, £96; unenumerated, £236. *Holland:* Elec. glow lamps, £2,888. *Canada:* Unenumerated, £114.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £100; unenumerated, £65. *Melbourne:* Elec. machinery, £106; unenumerated, £78. *Sydney:* Elec. machinery, £423; unenumerated, £659. *Wellington:* Wire and cable, £360; unenumerated, £858, *Adelaide:* Elec. machinery, £446; unenumerated, £36. *Christchurch:* Elec. machinery, £342. *Brisbane:* Unenumerated, £27. *Perth:* Elec. machinery, £12; unenumerated, £137. *Dunedin:* Unenumerated, £105. *Freemantle:* Elec. machinery, £32

Africa.—*Cape Town:* Elec. machinery, £146; elec. lamps, 3,650 n.o.; unenumerated, £173. *Port Elizabeth:* Unenumerated, £23. *Durban:* Elec. machinery, £102; wire and cable, £1,665; unenumerated, £616. *East London:* Unenumerated, £122. *Mossel Bay:* Unenumerated, £10.

Egypt.—*Port Sudan:* Unenumerated, £24. *Suez:* Unenumerated, £28. *Aden:* Elec. lamps, 250 n.o.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery, £12; elec. lamps, 2,800 n.o.; unenumerated, £1,003. *Calcutta:* Elec. machinery, £55; unenumerated, £80. *Singapore:* Wire and cable, £6; unenumerated, £398. *Penang:* Unenumerated, £748. *Bangkok:* Elec. machinery, £285; unenumerated, £1,410. *Sourabaya:* Unenumerated, £11. *Kilindini:* Telegraph material, £164; unenumerated, £47. *Port Swettenham:* Telegraph material, £286. *Karachi:* Unenumerated, £15.

China.—*Hankow:* Unenumerated, £33. *Hongkong:* Unenumerated, £133. *Shanghai:* Unenumerated, £756. *Dalny:* Unenumerated, £73. *Tientsin:* Unenumerated, £52.

U.S.A.—*New York:* Elec. machinery, £89; unenumerated, £64.

Canada.—*St. Johns, N.S.:* Unenumerated, £354. *Toronto:* Unenumerated, £88. *Montreal:* Elec. machinery, £280.

South and Central America.—*Buenos Ayres:* Wire and cable, £38; elec. lamps, 450 n.o.; unenumerated, £264. *Valparaisa:* Unenumerated, £29.

West Indies.—*Barbadoes:* Unenumerated, £18. *St. Lucia:* Unenumerated, £20.

Holland.—*Rotterdam:* Wire and cable, £4,242. *Amsterdam:* Elec. machinery, £135; unenumerated, £293.

France.—*Paris:* Wire and cable, £28; unenumerated, £2,673. *Dieppe:* Elec. machinery, £87; wire and cable, £546; unenumerated, £1,774. *Boulogne:* Unenumerated, £64. *Havre:* Unenumerated, £12. *Nantes:* Elec. machinery, £186.

Portugal.—*Lisbon:* Elec. machinery, £116; unenumerated, £187.

Italy.—*Genoa:* Elec. machinery, £78.

Japan.—*Yakohama:* Unenumerated, £58.

Malta.—Unenumerated, £214.

Gibraltar.—Unenumerated, £103.

FOREIGN GOODS (duty paid and free).

Bombay: Elec. lamps, 20,500, n.o.; unenumerated, £12. *Hankow:* Unenumerated, £23. *Amsterdam:* Unenumerated, £56. *Buenos Ayres:* Unenumerated, £217. *Calcutta* Elec. lamps, 53,000, n.o.; unenumerated, £70. *Hangkong:* Unenumerated, £108.

IN TRANSIT.

Singapore: Elec. lamps, 2,495.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS ITEMS.

Mr. James Bastian, who for many years represented the Bastian Meter Co. and the Dussek Bitumen Co., and has latterly held the position of sales manager for the Bastian Electric Co., has accepted an appointment under the Ministry of Munitions.

The "Z" Electric Lamp Mfg. Co. has opened a branch at 59, Victoria-street, Bristol, to look after the business in the west of England and S. Wales.

Comprehensive stocks of all classes of "Z" drawn wire lamps, Vacuum "One Watt" and gas filled "Half Watt" types will be held, together with motor car and other types of lamps and also large stocks of all classes of accessories and cable. Mr. W. Weeks is manager of the depot.

The offices of the Thermo Electric Ore Reduction Corporation have been removed to 244, High Holborn, London, W.C.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Sale by Tender.—Tenders are invited for the purchase, as a going concern, of the business of the Brimsdown Lamp Works (Ltd.), Brimsdown, Middlesex.

Tenders to the Controller, Mr. H. J. Morland (Messrs. Price, Waterhouse & Co.), 3, Frederick's-place, Old Jewry, E.C., by Wednesday, April 18. Particulars and conditions of sale and forms of tender may be obtained from Mr. Morland; the Public Trustee, New-buildings, Kingsway, W.C.; Mr. J. R. Cardew-Smith, solicitor, 25, Bedford-row, W.C.; or Messrs. Garland-Smith & Co., 100, Mount-street, Grosvenor-square, W. *Further particulars are given in an advertisement.*

Agency Wanted.—A Russian electrical engineer, with good State and municipal connection, seeks the sole representation for Russia of manufacturers of turbo-generators and other electrical plant and machinery, &c. Communications to M. A. Kraminsky, Kamenoostrowsky, Prospect 29, Petrograd.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of S. S. Coster & Co., electrical and mechanical engineers, 14, Gladstone-road, West Ham Park, London, E., will take place on April 3 and the public examination on May 9, both at Bankruptcy-buildings, London, W.C.

A meeting of creditors of Simplex Insulators (Bourke's Patent, (Ltd.) (in vol. liq.) will be held on April 5 at 56, Moorgate-street, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bedford.—The L.G. Board have sanctioned without local inquiry the following loans for the electric supply department:—

£8,150 for building (repayable in 30 years); £20,711 for boiler house plant, steel chimney, pumps, &c., turbo-generator, engine room accessories, switchboard connections, transformers and switchgear; £1,502 for mains (25 years); £1,140 for mechanical stokers and motors (10 years); £[illegible] for coal bunkers (20 years).

Mexborough.—The Council have applied for authority to borrow £[illegible] for extensions of the electric supply undertaking.

Middlesbrough.—Owing to the increasing demand for electric power it is proposed to lay a new cable from the Commercial-street sub-station to [illegible]-street at a cost of £1,800.

Morecambe.—The Council will apply for sanction to a loan of [illegible] for extension of the electricity works after the war.

Southend.—At last week's meeting of the Council the Light Railways and Electric Lighting Committee's recommendation to apply to the L.G.B. for sanction to borrow £15,520 for additional generating plant led to an animated debate, but as the voting was equal the recommendation fell through.

GENERAL.

Aylesbury.—The salary of the borough electrical engineer (Mr. W. A. [illegible]) has been increased to [illegible], rising by annual increments of [illegible] to [illegible] per annum.

Clayton (Yorks).—At a public meeting of ratepayers a resolution was passed asking the Council to repudiate their agreement with the [illegible] Distribution of Yorkshire (Ltd.) to apply for a provisional order. The meeting favoured a supply of electric current being obtained from Bradford Corporation.

Dublin.—Some of the new members of the Port and Docks Board have been investigating the administration of the electricity department.

The number of units of electric current generated by the plant in 1916 was 437,840; generating cost was 2·538d. per unit, interest and sinking fund amounted to 1·119d. and salaries 0·110d. a total of 3·767d. per unit. As the total cost per unit sold by the Corporation for 1916 was 2·62d. it is suggested that it might be possible to enter into an arrangement by which the Corporation would take over the Board's station or supply them with current.

Dundee.—On the 20th inst. there was a failure of the electricity supply.

At 11 a.m., owing to the failure of the greater portion of the d.c. supply, the tramways were stopped, although only a few works supplied with e.h.t. current were affected. The duration of the stoppage lasted till about 12.30, by which time everything was again normal. The fault was discovered on one of the e.h.t. trunk feeders supplying one of the sub-stations. On the following morning (the 21st inst.) the second e.h.t. trunk feeder supplying the same station broke down. On this occasion a few of the e.h.t. consumers were cut off, but no interruptions were caused to the d.c. or tramway supply. When the second cable broke down the sub-station was entirely cut off, but the consumers mentioned were changed over and fed from one of the other stations. On localising the fault, the ground, which is chiefly composed of gasworks refuse, was found to be on fire under the cables, which accounted for the mains giving way. The cables were laid some five or six years ago in fibre conduits surrounded by concrete, and at that time the ground appeared to be all right, no indication of any occurrence which has happened at present appearing then possible.

Gorey (Ireland).—A local company is being formed in order to establish electric supply works.

Grimsby.—The Council has entered into an agreement with the Great Central Railway Co. for a supply of current for emergency purposes.

Hackney.—The official tests of the 5,000 kw. turbo-alternator and auxiliary plant recently installed by Messrs. Willans & Robinson have been made, and the borough electrical engineer (Mr. L. L. Robinson) has certified that the contractors have duly completed their contract in accordance with the general conditions.

The Electricity Committee recommend, subject to certain conditions, an annual subscription of £5. 5s. to the Engineering Standards Committee.

Leicester.—The shift engineers at the Lero power station and the superintendent of overhead electrical equipment have been granted an additional 5s. per week.

North-East Coast Linking-up Scheme.—A scheme for the linking-up of the electric supply undertakings of South Shields and Sunderland Corporations and of the Newcastle-upon-Tyne Electric Supply Co. is under consideration.

Middleton.—A scheme for connecting up the electricity works with the Manchester electricity supply, and thus enabling a considerable reduction of the present generating plant, has been submitted to the Board of Trade.

Provincial Electric Supply Committee.—In reference to the recent announcement in our columns that a Committee was being formed to represent the Provincial Electric Supply Committee of England holding provisional orders, we are pleased to hear that the proposal has met with great success.

In the short space of time that has elapsed some 60 provincial companies (representing between 200 and 300 provisional orders) have become members. The bulk of the capital invested in provincial companies, which amounts to some £7,000,000 or £8,000,000, is, therefore, fully represented, and the Committee represents all the important companies in the United Kingdom.

In view of the many serious problems which electric supply industry has to deal with in the immediate future, the Committee ought to offer an invaluable means of focussing the active lines of policy of the various companies on any of those important questions which have to be solved at the present moment.

Provisional Order Transfers.—The Board of Trade has extended for one year from Jan. 30, 1917, the time limited for transfers by the Bradford-on-Avon Electric Lighting Order, 1914, and the Warminster Electric Lighting Order, 1914.

Sheffield.—The enterprising engineer and manager of the electric power department (Mr. S. Edgar Fedden) has found a new field for expending his surplus energy, and his example is one which might be copied by others in connection with National Service.

Mr. Fedden got into communication with the Board of Agriculture and asked them to provide motor-ploughs and he would get the land ploughed. The ploughs are (it is stated) arriving, and expert members of Mr. Fedden's staff at the electricity stations are to put in their spare time as volunteer ploughmen. "They will motor to farms in the evening and plough all night; they will also spend their week-ends in healthy work on the land." That is an example of practical patriotism which will add to the nation's food supply and also improve the health of the men who are engaged in the work.

West Ham.—An agreement has been approved for the supply of electricity to Messrs. Whitefields (Ltd.), and revised contracts have also been approved for supplies to the Hart Accumulator Co., Venesta, Limited, and the London & Scottish Engineering Co.

West London Linking-up Scheme. We are glad to learn that further progress is likely to be made with the scheme for the linking-up of the Fulham, Hammersmith and Battersea electricity undertakings.

It will be remembered that the linking-up scheme was promoted some 2½ years ago and everything was arranged, but unfortunately on the outbreak of war the Tresaury objected to that portion between Fulham and Hammersmith being carried out at that date on account of expenditure. Negotiations are now proceeding with a view to getting this part of the line completed, and it is hoped to have the complete scheme finished by next winter. The linking-up between Fulham and Battersea has been in operation for 18 months, and has proved of great benefit. Some 8,000,000 units have been supplied by means of linking-up.

Willesden. Notice has been given to terminate the Council's agreement with the North Metropolitan Electric Power Supply Co. for the supply to the Council of energy in bulk on March 31, 1918, and negotiations are to be entered into with the company with a view to fresh rates being fixed and embodied in a new agreement.

The L.G. Board have intimated that they are not prepared at present to sanction the raising of a loan of £10,110 for new cables from Taylor's-lane to Acton-lane sub-station and from Taylor's-lane to Anson-road, and for transformers and services.

ELECTRIC TRACTION.

Belfast. In a recent report on the tramways the general manager (Mr. J. S. D. Moffet) makes the following recommendations:—

That all discount and cheap privilege tickets, including P.O. official tickets, workmen's return tickets, constables' privilege tickets and children's halfpenny school tickets be abolished.

That the penny stages be shortened, and that the length of the first stage on each route from the Castle Junction do not exceed 1½ miles.

That the standard length of the ordinary penny stages, excluding overlapping stages, be fixed at from 2,300 yds. to 2,600 yds. (1⅜ to 1½ miles), and that the other stages be regulated accordingly.

A revised fare scheme in accordance with the above suggestions was submitted.

Bootle.—The tramway track in the borough over which the Liverpool tramcars run, is maintained by Bootle Corporation, and it is alleged by Liverpool Tramways Committee that the track has been allowed to get into such a state of bad repair that their cars were damaged, and a financial claim has been made on that ground.

Carlisle.—It is proposed to purchase a 2½-ton electric vehicle for the removal of ashes and refuse, &c., at a cost of £795.

L.C.C. Tramways and Snowfalls.—During the snowstorms of last month salt was used by the Borough Councils to melt the snow, and this was alleged to have been the cause of the disorganisation of the service.

The London County Council has circularised the Borough Councils on the subject. Attention is drawn to the serious effects on the tramways service of the use of salt for melting snow, and a hope is expressed that, in considering the steps to be taken on the occasion of snowfalls, the Council will avoid the use of salt on or near conduit tramway tracks.

The Cleansing Committee of Lambeth Borough Council suggested that the London County Council should be asked to investigate the practicability of brooms being affixed to tramcars, whereby the slush resulting from the thawing of the snow by salt might be swept up. The general manager of the tramways stated, in reply, that there were a few features in connection with the proposal which would make its application to London very difficult and objectionable, if not, indeed, impracticable. The total number of Lambeth Council's staff available for snow cleansing was 200, and no casual labour was obtainable. In pre-war times as many as 1,500 men had been engaged for several successive days at a time in snow clearing. Under the present conditions, unless the use of salt is continued in times of snow, the whole of the vehicular traffic on the main roads of the borough, apart from the tramways, would suffer serious inconvenience and disorganisation.

Motor Traction v. Horse Haulage.—The "Municipal Journal" has published a table by Mr. F. S. R. Carter, surveyor to Beddington and Wallington Council, giving information obtained from 13 local authorities on the subject of motor traction for municipal purposes.

The motors were mainly used for carting materials, collecting house refuse, for watering and street sweeping, &c., and in 11 cases the replies stated that motors were more economical and convenient than horses. In two cases it was reported that they were not more economical, because the journeys in the district were short. In only one instance was electric power employed—viz., at Heston and Isleworth—and the reply was that the Edison wagon used was more economical than the former system.

Newport (Mon.).—The tramway men struck last week owing to a refusal of their demand for increased pay and as a protest against women drivers.

On the 22nd inst. the men decided to drive the early munition workers' car, and subsequently to take the cars to the sheds.

The chairman of the Tramways Committee (Mr. Moxon) issued a statement that at their last meeting a request for increased pay was received from the men's association, upon which the manager was asked to report at the next meeting. This was conveyed to the men's secretary, who expressed pleasure at the decision, and a hope that the branch president would be reinstated, and the offence for which he was suspended overlooked. The Cardiff branch secretary on Wednesday saw the chairman and manager, and asked that no women should drive cars, but in view of the demands of the Minister of Munitions and the Director of National Service such a promise could not be given. The Committee decided to run the best service possible, and agreed to meet a deputation from the men when the strikers had returned to work. Instructions have been issued to give preference to munition and transport workers.

Stretford.—The Council have decided to make inquiries from local authorities as to the use of electrically driven and petrol motor wagons for the removal of house refuse.

Tramway Track Renewal.—The South Lancashire Tramways Co. has notified Hindley Council that it may be necessary in the near future to take up the rails in Market-street owing to the importance of obtaining rails for renewals of other parts of the company's system. The track will be reinstated when rails can be obtained after the war.

Tramway Women's Wages.—In Lancashire and Cheshire the women tramway workers are demanding an increased war bonus varying from 2s. or 3s. to 6s. 6d. per week, and formal notice has been given of intention to cease work at the end of the month unless the demand is granted by the tramway authorities.

LIGHTING AND INDUSTRIAL POWER.

Dungannon.—A recent public meeting passed a resolution in favour of the public electric lighting scheme of Mr. John Cunningham, an ex-member of the Urban Council.

Factory Driving.—The electric drive is now employed in every modern factory, and the reconstructed works of the Willesden Paper & Canvas Works (Ltd.) are no exception to the rule, for electric power is employed throughout, except for the drying machine, which is steam heated.

Fifeshire.—Dunfermline District Committee has granted permission to the Fife Electric Power Co. to erect poles for carrying two overhead cables from the Townhill-Lochgelly transmission line to No. 3 Pit, Kingseat.

Kensington.—The Notting Hill Electric Lighting Co. recently offered to convert the public electric lamps from the "series" to the "parallel" system.

The company offered to give a separate supply of electricity to each of the 52 street lamps provided the Council supplied and fixed the necessary switches and fuses at an estimated cost of £72. The engineer reported that the alteration would permit of any candle power lamps being fixed on the standards, reduce the probability of earth leakage and in the event of one lamp becoming defective, the lighting of the other lamps would not be interferred with. The Engineer was, therefore, authorised to carry out the work.

IMPERIAL NOTES.

Australasia.—Investigations are being made in connection with proposals to develop hydro-electric power in the North Island of New Zealand

It is thought that three generating stations will be necessary on account of the large and rough area over which it would be essential to run transmission wires. Surveys are being made in the Auckland district with a view to the erection of works to utilise power from the Waikato river; the other two stations will probably be in the Manawatu and Waikaremoana districts. At a conference held recently of about a dozen local bodies in the Auckland district it was decided to urge the Government to provide hydro-electric power in the Province of Auckland. It was stated that an up-to-date scheme would cost from £200,000 to £300,000, saving £50,000 a year in Auckland and suburbs.

A company has recently been formed in New Zealand, with a capital of £70,000, to produce iron and steel from magnetic and titaniferous ironsands, of which there is a large deposit on the coast at Taranaki, near New Plymouth, North Island. The intention is to instal a furnace capable of dealing with 70 tons of ironsands weekly. It is claimed that pig iron can be produced from ironsands at a cost not exceeding £3 a ton.

In January Mr. J. H. Butters, manager of the Tasmanian State Hydro-electric Department, who has made (in company with members of the Mt. Lyell Co.'s engineering staff) an inspection of the King river, is of opinion that the King river might be used for generating power, and he proposes to make a complete survey of the river in the locality of the Gorge, about 7 miles from Queenstown. The electrical energy would be supplied to the Mount Read and Rosebery Mines. It is expected that 23,000 H.P. can be obtained.

India.—On Jan. 26 the Governor of Bombay laid the foundation stone of the new Victoria Jubilee Technical Institute at Matunga.

In 1912 the trustees of the Institute considered it necessary to have a systematic organisation of technical education, to convert the Institute into a Central Technological institute for the Presidency and to remove from its present site to a more extensive one.

The report on the work of the Electrical Division of the Punjab Public Works Department for 1915-16 shows expenditure on original works Rs. 1,19,828. In Lahore electric lights and fans were installed in the medical, veterinary and Government colleges and in the lunatic asylum. The Government press was also supplied with electric motors, the roads in the Lawrence Gardens were lighted, and additions and alteration were made to the electric lighting at Government House. In Lahore the Electrical Division has charge of 1,952 fans, 3,693 lamps and 21 motors, which represent a capital value of about Rs. 3,66,000.

MISCELLANEOUS.

British Westinghouse Employees' War Relief Fund.—The accounts of this fund for the period from Aug. 22, 1914, to Dec. 31, 1916, gives the following particulars:—

Contributions by employees amount to £24,529 and by company to £11,391, while donations and interest received bring total receipts to £36,394, out of which £20,584 has been paid to dependents of employees, £11,090 transferred to disablement and dependents' fund, £1,204 distributed in Christmas gifts and £834 contributed to local and national funds.

We regret to learn that the number of war fatalities amongst the company's employees is 168.

Enemy Firms Wound Up.—Claims against Meirowsky & Co., Carriage-street, Old Trafford, Manchester, electrical insulation manufacturers, are to be sent to the Controller, Mr. G. H. Warmington, 33, St. Swithin's-lane, London, E.C. 4, by April 23.

The controllers of Kampe & Co., 2, Sandland-street, Red Lion-square, London, W.C. 1, machinery merchants; and the London Electron Works Co. (Ltd.), Regent's Dock, Limehouse, London, E. 14, chemical manufacturers, have applied for release. Objections to the Board of Trade by March 31.

Light Alloys for Aircraft.—In order to co-ordinate the work in connection with the use of light alloys in the construction of aircraft and aircraft engines, the Advisory Committee for Aeronautics recently appointed a Light Alloys Sub-committee. The members are:—

Mr. Henry Fowler, superintendent of the Royal Aircraft Factory (chairman), Lieut.-Commander C. F. Jenkin, R.N.V.R., and Prof. F. C. Lea (representing the Air Board), and Capt. H. P. Philpot, Mr. A. W. Johns and Dr. W. Rosenhain, representing respectively the Aeronautical Inspection Department, the Director of Naval Construction, Admiralty, and the National Physical Laboratory, together with the chairman of the Advisory Committee for Aeronautics, ex officio.

TENDERS INVITED AND ACCEPTED.

Cooling Towers.

The Electricity Committee of HULL Corporation invite tenders for the cooling towers required in connection with the extensions of plant at their Sculcoates-lane generating works. Forms of tender and specification from the City Treasurer, Mr. T. G. Milner, and tenders addressed to the chairman of the Electricity Committee, Guildhall, Hull, are to be in by noon, April 12.

Turbo-alternators, Transformers and Condensing Plant.

GLASGOW.—The Corporation of Glasgow invites tenders returnable April [illegible] for Turbo-alternators (15,000 kw.), transformers and condensing plant for their new generating station at Dalmarnock. Particulars from W. W. Lackie, Chief Engineer and Manager, 75, Waterloo-street, Glasgow.

[illegible] Electricity and Tramways Committee require tenders by noon April 11, for supply of one 3,000 kw. turbo-alternator and [illegible] condensing plant. Specifications from Borough Electrical Engineer.

MANCHESTER Electricity Committee require tenders by 10 a.m. April [illegible] for the supply and erection of a turbo-alternator and condensing plant at their Stuart-street station. Specifications from Mr. [illegible] Hughes, Town Hall, Manchester.

Motors and Transformers.

[illegible] Electricity and Tramways Committee require tenders by noon April 11 for the supply of Motors and Transformers. Specification from Borough Electrical Engineer.

Arc Lamp Carbons.

ST. PANCRAS (London) Borough Council invite tenders for the supply of arc lamp carbons, delivery to be made as required. Specifications from the Electricity Department, Offices 57, Pratt-street, N.W. 1, and tenders to Town Clerk by noon of April 12.

Electrical Stores.

BRAY (Co. Wicklow) Urban Council require tenders by 8 p.m. April 3 for the supply of General Stores for their electric light works. Schedules, &c., from the Clerk.

LEYTON.—A contract has been entered into with the British Insulated & Helsby Cables (Ltd.) for a supply of trolley wire.

WESTMINSTER.—The City Council has renewed the contracts with the Charing Cross, West End & City Electricity Supply Co., Metropolitan Electric Supply Co., and St. James' & Pall Mall Electric Light Co., for the supply of electrical energy to the Council's buildings.

The Guardians have accepted the tender of Pope's Lamp Co. for the supply of electric lamps and that of Bell's United Asbestos Co. for engineers' sundries.

SHEFFIELD.—The Highways Committee have accepted the offer of Messrs. Ransomes, Sims & Jefferies to supply a 2 2½ ton "Orwell" electric lorry, on condition that one month's trial is allowed, and a payment of £25, plus carriage, to be made if the vehicle is not found satisfactory.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

City of London Electric Lighting Co. (Ltd.)

The twenty-seventh ordinary general meeting was held on the 21st inst., Mr. J. B. BRAITHWAITE, presiding.

The notice convening the meeting was read by Mr. J. CECIL BULL, one of the Joint Managing Directors.

The CHAIRMAN said: Gentlemen, the total capital spent during the past year has been £7,775, but we have written off £5,587, so that the net increase is only £2,188. The result has been that we have been able largely to reduce the loan from our bankers. Last year it stood at £66,000, at the date of the balance sheet it stood at £34,000, and at the present date at nothing. Our total gross revenue has increased by £21,116 to a figure of £332,935 16s. 10d. That, of course, is due to the increase in price which we have made towards meeting the increased cost of coal and other generation expenses. In connection with that I may say that the last increase only came into force on April 1 last year, and, therefore, we had only 9 months' benefit of it in the accounts under review. This year we shall get the benefit for the whole 12 months, so that should enable us to maintain our revenue this year, and possibly show some further increase. On the other hand, our increase in cost of generation was nearly the same figure, namely, £20,817—from £82,505 to £103,322. Repairs remain at about the same figure, and rents, rates and taxes, management expenses and special charges increased from £161,059 to £199,110. Including balance brought forward, the total available revenue shows a decrease of £22,284. After making the necessary adjustments we get some of it back Having explained various items which accounted for a decrease of £18,356 and enables us to maintain our dividend at 8 per cent, he proceeded: If you will turn to the revenue account you will see under the head of special charges two items which explain our reduction in the depreciation allowance from £50,000 to £40,000—the War Bonus to employees of £4,188 and allowances to employees on service £7,993, or together £12,181. Our auditors were quite willing that these special amounts should have been carried to a suspense account and written off over a period of years, but we came to the conclusion, and I hope you will approve it, that it was better to debit them straight away to the revenue of the year and reduce to some extent our appropriation to the depreciation fund. I may say that this reduction of £10,000 to the depreciation fund is quite exceptional for this year, and we propose not only to resume our regular allocation of £50,000 but also to make up this year's £10,000. The chief item of increased expenditure is coal, which has cost us £68,286, or an increase of £18,428, which, curiously enough, is almost exactly the amount of our reduced net revenue after making those other provisions. Of course, this increase in the cost of coal is chiefly due to the exceptional freights at present prevailing on sea borne coal. Our power works, unlike those of other companies, were put down on the water for the purpose of securing cheap coal, but we are now temporarily suffering from the fact that at the present time railway borne coal is cheaper than sea borne coal, because railway freights have not increased to the same extent as sea freights. Therefore, for the moment the advantage your company has always enjoyed by being on the water is neutralised by the exceptional conditions that now prevail. Of course, as soon as we get back to normal times we shall reap the advantage of having our coal come by water. I notice that the President of the Board of Trade, Sir Albert Stanley, in his speech yesterday to the Associated Chambers of Commerce, stated that we should have to burn less coal, and I know from past experience that it is a popular idea that the electric supply companies of the country are the great offenders in this respect. But the fact that one burns a large quantity does not necessarily mean that one is wasteful in its burning, and I wish to point out that as a matter of fact all electric supply companies are great economisers of coal. During 1916 there were used in electric supply, not including electric traction or electric railways, 2,000 million units. Talking a very low rate of production, say, only 500 units per ton of coal, whereas as a matter of fact in power houses like ours the figure is very much nearer 1,000 units than 500, but taking it at only 500 units per ton of coal used, that consumed four million tons of coal during the year. Now, if there had been no electric supply the same needs would have been supplied with less convenience, less value and less efficoency, and would have required at the very least nine million tons of coal to do it The saving has, therefore, been by the use of electric instead of other forms of energy, five million tons of coal, so that in seeking to reduce the consumption of coal by electric supply companies the authorities would be, so to speak, "killing the goose that lays the golden egg." They would be hitting the very people who are economising coal, and, as all you gentlemen are, I know, patriotic, you may lay the flattering unction to your souls that in being shareholders in this or any other electric supply company you are assisting in economising coal, which is so necessary at a time like this. And this economy is true in both branches of our supply. Take the case of lighting. Suppose they say we will restrict the supply of light by electric companies with a view to economising coal. The effect of that would be either that they would increase the consumption of coal or people would have to go without light. Taking a very moderate estimate, the one I mentioned just now, that 1 ton of coal produces 500 units of electricity, and taking the consumption of ordinary lamps at 1½ watts per candle-power, also a conservative figure, we get 333,330 c.p. hours Now, suppose the same amount of coal was expended in gas. One ton of coal would produce, say, 13,000 cubic ft. of gas, and at 20 c.p. per cubic foot, that would give 260,000 c.p. hours so that the advantage of electricity supply from the lighting point of view is that you save 73,330 c.p. hours, or a 28 per cent. saving in fuel. Consequently, any attempt to restrict the supply of electric light would only increase the consumption of coal. And if this is true of lighting it is very much more true of electric power. That, of course, is obvious when you come to figures and demonstrate it. It is obvious that where you are burning coal in the most efficient boilers of a large size, and supplying electricity with steam turbines of the highest possible economy, you are burning very much less coal per indicated horse-power delivered to your mains than with a number of small users, having their own separate steam engines with very much smaller boilers, less efficient engines and greater expense in every way. Therefore, whichever way you look at it, an electric supply company is one of the greatest economisers of coal in the country, and if they want to economise coal they should extend electric supply largely in all directions. It may interest you to know that as far as our own supply is concerned, 55 per cent. of it is used for power and heating and only 45 per cent. for lighting. Of course, of all methods of burning coal an open coal fire is the most wasteful. I am surprised that an enlightened place like this, to which we supply electric light, have not put in electric radiators to heat it. I hope if we meet here another year we shall not have to complain of their waste of coal in this scandalous manner. The first quarter of the current year we get the benefit of the last advance we made in price, and in addition our output has increased about 13 per cent. this quarter. On the other hand the Summer Time Act is coming into force earlier than last year, and in case any of the remarks I have made to-day should filter through to the proper quarters and have an effect, there is the prospect of a restriction to us in the supply of coal, which, as I have pointed out, would defeat its own object. However, people do not always do the right thing, and if they try to save coal by causing it to be more wastefully used we may suffer a little in revenue in that respect. You may rest confident, however, that in the hands of Mr. Bailey, one of the managing directors on the technical side, and of Mr. Bull, on the commercial side, the very utmost will be done for the Company, and so far as I can see I do not think there is any reason to anticipate that we shall have to make any further reduction in dividends. I now move that the report and accounts be adopted.

Mr FRANK BAILEY seconded the resolution, and after a question had been answered it was carried unanimously.

The dividends recommended were then declared. The retiring directors (Mr. J. B. Braithwaite and Mr. P. D. Tuckett) were unanimously re-elected, and Messrs. W. H. Pannell & Co. were re-elected auditors. A vote of thanks to the chairman and staff concluded the proceedings.

ALBY UNITED CARBIDE FACTORIES (LTD.)—At the annual meeting last week, the chairman (Mr. A. E. Barton) announced that the company was erecting an electrode factory at Newcastle. The company consumed a very large quantity of electrodes (about 4,000 tons a year) and the matter had given the directors a great deal of anxiety. Prior to the war they were purchased in Germany and Austria, but since the war the company had been purchasing them in America. Shipping was not an easy matter in these times, and therefore the directors decided some few months ago to build works in England. They were starting with works of a capacity of 5,000 tons, which would afterwards be increased. He said it would mean a saving, when the works were completed about six months hence, of about £15,000 a year to the company. There was no doubt that the factory would be considerably enlarged in the very near future, because he firmly believed that after the war there would be in England a very big production of steel by electric processes. It was going ahead very rapidly, and he thought it would consume very large quantities of electrodes, so that he had every hope that it would be quite a profitable branch of their business, in addition to giving a supply to meet their own requirements.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—Mr. James Taylor, J.P., presided over the meeting on Monday and in moving the adoption of the report and accounts and the declaration of a dividend of 5 per cent. for the year (less tax) on the ordinary shares, said the profits (after deducting estimated excess profits tax) amounted to £56,150, and with amount brought forward the total was £63,224. During 1916 the factory had been working day and night. They had been able to complete the automatic exchanges at Portsmouth, Paisley and Blackburn. All the exchanges they had erected to date were giving satisfaction, which was a good augury for the future. He had on previous occasions mentioned the Leeds exchange—the largest automatic exchange to be erected in this country. They had every reason to expect that the exchange would be finished for service as soon as the Post Office was ready for it. This department, owing to shortness of staff and other calls upon the service, had not been able to proceed with their part of the scheme as rapidly as expected. He drew attention to the cash balance of £139,877, which was a large increase over last year, but out of which they had to pay excess profit duty. That balance was due to increased trading and a quicker turnover. The money, which was largely invested in short-date Government security and subsequently in the last War Loan, should be a source of strength to them when normal times were restored. At present the works were fully employed and were likely to continue until the end of the war. They were, of course all anxious that the war should cease as soon as possible, but he thought it only right to point out that when this time arrived the company was bound to suffer, inasmuch as it would be quite impossible to cease the manufactures on which they were now engaged and revert to their ordinary business without considerable loss of time and money.

BOGNOR GAS, LIGHT & COKE CO. (LTD.).—At the recent half-yearly meeting the directors' report stated that there were 205 consumers of electric current. The chairman (Mr. Lovett) said the undertaking was proceeding very satisfactorily. No doubt it would have been far more prosperous if it had not been for the war. No end of houses remained to be built, but that work was entirely suspended. He had land which would have been covered with houses by this time had it not been for the war. The electricity department had more than paid its way, and said the company did very well in securing electric lighting powers for themselves and so avoiding opposition. Ald. J. G. Denton, who seconded the motion for the adoption of the report, stated that the electricity profit was £110, and although everyone would liked to have seen it yt £1,000, they must remember that there was no building going on. Later the undertaking would prove a valuable asset.

BRITISH ALUMINIUM CO. (LTD.)—The profit for 1916 (including amount brought forward), after making provision for excess profits duty and after charging amounts required for the service of the prior loan debentures and the debenture stock, was £239,962. £60,000 has been set aside for depreciation and £75,000 added to reserve. The directors recommend a final dividend at rate of 12 per cent. per annum on the ordinary share capital (making 10 per cent. for year), leaving £26,926 to be carried forward.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—The accounts for 1916 show, after paying all manufacturing costs and expenses of administration, a net profit of £21,277, and with £4,604 brought forward, the available total is £25,881. The board recommend that £7,500 be placed to reserve and £1,500 to depreciation reserve, that a preference dividend of 6 per cent. for the year (£3,719) be declared, also a dividend of 7½ per cent. on the ordinary shares (3 per cent. of which was paid in September last), absorbing £6,412, and that extra remuneration of £969 be voted to the directors, leaving to carry forward £5,781.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The chairman (Dr. E. K. Muspratt, J.P.) presided over the 21st ordinary general meeting on Monday. He stated that the profit for the year 1916 was £300,456, compared with £295,131 for 1915, an increase of £5,335, which made the result the best year in the history of the company. He was sure the shareholders would regard this as satisfactory, considering the difficult times through which the country was passing. The good results were the outcome of a much larger volume of business in money value during the year than ever before. The work done—especially during the latter months of the year—had been almost entirely for the Government, directly or indirectly. All the resources of the several works were at the disposal of the military and naval authorities, and Government work took precedence of any other form of manufacture. He felt sure that it was the wish of the shareholders that the company should render all assistance in its power to produce as large a quantity of material as possible to enable our gallant soldiers and sailors to bring this terrible war to a satisfactory termination. The changes they had had to make to enable them to manufacture articles comparatively new to the company, the curtailment of the company's ordinary trade and the stoppage of almost the whole of the export business, all pointed to the fact that after the war was over new and strenuous efforts would have to be made to enable the company to resume the important position held by it before the outbreak of the conflict. Doubtless some of the new departments created would help to attain that end. During the year the number of the company's men with the Forces had increased by 291, making a total of [illegible], and the directors continue to make them allowances. He regretted to say that up to date 12 of the men had fallen while on active service. With the balance brought forward from the year 1915 there was available for all purposes £[illegible], out of which there had been paid [illegible] trustees' fees, &c., and after placing £25,000 to [illegible] machinery, &c., £20,000 to special [illegible] plant [illegible] which was necessary due to the [illegible] £50,000 to reserve, [illegible] to debenture stock redemption account, [illegible] preference dividend and interim dividend on ordinary shares, amounting to £87,500, there remained [illegible]. The directors recommend payment of a further dividend of [illegible] per share, making, with the interim dividend, a distribution on the ordinary shares of [illegible] and a bonus of 5 per cent., a total of 20 per cent., leaving a balance, after making provision for [illegible] liability for excess profits duty, to carry forward of £163,648, [illegible] of last year's carry forward of £3,551. With [illegible] capital expenditure, [illegible] the amounts expended [illegible] the Prescot and Helsby factories, the amount now stood at £[illegible] compared with £[illegible] last year. The reduction [illegible] provided by depreciation £[illegible] more than was expended upon capital account. The employment of so much unskilled female labour had unduly increased the wear and tear of plant, and had necessitated the provision of a larger sum for depreciation. The value of stocks and work in progress had increased by £54,572, largely owing to the cost of copper, lead and other raw materials which had risen to an unprecedented extent. The shareholders would be interested to learn that after careful re-valuation the directors were of opinion that, notwithstanding the general depreciation in the value of securities, they still reached a figure more than that appearing in the balance-sheet. Having referred to the company's large investments in the Midland Electric Corpn. for Power Distribution, the Electric Supply Co. of Victoria, and the Automatic Telephone Mfg. Co., all of which were producing satisfactory returns, the chairman proceeded to pay a warm tribute to the staff of the company. The conditions under which business had been conducted had been very onerous during the past year. The committees set up by the Government for the control of raw material, the provision of men, the adjustment of taxation, the welfare of workpeople, &c., were very numerous, and the difficulty in satisfying the desires of conflicting bodies, such as those who wanted the company's men and those who were desperately in need of the product of their labour, had made the positon very difficult, and in addition to having had to carry on with a reduced staff, there was now required by these numerous committees an unprecedented number of returns, and forms to be filled in with minute particulars, involving a very great deal of labour. The work had to be done by a staff which had lost many of its well-trained workers, and he told the shareholders that in order that they might understand that the thanks he offered on their behalf to the staff and workpeople were sincere. He would like specially to name the general manager (Mr. Dane Sinclair), Mr. Nisbett, Mr. Brotherton and the secretary (Mr. Kerfoot), upon whom so much of that additional strain had fallen.

Sir Harmood Banner, M.P., seconded the motion, which was unanimously agreed to.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—During 1916 the connections increased from 4,254 to 4,499 kw., but the stringent lighting restrictions and the Summer Time Act caused a large reduction in revenue. There is a profit of £8,573 on the year's trading, compared with £10,529 in 1915 and after payment of debenture interest and trustees' fees, &c. (£2,956), and adding £1,672 brought forward, the balance is £7,288. An interim dividend at rate of 4 per cent. per annum was paid for the half-year in October, and the directors recommend the payment of a further dividend for the second half-year at rate of 6 per cent. per annum (making 5 per cent. for the year) and that £2,000 be placed to general reserve, leaving £1,538 to be carried forward.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The revenue account for 1916 shows a credit balance of £23,938, which, with the £6,012 brought forward and £177 balance of interest received, makes a total of £30,126. After deducting £1,051 for interim dividend on the 7 per cent. cumulative preference shares and £6,799 interim dividend at rate of 8 per cent. per annum for the half-year to June 30 on the ordinary shares, the balance is £22,277. The directors recommend that £46 be written off cost of investments and that £5,104 be placed to credit of depreciation and £2,000 to reserve. After payment of dividend on the preference shares for half-year ended Dec. 31 (£1,049) it is recommended to pay a dividend on the ordinary shares for half-year ended Dec. 31 at rate of 10 per cent. per annum, making 9 per cent. for the year (£8,501); a sum of £501 is to be paid as directors' additional remuneration, leaving to be carried forward £5,075. The equivalent of 345,744 35-watt lamps is connected to the mains, an increase of 18,452 over 1915. There are 6,678 consumers, against 6,512. The gross receipts were £55,878, the expenditure was £31,940, and average price obtained was 4·1d. per unit, against 4d.

BROWETT, LINDLEY & CO. (LTD.)—The directors, who are unable to submit the accounts for 1916, are satisfied that the results of the year's trading justify them in paying the full year's dividend on the 6 per cent. preference shares, a further 3 per cent. on the preference shares on account of arrears (£1,500), and 4 per cent. per annum on the ordinary shares (£1,500). The last ordinary dividend was 8 per cent. for 1900

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The profit for the year 1916 amounts to £31,679. 10s. 8d., which with £3,292. 11s. 11d. brought forward and £1,809. 13s. 8d. for interest, makes a total of £36,781. 16s. 3d. After deducting interest on debenture stock (£6,677. 14s. 7d.), interim dividend on preference shares at rate of 6 per cent. per annum (£900), and interim dividend on ordinary shares at rate of 3 per cent. per annum (£3,707. 11s.), the balance is £25,496. 7s. 8d. The directors recommend that £15,300 be placed to credit of reserve for renewals, depreciation and contingencies and £815. 11s. 6d. to credit of debenture stock premium redemption fund, and that £1,089 be written off cost of extinction of founders' shares, and also a final dividend on preference shares at rate of 6 per cent. per annum, making 6 per cent. for the year (£900), and a final dividend on ordinary shares at rate of 3 per cent. per annum, making 3 per cent. for the year (£3,707. 11s.), leaving to be carried forward £3,684. 2s. 2d. The number of 8 c.p. lamp equivalents connected on Dec. 31, 1916, was 327,528, an addition of 7,688 during the year, and the total number of units sold was 4,271,170, being 78,578 more than that for the previous year.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.)—The chairman (Mr. Jas. Falconer, M.P.), who presided at the meeting last week, explained the proposal for the sale of the shares to the Newcastle-upon-Tyne Electric Supply Co. While in the last four years the revenue had risen by £80,501, the costs had increased by four-fifths of the amount, chiefly on increased cost for generation, and the company was faced with requests for further supplies from old customers and for supplies from new customers. The iron and steel trades had made great extensions, and from those and new industries a larger demand for power was to be expected. The company had provided for an extension of 11.000 H.P., but it could not arrange during the war for the erection of further waste-heat stations, or obtain capital for extensions of its coal generating plant. The profits of the Cleveland & Durham Co. for the past year were £37,129, and a dividend of 2 per cent. on the preference shares was sanctioned. They had had to provide £5.000 more for depreciation, because they had to use their own generating stations fully owing to the reduced supply of waste heat.

The proposal was approved, and the report and accounts were adopted.

COALITE (LTD.)—The directors' report states that during the past year further patents for improvements in the Coalite process have been taken out in the principal foreign countries. The arrangements with the Barnsley Smokeless Fuel Co. and British Coalite Co. secure for it the benefit of all new inventions, plans and drawings for the erection of low-temperature plants. The plant of the Barnsley Smokeless Fuel Co. is now on the eve of completion as to the first series of retorts, serious delays having occurred in the delivery of materials.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—Including amount brought forward, the accounts for 1916 show, after payment of income tax and excess profits duty for 1914 and 1915, a balance of £57.709. The directors propose to pay a dividend on the preference shares at 10 per cent. per annum (£3,000), a dividend on the ordinary shares at 5 per cent. per annum (2 per cent. having been paid as an interim dividend in October last), absorbing £3.233, and a bonus on the ordinary shares of 2 per cent. (£1,293), also to transfer £5,000 to reserve fund, to make provision on account of investment fluctuations (£3,134), and to carry forward £42,048. 16s. 11d., subject to special taxation of profits. The dividend and bonus on the ordinary shares are tax free. The company's cables and land lines continued in good working order throughout the year.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The directors' report states that up to Dec. 31 last the equivalent of 157,931 8 c.p. lamps was being supplied, an increase of 4,480 8 c.p. lamps during 1916. Owing to the high price of fuel and the difficulties of freightage, it has been found necessary to increase the price charged for current. Including the receipts from hired installations, the profit for the three undertakings amounts to £16,373. With £2,602 brought forward and interest and installation profits, and after allowing for interest on debenture stock and dividend on preference shares and payment of excess profits duty for 1914 and 1915, the balance is £12,094. Out of this an interim dividend at rate of 6 per cent. per annum has been paid on the ordinary shares, and the directors have carried £5,000 to depreciation fund and £1,000 to reserve fund, and they recommend payment of a dividend at rate of 8 per cent. per annum (less tax) on the ordinary shares for the half-year (making 7 per cent. for 1916), leaving £2,594 to carry forward.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors' report states that the profit made during 1916 was £198,270. Deducting directors' and auditors' fees, debenture interest, income tax and amount written off for depreciation (£87,154), and adding amount brought forward (£55,264), the total is £166,380. After deducting amount transferred to reserve in respect of depreciation of trustee securities (£7,650), to reserve account (£20,000) and to special war allowance reserve (£5.000) and the year's dividend on the preference shares (£9,000), and interim dividend on the ordinary shares (£10,000), the available balance is £114,730. A sum of £5,000 is to be voted to the staff pension and benefit fund, and the directors recommend payment of a final dividend on the ordinary shares of 10 per cent. (less tax), making 15 per cent. for the year, and also a bonus of 10s per share (less tax). This will require £40,000, and leave to be carried forward £69,730. A reserve has been made in the accounts in respect of the liabilities of the comapny for special taxation under the Munitions of War and Finance Acts. As the greater part of the machinery in the factories has been running day and night, it has been necessary to again provide a considerable sum for depreciation and provision has been made also for machinery which has been bought specially for war purposes, and which will be useless after the war. The company has been training women since the commencement of the war to take the place of men with H.M. Forces, and the number of women now employed exceeds 800.

MACKAY COMPANIES.—The report for the year ended Feb. 1 last states that the various telegraph and cable enterprises controlled by the Mackay Companies have enjoyed a very successful year. The income of the parent undertaking, exclusively derived from investments in other companies, was $4,683,265, against $4,274,900 for the previous year, while operating expenses absorbed $56,800, and dividends on the preferred and common shares at the usual rates of 4 and 5 per cent. respectively, $4,069,020. The surplus of $557,445 raised the accumulated surplus to $1,913,344. The trustees have under consideration the advisability of increasing the dividend on the common shares from 5 to 6 per cent. per annum. The extra 1 per cent. calls for only $413,804. The financial position of the various subsidiary undertakings is quite satisfactory. The companies have felt the enormous increases in the cost of materials and labour, but so far increased traffic has fully compensated for increased costs. The surplus and reserves of the system have been further increased during the year and are now invested in Government securities of the highest class, so that the trustees state in the report that they know of no other great quasi-public institution in the United States that occupies quite so strong a financial position. It is now 10 years since the outstanding preferred shares, and 12 years since the outstanding common shares were increased, and in the interval no notes have been issued or debts incurred. The issued capital is $50,000,000 of preferred and $11,380,400 of common shares, while investments in other companies represent $92,005,445, and cash $1 288,300.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—The accounts for 1916 show a gross profit of £24,408. After debiting interest and London office expenses, making provision for debenture stock sinking fund and transferring £6,000 to depreciation and renewal account, the balance is £13,124 and with £4,272 brought forward the total is £17,396. It is proposed to pay a dividend of 6 per cent. per annum on the preference shares, (whereof a moiety was paid in September) absorbing £6,000, and a dividend of 8 per cent. per annum on the ordinary shares (£4,580. 16s.), to place £2,500 to general reserve, leaving £4,315 to be carried forward subject to excess profits duty (if any). The traffic receipts increased by 8·3 per cent. upon 1915 and the cost per mile run rose 6·1 per cent., due chiefly to increased prices of materials and higher rates of freight.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.).—The chairman (Mr. J. H. Armstrong), who presided at the meeting last Friday, said that the horse-power connected during the 12 months was 24,630, making the total 282,750. The profit for the year was £224,626, and the sum available for dividend was £168,888, out of which they were paying the full dividend of 5 per cent. on the preference shares and 7 per cent. on the ordinary shares, which was 1 per cent. in excess of that for 1915. Apart from the extra amount required to pay the additional dividend of 1 per cent., they had been able to increase their two reserve accounts by £7,000, and they carried forward a further sum of £2,244. The plant had been efficiently maintained, and the sum of £98,198 had been spent thereon out of revenue. They had only laid 20½ miles of mains last year whereas the expenditure under that item was £32,948. The reason was that they had acquired from the Durham Company a certain amount of mains in their district, which they had used as interconnector cables between their Dunston station and other stations in Durham. The other item (£21,522) was on the completion of the engine house at Carville, which would eventually accommodate five large turbines. Only one of those turbines was installed in 1916, but it was fortunate they had completed that engine house last year, and did not wait to build it as they got delivery of the turbines, because at present it was practically impossible to get delivery of steel. Of their employés, 270 had gone to the war, and the vacancies had been partly filled by female labour and partly by discharged service men. As it was necessary that some of these men and women should have a technical knowledge, the company had established regular classes for them, where lectures were delivered and demonstrations given by their own officials. That systematic training had proved beneficial and the men and girls were giving satisfaction.

The report and accounts having been adopted, the chairman dealt with the proposal for the acquisition by the company of the entire assets and undertaking of the Cleveland & Durham Electric Power (Ltd.). There were 6,300 miles of cables in the Cleveland Company's area, with 681,469 H.P. connected, and its gross profit last year was £37,129. The Tees-side area during recent years had shown promise of becoming a very large industrial centre, and quite recently it had given indications of more active development. In fact, there was every reason to believe that before many years passed the Tees district would hold a leading position in the industrial enterprises of the north-east coast. The Cleveland Company in its earlier days suffered through not having behind it a nucleus of profit to go on with, which the Newcastle Company had in its lighting load, and the result was that it had no profits to assist it during the time when money was being expended on capital account from which no adequate return was received for some period. The Cleveland Company benefited largely by the fact that the majority of the waste heat stations were within its area. In fact, the Cleveland Company obtained the whole of its power from those waste-heat stations; but owing to the war the output of the collieries was reduced, and there was a considerable falling off temporarily in the waste heat from those stations. The result was that the company were compelled to fall back on the coal-fired generating station at Grangetown, from which they had to get a considerable portion of their supply. That station, partly owing to its situation and partly owing to the class of plant installed, was far from economical, and the effect, therefore, of the lost waste heat and the extra cost of coal in firing the hand-fired station was very adverse to the profits of the company. During the last two years the Cleveland Company had received many applications for additional current both from old customers and from new manufacturing undertakings. Consequent upon these large demands and the difficulties in connection with finance, with which they were faced they had not seen their way to take advantage of the position, and undertake what promised to be a very large development in that district both at present and after the war. The position became acute just before the end of last year, hence arose the scheme put before them. Bishop Auckland and Consett could be much more advantageously developed by the Newcastle Company than by the Cleveland Company. The cost of connecting up to these colliery districts could be much more cheaply done by the Newcastle than by the Cleveland Company. The Newcastle Company was already linked up with Cleveland. They had an interconnector cable, and that system of exchange could be extended without any difficulty and with the greatest possible benefit to the general supply of the combined areas. If the whole of those stations were run jointly and under one control it would enable them to obtain the maximum economy possible. The situation of the Newcastle Company with regard to Cleveland was such that they were in a position to deal with the supply and development of their area from the point of view of economy and success to themselves in a way that no other independent company could attain to, and it was for that reason that the directors, realising that fact and the many advantages that would accrue to the general interests of power supply (which latterly had become a matter of national importance), advised that advantage should be taken of the opportunity for the closer union with the Cleveland Company.

The scheme was approved unanimously.

NITROGEN PRODUCTS & CARBIDE CO. (LTD.)—Mr. A. E. Barton, who presided at the recent meeting, stated that the demand for their products for chemical purposes had been very great and all the subsidiary companies had also done well. The English factory for the production of nitric acid and nitrate of ammonia by their catalytic process had commenced working. The plant erected in France had been running for some months, and it was proposed to erect large works in Italy. An American company had also decided to adopt the process. With the large amount of water power at their disposal they should be in a unique position to assist not only their own country, but the whole world, by the production on a large scale of a cheap nitrogenous fertiliser. The harnessing of the Aura water-power was being proceeded with. It was hoped by undertaking the work at the present time that the ultimate completion of the scheme might be as little delayed as possible. It has not been considered advisable to purchase plant at the high prices now ruling, but all machinery, &c., which was bought before the outbreak of war was being installed.

TORPOINT ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the directors reported that the lighting restrictions and the Summer Time Act, as well as the high cost of fuel, had adversely affected the development of the undertaking. The profit on trading last year amounted to £80, compared with £15 for the previous year. The chairman (Dr. Purves) stated that new plant would be installed before the commencement of next winter, and the directors were in negotiation for the purchase of a suction gas plant and dynamo.

WINDERMERE & DISTRICT ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for 1916 states that the lighting and other restrictions caused a drop in the receipts from the sale of current of £543. The Diesel oil set has been in use during nearly the whole year and has worked well. The Keswick Electric Light Co. has also had smaller sales of current, and has only been able to make a payment of 2 per cent. on account of arrears of debenture interest. The total available balance is £1,905. Debenture interest and an interim dividend of 1 per cent. on the preference shares, &c., absorb £512. A sum of £200 has been transferred to depreciation reserve, and a further 1 per cent. dividend is to be paid on the preference shares and £62 carried forward.

NEW COMPANIES, &c.

BURDETTE & CO. (LTD.) (146,713).—Private company, reg. March 21, capital £6,000 in £1 shares, (1,000 pref.), to take over business of electrical and general engineers carried on by P. Speedy, G. L. Eynon and J. Meech as Burdette & Co. First directors are: J. Meech, P. Speedy and G. L. Eynon.

DOUBLE ARC ELECTRIC WELDERS (LTD.) (9,782).—Reg. in Edinburgh, capital £1,000, in 980 ordinary shares of £1 each and 800 deferred shares of 6d. each, to act as a preliminary company to acquire certain inventions relating to methods of electric welding of steel, &c.

HACKBRIDGE CABLE CO. (LTD.) (146,684).—Private company, reg. March 20, capital £25,000 in £1 shares, to take over the business carried on as the Hackbridge Mfg. Co., and to carry on the business of cable makers, electrical engineers, &c. Permanent governing director, C. W. Bloomfield. Reg. office: London-road, Hackbridge, Surrey.

HENDON ENGINEERING CO. (LTD.) (146,146).—Reg. Feb. 22, capital £2,500 in 3,000 preference shares of 10s. each and 4,000 ordinary shares of 5s., to carry on the business of engineers, electricians, motor and cycle manufacturers, &c. Reg. office, 3, Broad-street-buildings, E.C.

HUDSON'S ELECTRICAL ENGINEERING CO. (LTD.) (146,731).—Private company, reg. March 21, capital £1,000 in £1 shares to take over the business of an electrical engineer carried on as Hudson & Co.

INDIA RUBBER MANUFACTURERS ASSOCIATION (LTD.) (146,506).—Private company, reg. March 15, as a company limited by guarantee [illegible] 100 members each liable to £1 in event of winding up, to promote the interests of india rubber manufacturers in the United Kingdom, to collect statistical information, &c. The annual subscription is [illegible]. The first members of the Committee of management are: J. T. [illegible] (Birmingham Rubber Co.), P. Bate (Castle Rubber Co.), [illegible] (Chas. Macintosh & Co.), J. H. C. Brooking (St. Helens Cable & Rubber Co.), F. Eccles (F. Reddaway & Co.), J. Henderson ([illegible] Rubber Co.), D. Moseley (David Moseley & Sons), J. Tinto ([illegible] Rubber Co.) and T. W. [illegible] (Avon India Rubber Co.). Reg. office: [illegible]

[illegible]THAL & CO. (LTD.) (146,791).—Private company, reg. March [illegible] to take over the business of an electrical engineer and manufacturer of and dealer in electrical and mechanical [illegible] carried on by A. W. [illegible] as [illegible]thal & Co. First directors are A. W. [illegible], Mrs. C. [illegible]thal and L. F. Fogarty.

E. A. MANNLER (LTD.) ([illegible]).—Private company, reg. March 3, [illegible] to carry on the business of consulting, mining [illegible] &c. Reg. office: [illegible] London Wall, E.C.

MAYALL & CO. (LTD.) ([illegible]).—Private company, reg. March 17, [illegible] to take over the business of factors of and dealers in [illegible] carried on by J. W. [illegible] J. W. Mayall permanent director and chairman. [illegible] 147, Corporation-street, [illegible]

NATIONAL TIME RECORDER CO. (LTD.) (146,424).—Private company, reg. March 12, capital £10,000 in £1 shares, to carry on the business of manufacturers of time recording machines and clocks, electrical engineers, &c. First directors are A. C. Krause (chairman and permanent governing director), F. W. Lowe, S. B. Causer and A. T. Brown.

POWER ENGINEERING CO. (LTD.) (146,808).—Private company, reg. March 22, capital £1,000 in £1 shares, to take over the business carried on at Manchester by E. R. Voigt and partners, as the Power Engineering Co., and to carry on the business of engineers, welding experts, manufacturers of wood and rubber blocks, cranes, hoists, &c. First directors are: Emil R. Voigt (permanent director and secretary), Ernest M. Ginders and Mrs. M. Voigt. Reg. office: Thomas-street, Cheetham Hill, Manchester.

RAILWAY & STEAMSHIP ENGINEERING CO. (LTD.) (146,566).—Private company; reg. March 16, capital £3,000 in £1 shares, to carry on the business indicated by the title and that of mechanical, electrical and manufacturing engineers, &c. First directors are A. N. Homer and E. O. M. Slatter.

E. READER & SONS (LTD.) (146,472).—Private company, reg. March 14, capital £20,000 in £1 shares, to take over the leasehold "Phœnix Works," Nottingham, and to carry on the business of engineers, founders, boiler makers, electrical engineers, &c.

RENSHAW ENGINEERING WORKS (LTD.) (146,484).—Private company, reg. March 14, capital £5,000 in £1 shares, to carry on the business of mechanical, electrical and general engineers, &c. First directors are T. P. Hartley and C. E. Holder. Reg. office: 27, Chatham-road, Battersea, S.W.

SENTINEL CO. (LTD.) (146,485).—Private company, reg. March 14, capital £5,000 in 496 preference shares of £10 each and 800 ordinary shares of 10s. each, to carry on the business of electricians, electrical, mechanical, motor, telephone, ventilating and general engineers, manufacturers of scientific and other instruments, signals, &c. First directors are J. F. J. Malone, H. L. Riseley, F. E. Hannay and E. Hannay.

J. & W. B. SMITH (LTD.) (146,734).—Private company, reg. March 21, capital £70,000 in £1 shares, to acquire from the executors of the late J. G. Watkinson the business of manufacturers of and dealers in gas, electrical, glass and ironmongery goods, &c., formerly carried on by the said J. G. Watkinson, in succession to J. & W. B. Smith. Secretary: E. A. Irwin. Reg. office: 19, Farringdon-road, E.C.

TINGEY & CO. (LTD.) (146,292).—Private company; reg. March 1, capital £1,000 in £1 shares, to take over the business of engineers carried on by L. I. Robinson and W. H. Tingey as Tingey & Co., and to carry on the business of mechanical, electrical, experimental and scientific engineers. First directors are L. I. Robinson and W. H. Tingey. Reg. office, 3, Staple Inn, Holborn, E.C.

RECEIVERSHIP.

LONDON ELECTRON WORKS CO. (LTD.)—A. Taylor, Thames House, Queen-Street-place, E.C., ceased to act as receiver or manager on Feb. 19, 1917.

CITY NOTES.

MEMORANDA.—(March 27).—Consols, 54⅛. Consols Pay Day, April 4. Stocks and Shares Ticket Days, April 12 and 26. Pay Days, April 13 and 27. Price of Silver, 35 11/16d.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—A dividend of 2 per cent. on the ordinary stock has been declared for the quarter ended March 31.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—Warrants in payment of the dividends on the preference and ordinary shares have been posted.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on March 13:—Electrac um, Electric Stores, Engineering & Electrical Co., New Electric Rifle & Target Co., Panama Electric Lighting Power & Traction Co., Telephone Instalment System Co.

CORNWALL ELECTRIC POWER CO.—A dividend of 3 per cent. has been declared for the past year, £1,000 placed to reserve and £913 carried forward.

HONG KONG TRAMWAY CO. (LTD.)—A dividend of 23 per cent. (less tax) is recommended for the past half-year, making 30 per cent. for year; £2,111 is written off cost of undertaking, and £16,705 carried forward. Last year 12 per cent. was paid for year.

P. R. JACKSON & CO. (LTD.)—A final dividend of 7½ per cent. has been declared on the ordinary shares, making with the interim dividend 10 per cent. for the past year, compared with 7½ per cent. for 1915.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—A dividend of 5 per cent., tax free, is announced.

ROBEY & CO. (LTD.)—The directors have declared a dividend of 6 per cent. (less tax) on both the preference and ordinary shares.

SHAWINIGAN WATER & POWER CO.—A dividend of 1¾ per cent. has been declared for the quarter ending March 31.

SOUTH STAFFORDSHIRE TRAMWAYS CO. (LTD.)—The accounts for 1916 show an available sum (including £753 brought in) of £1,122, and the directors recommend a dividend of 4 per cent. on the preference shares carrying forward £811.

THE ROUND TABLE.

By "KVA."

A curious juxtaposition of posters is to be seen just now in the Strand. One reads:—

DON'T WASTE COAL, GAS OR ELECTRIC LIGHT.

The other says:

TRAVEL TO AUSTRALIA BY THE ORIENT LINE.

We are all trying to act up to the first, but who, at this moment, wants to follow the advice of the second?

* * * *

"Windows were shattered and other damage done by a gas explosion at the office of the Incorporated Society of Licensed Victuallers in Fleet-street."

Considering the unfaltering support which the electrical industry has given this ancient institution it should have broken away from gas long since.

AN AMERICAN VIEW OF THE HIGH PRICE OF PETROL IN THE UNITED STATES AND THE TENDENCY TO EMPLOY "ELECTRICS."

That this is an engineers' war is being proved over and over again, but it has been left to the "Star" to place the matter beyond any doubt, thus:—

> Rumania's position, surrounded, save on the Bessarabian frontier, by enemies, has led to violent oscillations like the thrusts of an internal combustion engine.

* * * *

Mr. Llewelyn Foster, who has guided the destinies of the Electrical Department of the British Engine, Boiler and Electrical Insurance Co. since '98, showed me, at his new London office, some interesting photos of breakdowns discovered by the company's inspectors at various times. One picture illustrates three good-sized rats in the armature "spider" of a large direct-current generator, and the effects on them of a late dinner upon the insulation of the commutator leads. The result was a shut-down of the machine, and three "nicely done" electrically cooked rodents, cooked without loss of weight, too!

* * * *

The other picture was even more interesting, and it reminded me of the story of the countryman who, on first seeing a giraffe, exclaimed, "I won't believe it." It showed how a soft brass oiling ring on a dynamo bearing in the course of its "hundreds of hundreds of revolutions" had neatly severed the shaft! When the dynamo attendant saw the pulley revolving and the armature standing still I expect he felt like "Punch's" famous "late-nighter," who pointed to an extra large fish in a case on the stairs of the Club, blurted out to his friend, "The man who caught that fish is a   liar!" However, the dynamo attendant, after carefully counting the fingers on each hand and "touching wood," sent for the insurance company's inspector, who was, of course, delighted to add this curious specimen to his collection.

"French Take Bastion," shouted an evening paper placard. I hope they will return him before the Real Red Heat winter season is upon us once more.

* * * *

Out of deference to popular feeling, I understand that the lightning conductor upon seminaries and ladies' establishments generally will be known in future as the "lightning conductress"!

* * * *

There is no truth in the suggestion of a correspondent that the head-line in the "Sheffield Independent" "Electric Wire Fusion," relates to the formation of a rival organisation to the Cable Makers' Association.

* * * *

Says the "Yorkshire Observer": "From the public point of view the multiplication of electric vehicles would give unalloyed satisfaction." The metallurgical reference is presumably not intended as a joke on the battery makers: at least, I hope not.

* * * *

I hear that a flicker electric fire which has all the appearance of a "living flame," was the subject of a humorous story recently told at a gathering of commercial electrical men. The flicker effect is produced by means of a heat operated fan wheel which revolves a disc in the lower part of the fire, just above the rays of a small lamp. A "satisfied" user of one of these fires wrote in to the maker to say that the fan wheel speeded up and the whole apparatus disappeared up the chimney. The up draught was so great that it was only with difficulty the carpet was prevented from following the fire!

* * * *

THIRTY-SEVEN YEARS AGO.

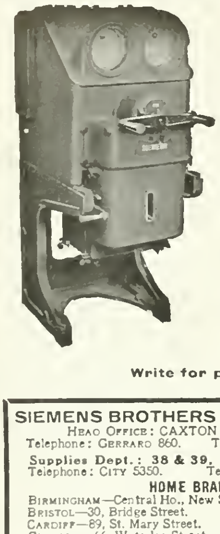
[From THE ELECTRICIAN (Second Series), Oct. 4, 1879.]

TELEGRAPH WORD-TARIFF.—On Wednesday the new tariff for telegrams came into force in Holland. For every telegram must be paid a standard price of 3d., added to which is one cent, or a fifth of a penny, for every word which the telegram contains. "Answer paid" will hold good for 10 words only; the letters R.P. (*réponse payée*) will be reckoned as one word. The new arrangement at present does not extend to any other countries than Holland and Belgium.

ORNAMENTS WITH MOTION PRODUCED ELECTRICALLY.—Some curious trinkets, to which certain motions can be given at will by means of electricity, have recently been devised by M. Trouvé. Two of these (described in *La Nature*) are scarfpins; one has a death's head, gold or enamel, with diamond eyes and an articulated jaw; the other has a rabbit seated upright on a box with a little bell before it, to be struck with two rods held in the animal's forepaws. An invisible wire connects these objects with a small hermetically-closed battery, the ebonite case of which is about the size of a cigarette. It is kept in the waistcoat pocket, and acts only when turned horizontally or inverted. When a person looks at the pin the owner, slipping a finger into his pocket, moves the battery, whereupon the death's head rolls its eyes and grinds its teeth, or the little rabbit beats the bell with its rods (through electromagnetic action). A third kind of ornament is a small bird set with diamonds, to be fixed in a lady's hair, and the wings of which can be set in motion electrically.

L. P. S.
CLIPS, TIPS & TERMINALS
of all descriptions.
Write for Booklet, with Illustrations, of 75 types to:—
THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Goldsplat, Ox., London." 4746 Gerrard.



SIEMENS

IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Illustration shows our Standard Cast-iron Mining Pillar suitable for pressures up to 3,300 volts.

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: Gerrard 860. Telegrams: "Siembralos, Vic, London."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs.
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

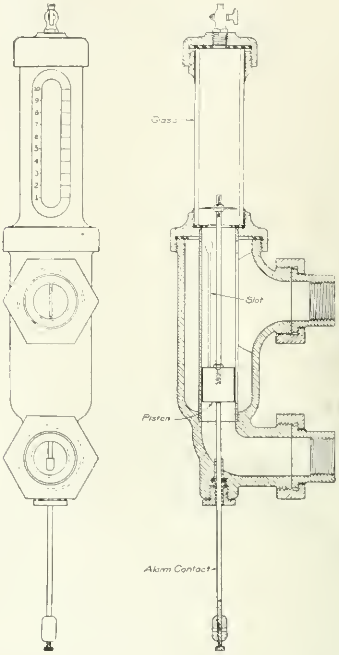
THE VAUGHAN FLOW METER.

This instrument, designed and patented by Mr. J. F. Vaughan, meets the demand for a simple and efficient method of indicating the flow of liquids in pipes. It is applicable to a large number of commercial systems, such as cooling, heating, lubricating, refrigerating, boiler supply and various other manufacturing processes.

As shown in the illustration, the instrument consists of a cylindrical chamber with suitable pipe connections enclosing a slotted tube through which the liquid must pass. Enclosed in the slotted tube is a piston which, as the liquid is turned on, is carried up until the exposed area of the slots is sufficient to allow the flow of the liquid up to the capacity of the indicator. An index is attached to the upper end of the piston rod, which extends up into the glass tube at the top of the cylindrical chamber. The glass tube is encased in a protecting cover, cut away to allow the movement of the index, corresponding to the rise or fall of the piston, to be noted. A scale on the side of the cover enables the operator to determine accurately the amount of flow in gallons per minute.

An electric contact consisting of an adjustable brass rod set through an insulated stuffing box at the bottom of the chamber can be connected to a lamp or bell, calling attention when the flow has [illegible] maximum. Contact is established immediately the piston rests on the brass rod. The desired flow of the liquid may thus be secured within the capacity of the instrument. The flow is directly proportional to the area of the slots in the enclosed tube, or to the rise or fall of the piston.

[illegible] we understand that the indicator gives practically a straight line [illegible] over a large range, and the loss of head in operating the instrument has been found to be negligible, not exceeding 0·004 lb. per square inch with a capacity of 15 gallons per minute. The indicator may be used with screens for dirty water, and can readily be cleaned by unscrewing the top and slipping out the slotted tube and glass.



Sectional View of Vaughan Flow Meter.

The instrument is constructed in several sizes, and all the parts are neatly finished.

No.	Capacity in G.P.M.	Pipe connection.	Value of each division.
A	1–5	½ in.	1 gallon
B	1–10	¾ in.	1 gallon
C	1–20	1 in.	1 gallon

Additional information and prices of this instrument can be obtained from the manufacturers, The Spray Engineering Co., Boston, Mass.

NATIONAL ECONOMY EXHIBITION.

This exhibition, organised by a committee of which Mr. C. J. Stewart is official trustee and chairman, was held at the People's Palace, Mile End, London, E., from September 18th to 30th inclusive.

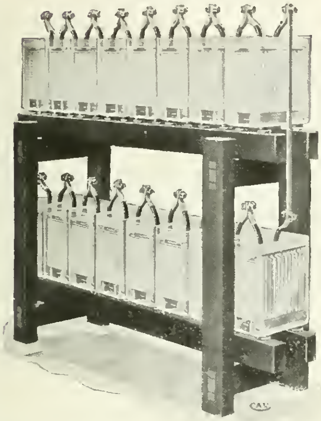
In addition to exhibits of food products, food cooked by or under the direction of L.C.C. cookery demonstrators; gas fittings and cooking and heating appliances (shown by the Commercial Gas Co. and the London Warming & Ventilating Co.), a stand at which boys trained by the Shaftesbury Society were at work; furniture made by L.C.C. technical school students, poultry, apiaries, &c., there was a stand organised by the Poplar and Stepney municipal electricity departments combined. Mr. J. H. Bowden (borough electrical engineer, Poplar), Mr. W. C. P. Tapper (borough electrical engineer, Stepney), and Mr. E. E. Farrance and Mr. Parker, the sales managers of the respective undertakings, are to be congratulated upon the up-to-date and varied apparatus shown, which is nearly all wired ready to be switched on for demonstration purposes, and includes

One, Two & Three Phase
MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

C.A.V

Country House Lighting Plants



Country House Battery set on Teak Stand,
32 volt, 270 amphere hours.
We undertake the manufacture of special assemblies.

THE Battery is rightly described as the "heart of" an electric lighting equipment, for it is upon the efficiency of this unit that the reliability of the entire system depends.

The main characteristics of C.A.V. Accumulators are :—

HIGH-GRADE MATERIALS
and
SKILLED WORKMANSHIP

C.A.V. Batteries are known and appreciated throughout the civilized world, and to-day, with 24 years' experience, we produce accumulators for every purpose and every climate.

Enquiries dealt with by return.
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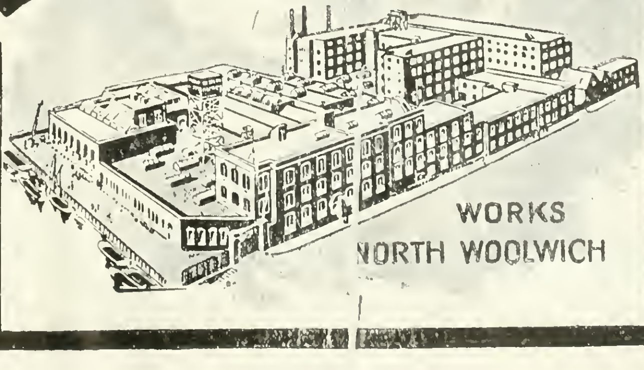
Members of
THE MOTOR TRADE ASSOCIATION

C.A.Vandervell & Co; Ltd.
Electrical Engineers, ACTON, LONDON, W.

Western Electric

TELEPHONE
AND
CABLE WORKS
ARE THE
BEST EQUIPPED IN
THE UNITED KINGDOM.

BRANCHES AT
BIRMINGHAM, LEEDS, JOHANNESBURG,
GLASGOW, SYDNEY, BUENOS AIRES.



WORKS
NORTH WOOLWICH

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.
SEA CLIFF
TRADE MARK.
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

the Arora, the Tricity and the Belling cookers and the Bastian Pyrostove; Osram, Mazda, Ediswan and Falk Stadelmann lamps, artistic Verity brackets, Ellis, Simpson and Saunders' shades, the Electric Suction Cleaner Co.'s vacuum cleaners, hot-point irons and curling tongs, and a good range of Hosgood stoneware electric utensils (boiling mugs, &c.). The Poplar and Stepney Councils both do wiring and supply motors, cooking and heating apparatus, &c., and we are informed that the former Council has 25,000 H.P. and the latter 23,000 H.P. of motors connected. Attractive and convincing literature displayed on the stand shows that Poplar's maximum charge is 3d. per unit (having been *reduced* by 25 per cent.), and that Stepney can supply for power at a maximum of 1d., and for lighting on the maximum demand system at rates varying up to 7d. for first 30 hours' maximum demand per month, and 1d. for remainder of consumption.

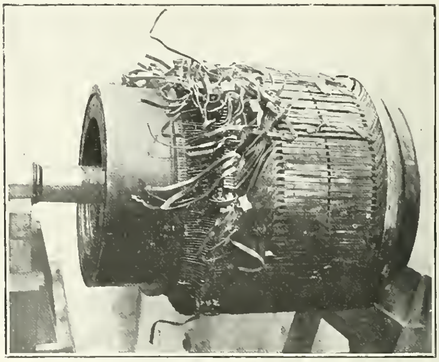
Mr. Farrance informs us that many inquiries have been dealt with at the stand, and that more are from country and west-end visitors than from residents in Poplar and Stepney, so that the managers of other undertakings will probably share in the benefits resulting from the holding of the exhibition; but it is rumoured that at least one west-end undertaking has got a "nagging" from a west-end lady who had discovered on visiting the exhibition that the Poplar maximum charge was 3d., and who wanted to know why the charge in her district was so much higher, so the west-end managers' gratitude may after all be somewhat qualified.

At the Falkirk Iron Co.'s stand there were shown Falco and Falco-orbit electric fires, Falco air and hot-water convectors, Compactum cooker, grills and toasters, electric household ranges, hot plates, hollow ware, electric irons, kettles and other table appliances, electric hot water circulators, &c. At this stand also many inquiries from outside districts have been received, resulting in much business. The company's London address is Craven House, Kingsway, W.C.

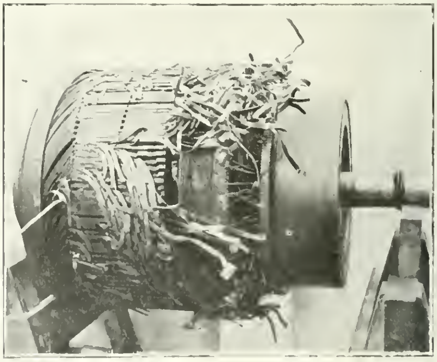
ELECTRICAL PLANT INSURANCE.

We were reminded of the interesting fact that the insurance of electrical plant and machinery was made possible as early as 1898 by the enterprise of the British Engine, Boiler & Electrical Insurance Co. Mr. H. Llewellyn T. Foster, M.Inst.C.E., M.I.E.E., formerly the chief electrical engineer of the company at their head office, Manchester, informed us in showing us round their new London offices, 46, Kingsway, W.C., that his company were the pioneers of this form of insurance at the date mentioned. In moving from its old offices in Queen Victoria-street to more modern and more commodious premises in Kingsway, the company wishes us to direct attention to the special features which its electrical plant policies offer to the insured. The new London office, which is presided over by Mr. H. T. Taylor, formerly secretary to the company, is the headquarters of the company's operations in what is known as the southern district—that is, the territory south of the line drawn from the Wash to the Severn at Bristol.

Many of our readers will have perused with interest the annual reports of Mr. Michael Longridge, the chief engineer of the company, and which until recently contained a section exclusively dealing with the electrical department. These reports, almost without exception, contained particulars of breakdowns in generators, motors, transformers and switchgear which were of undoubted value to designers and manufacturers. Mr. Foster informed us that as a result of the experiences of its inspectors the electrical department had on several occasions made suggestions to manufacturers for the introduction of modifications in design which had tended to obviate certain classes of breakdown. In this respect the co-operation of the insurance and manufacturing interests has proved mutually beneficial.



135-KW. ARMATURE BINDING-WIRE BURST. COST OF RE-WIND, £69.



135-KW. ARMATURE BINDING-WIRE BURST.

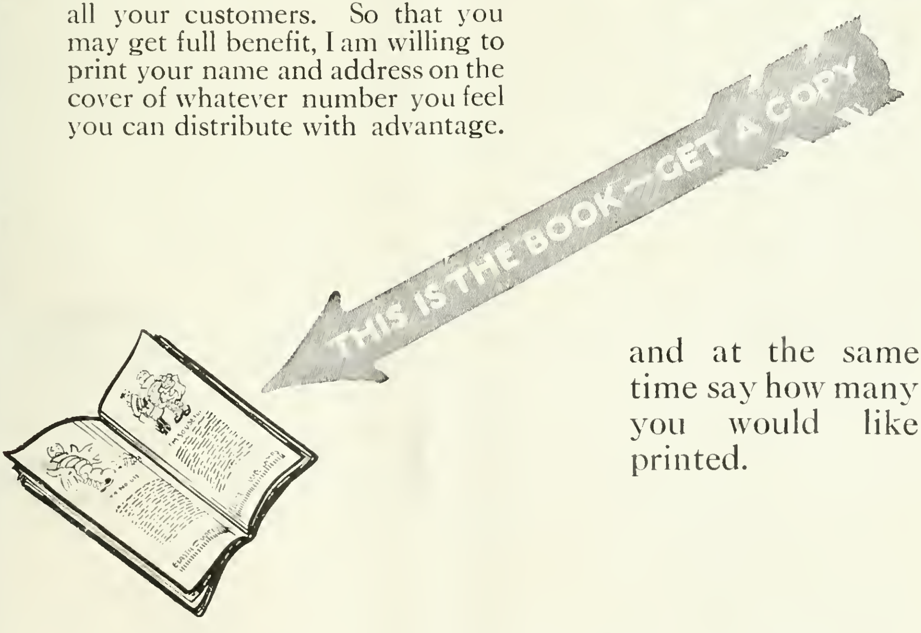
We were particularly interested to find that the insurance facilities also include periodical inspection and insulation tests by the company's engineer surveyors. Upwards of 40 of these inspectors are employed by the company, and the extent of the operations of the electrical department may be gathered from the fact that upwards of 50,000 motors, of which 15,000 are in the southern area, are insured. The premiums have been prepared on the basis of kilowatt

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 402[illegible] Grams: Vicminster, Sowest, London.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

An Idea Struck Me!

to publish a book of my life for circulation amongst the general public. It is already in the press and the next week or so would be just a happy time to send copies to all your customers. So that you may get full benefit, I am willing to print your name and address on the cover of whatever number you feel you can distribute with advantage.


THIS IS THE BOOK—GET A COPY

and at the same time say how many you would like printed.

POPE'S ELECTRIC LAMP Co., Ltd.,

Hythe Road, Willesden,
LONDON, N.W.

POPE
ELASTA
WIRE LAMPS
MADE IN
ENGLAND

A. J. G. & Co.

H. Weidmann, Ltd., Rapperswil, Switzerland.

WE ARE SPECIALISTS IN THE MANUFACTURE OF—

PRESSPAN (3)

(Pressboard)

Best Quality.—— Proved by repeated tests.

Sheets in thickness from 0·1 upwards.
Endless Rolls and Strips from 0·1 to 1 mm. thickness.
Presspan Coils and Tubes for Transformers.
Presspan Armatures, Discs and Shaped Articles.
VARNISHED PRESSPAN. BLACK PRESSPAN.
OILED PRESSPAN. MICA-COVERED PRESSPAN, &c.

Grand Prix: Marseilles 1908. Gold Medal: Berne 1914. Silver Medal: Paris 1900.

capacity, but this does not mean that the "insured" with a single motor receives less attention than the insured with several hundred horse-power of motors. The policy covers, up to the amount insured, all breakdowns which may occur to electrical machines while working, whether owing to the breakage of parts, burning out or failure of the insulation, or other causes, necessitating immediate stoppage of the machine for repair. Generating sets may be insured for inclusive amounts, the sum insured being available for breakdown of either the generator or the engine or turbine which drives it. Fans and blowers (if driven direct) may be insured with their driving motors and starters. Power and lighting cables, wiring installations and batteries are not included in the insurance, but can be periodically inspected at rates commensurate with their extent and the time involved.

Nature of business.	Nature of damage.	Amount paid.		
	Generating Sets.			
Supply Co.	Vertical "live" steam turbine, blading badly stripped	£116	9	8
Engineers	Vertical high-speed steam engine, exhaust valve box fractured	11	1	0
Provision merchants	High-speed steam engine, piston, trunk, elbow pipe, drain tap and valve spindle broken	22	9	7
Colliery	Connecting rod bolt broken, causing complete wreck of steam engine	475	4	7
Engineers	Turbine, blading stripped	339	18	4
	Generators.			
Stoneware mfrs.	Armature coils burnt out through accumulation of copper dust, armature re-wound	36	16	0
Supply Co.	High and low tension windings earthed to core, armature re-wound	86	1	10
Ironworks	Movement between spider and shaft through badly fitting keys, shaft renewed	13	13	6
Colliery	Windings of turbo-generator rotor partly burnt out, re-wound	55	9	5
Urban District Council	Faulty core teeth in turbo rotor, complete new rotor supplied	449	0	6
Dyeing Co.	Commutator micas faulty, causing overheating of winding, armature stripped and re-wound	108	0	3
	Motors, Transformers & Auto Converters.			
Engineers	Metallic dust caused failure of insulation of rotor, faulty conductors repaired	17	14	11
Paper mfrs.	Armature insulation deteriorated through age, armature replaced by one of modern type	45	0	0
Bleachworks	Armature windings fused on to core, some coils replaced, others re-taped and core reinsulated	18	5	11
Potters	Arcing between front end of winding and commutator spokes due to dust, thoroughly reinsulated	14	12	0
Ironworks	Rotor winding partially burnt out, insulation generally deteriorated, necessitating rewind	13	18	3
[illegible]	Conducting dust caused short circuit between [illegible] and starting [illegible] stator repaired	12	18	2
[illegible]	[illegible] bolt [illegible] caused failure of [illegible] armature re-wound	12	0	9
[illegible]	[illegible] pumps and [illegible] transformer was stripped and [illegible]	82	10	6
	[illegible] Controllers.			
[illegible]	Resistance [illegible] burnt out and plate [illegible]	10	0	0
[illegible]	Auto-transformer switch accidentally damaged [illegible] renewed	3	1	3
[illegible]	[illegible] supplied	2	1	3
[illegible]	[illegible] burnt out, renewed entirely	4	8	7
[illegible]	[illegible] coil burnt out and re-wound	2	1	0

Ordinary repairs for the upkeep of machines, such as the renewal of brushes and contacts, the replacement or adjustment of bearings, the trueing-up of commutators, &c., occasioned by wear and tear are not covered by the policy. On receipt of a proposal, a surveyor is sent to examine and test the plant, and the company bears the cost of the examination if they decline the risk. Should, however, the proposer refuse to complete the insurance the expenses of the examination will be charged.

Every insured machine is periodically inspected, and the inspections and tests frequently prevent disaster in the shape of electrical breakdowns and fire, and are also the means in many cases of effecting economy in the application of electricity to power and lighting and other uses. After each inspection a report is sent stating the condition of the plant and making such suggestions as may be necessary in the interest of safety and economy. These reports are sent for the benefit of the insured, who are under no obligation to adopt any suggestions, nor will their non-adoption in any way affect the validity of the policy. Where the attendant is not a trained electrician the regular visits of the surveyors are of great service in explaining the details necessary for the satisfactory working of the plant. Printed "Hints and Instructions to Attendants" are supplied free of charge to the insured.

A feature of interest and value in the operations of the electrical department is the method of dealing with breakdowns of the plant insured. Notice of failure is immediately given to the company, who, with a minimum of delay, send a surveyor to examine and instruct as to the necessary repairs, or advise what should be done. Unless time is of the utmost importance, it is to the advantage of the insured to await the surveyor's arrival before disturbing the damaged plant. In urgent cases, however, where it has been necessary to put minor repairs in hand at once, the company will not repudiate a claim for damage covered by the policy, provided the condition with regard to immediate notice has been complied with. The experience and knowledge possessed by the company's technical staff have, we understand, been found of value to the insured in ensuring speedy reinstatement, or in having the new parts made of the necessary strength and of the best design and workmanship.

The company also undertakes the periodical inspection and testing of all kinds of electrical plant, equipments, batteries and wiring installations. The company is prepared to examine second-hand electrical plant and to report upon same prior to purchase.

Some examples of claims paid are given in the table in the opposite column.

BURNER & HEAT CONTROL

Equipment for Lead Presses

(HALL'S PATENTS).

MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

Our Manufactures include:

Cables for Lighting, Power,
Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT KNIFE SWITCHES.

Quick Break Switches of first class material throughout, looking very much like other knife switches at a cursory glance, but a detailed examination will reveal the fact that expert knowledge and workmanship have been brought to bear on every part with a view to securing long life and high efficiency.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

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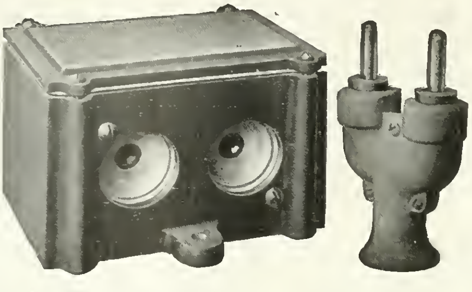
AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

IRONCASED SOCKETS & PLUGS
FOR HARD SERVICE.
Sizes up to 200 amps.
D.P. and T.P. 500 volts;
with "earthing" connection.

Also Combined Switch and Plug Boxes.



DORMAN & SMITH, Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

AN 8-KW. CARRON FIRE.

In our last issue we referred to the issue by Carron Company of a new catalogue dealing with their electric radiators and fires. A number of designs of these Carron fires have been adapted to existing coal grates, and the effect is artistically attractive and thermally efficient. The illustration shows a Carron fire made up of three panels, the centre one containing four 1-kw. units under the control of two switches and the two side panels, each fitted with two 1-kw. elements each with two switches for the control. The total loading of the fire is thus 8 kw., a capacity which is suitable for the heating of quite large rooms. The particular fire illustrated was, in fact, supplied for one of the public rooms of a leading Corporation.

Carron 8-kw. Electric Fire.

The construction of the fire follows the standard Carron lines, and each of the 1-kw. fire units is in a cast iron frame, being readily replaceable in case of breakdown from electrical or mechanical causes.

The fire illustrated is indicative of the special designs which Carron Company are prepared to undertake for every class of building in which electric heating is considered to be practicable.

C.A.V. ABRIDGED DYNAMO CAR LIGHTING CATALOGUE.

"When the war is over and the clouds have rolled away," we are promised a peace edition of the "Blue Book of Car Lighting," by Messrs. C. A. Vandervell & Co. Until then the abridged catalogue dealing with this subject will have to suffice. The publication referred to contains particulars and revised prices of C.A.V. dynamos and the many accessories which now go to make up the complete equipment of the modern petrol motor car. The dynamos are grouped in five different series according to the size of the car upon which they are fitted; the ratings range from 45 to 180 watts and the voltage from 6 to 12. The lightest model weighs 14 lb. and the largest 30 lb., the latter being suitable for Rolls-Royce cars.

An important section of the electrical equipment of any petrol car is the connections between the dynamo, switchboard and battery. The C.A.V. patented armoured cables make provision for those conditions under which it is found necessary to place the connecting leads constantly in proximity to oil and water. The specification of these conductors states that they are composed of pure india rubber copper strands, single cotton lapped, vulcanised india rubber covered, bound with pure india rubber, coated tape, laid up with cotton filling, wound circular braided and compounded and finally armoured with metal strip. In conjunction with the wiring system is described the C.A.V. junction box which is designed to occupy a position in the chassis frame, thus forming a miniature distribution board. It is cast in aluminium with spring clip lid and is provided with two 'bus bars with protecting fuses. When dismounting bodies this junction box makes it unnecessary to disturb the chassis wiring system. The box measures 5⅜ in. by 2⅞ in. and is known as junction box No. 2. The C.A.V. switchboards in the list are Nos. 2, 2A, 5 and 6. The first-named is suitable for fitting to dashboards where the switchboard must be fitted low down, and the instruments are slightly tilted to make reading an easy matter. Both Nos. 2 and 2A are fitted with six switches and No. 5 has four switches, and No. 6 has three switches.

EXTRA COPIES OF
ELECTRIC VEHICLE PROGRESS SUPPLEMENT
Can be supplied to Central Station Engineers for distribution. Annual Subscription Rates on application to
"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY,
1, 2 & 3, Salisbury Court, Fleet Street, London, E.C.

Another section of the list deals with C.A.V. headlights, side lamps and dashboard inspection lamps. A copy of the catalogue can be obtained from the company, at Warple Way, Acton, London, W.

BASTIAN METERS FOR DIRECT CURRENT ONLY.
Made in ENGLAND with
BRITISH CAPITAL and BRITISH LABOUR.
THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2, and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, October 6, 1916.

THE ROUND TABLE.

By "KVA."

THIS WEEK'S CHESTNUT.—A rumour has persisted for many months past that the lady munitioneers were calling themselves qualified engineers. A North country farmer has had substantial proof of this, for he engaged an ex-munitioness who proceeded to milk one of the cows with a shifting sparner!

* * * *

The Birmingham police on point duty in the centre of the city now have small red electric lamps fixed on the top of their helmets. Birmingham is so dark that late-nighters with the multiplying optic will not see the Bobby, but they may know he is there by a halo of red lights!

* * * *

THE NEED OF THE HOUR Some men are dead before they are buried. It is a delusion that a man has to wait 50 or 60 years to die. If the spirit of the man—the soul of hope and courage within his breast—has been extinguished, he is as dead as he ever will be, even though his body continues to walk the streets. His relatives and friends might just as well get together and hold a funeral service over him now as at any time. He has allowed his light to flicker out—the vital spark has fled. He has lost the essential quality of life and manhood—COURAGE. – From No. 4, Vol. II., "The Ambassador."

* * * *

Evidently Round Table readers are running no risk of earning ELECTRICIAN Hot-Plates by contributions to the Electro-Harmonic Unofficial Programmes. Perhaps by the time the next "men's" concert comes along they will feel equal to the occasion. I am compelled to put the first programme "to bed" without a song or march from some sympathetic scribe.

* * * *

Prof. Muirhead, of Birmingham, says that "slacking" is conscientious protection against fatigue. Here is a chance for the "adjectival" foreman to try his hand at a definition.

* * * *

The latest in headlines:

COMPULSORY USE OF ELECTRICAL ENERGY ADVOCATED.

In this way the Birmingham "Daily Post" "bills" Mr. R. A. Chattock's address to the Birmingham Association of Mechanical Engineers. We may now look forward to another form of conscientious objector!

* * * *

The "Daily Graphic" asks: "Is it possible for a man to be electrocuted if he accidentally touches an electric light standard?" I think the time of day ought to be specified; but the "Daily Graphic" says that "the chief engineer of one of London's largest power stations says a man could not have been killed in this way except by a miracle." Is this another name for "potential difference"?

* * * *

OUR HOT-PLATES.

No. 217 to ——

The Severn Board of Conservators, who state, in regard to the recent proposals to extend the hydro-electric works at Worcester," their view is that the works are contrary to the spirit of the fishery laws and highly detrimental to the passage of the fish for spawning and breeding purposes, and consequently injurious to the Severn fishery district as a whole."

ELECTRO-HARMONIC SOCIETY.

1ST CONCERT, 31ST SEASON, 1916-17.

Holborn Restaurant, London. To night, at 8 p.m.

Unofficial Programme.

In the Chair, Capt. H. Riall Sankey, R.E.

GOD SAVE THE KING.

OPENING SELECTION "Honour and Arms." ... ... *Handel*
Electrical Engineers with the Services.

CRASH OF PEACE SOLO "Bid Me Discourse." ... ... *Bishop*
Mr. T. C. ELDER.

CUFFLEY CHORUS ... "To-night's the Night." ... *Grossmith*
ANTI-AIRCRAFT CORPS.

FLAME FIRE-ETTE... "You're Ma Baby." ... *Ayer*
Mr. A. F. BERRY.

U-BOAT DIRGE "Rocked in the Cradle of the Deep." *Knight*
NEUTRAL ELECTRICAL TRADERS.

BOMB SOLO(W) ... "The Fly Be on the Turmuts." *Millington*
COUNT ZEPPELIN.

"ARORA" BOIL-EALIS "Cut Me Off a Bit of Roley-Poley." *Robey*
"KUKRI" GROGAN.

BARBED WIRE MEDLEY { "We're All Dressed Up and No Place to Go." } ... *Williams*
The INTERNED ELECTRICAL ONES.

LJUNGSTRÖM SATURETTE } "Won't You Come into My Labyrinth?"... *R.P.M.*
Mr. A. G. DEVERILL.

NON-TREATING CHORUS "Crossing the Bar." ... *Willeby*
ALL ELECTRICAL "SPECIALS."

EMRANKMENT SOLO "Wait and See." ... *After Alisquith*
THE INSTITUTION.

GAS-FIRED DUET ... "The Stoker's Farewell to His Shovel." *Adapted*
Messrs. CHRISTIE & WOODHOUSE.
(With Coalite Chorus.)

DISCOUNT EXTRAVAGANZA { "If You Knows of a Better 'Ole, Go to It." } *After Bairnsfather*
TUNGSTEN LAMP ASSOCIATION.

* * * *

THIRTY-SEVEN YEARS AGO.

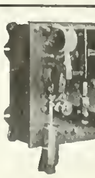
[From THE ELECTRICIAN (Second Series), Oct. 11, 1879.]

BLACKPOOL.—The success of the electric light has been so great that it has been decided to continue it in use.

CHEMICAL DISCOVERIES.—Eleven "new elements" have been brought forward since June, 1877, as claiming places in the list of substances which will not admit of decomposition. Surely, says "The Athenæum," it is time that some admitted authority should examine and revise this list.

THE TELEPHONE IN BUSINESS.—The first to introduce the telephone into Durham, and to apply it to business purposes, is Mr. John Hill, miller, North-road. In his office, and in the hall of his residence, telephones are fixed, together with call apparatus. The connecting wire is carried from the office over the mill premises to the house—a distance of 100 yards.

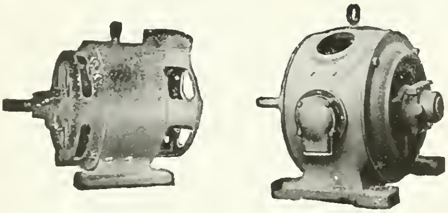
GAS EXHIBITION. The "Scientific Review" observes that the attempts to apply the electric light for general illumination have stimulated the gas companies to make great exertions. Recently they had, at Leeds, a very complete exhibition of gas apparatus for lighting and heating. Now the Gas Department of the Nottingham Corporation is to hold an exhibition of gas appliances in the Mechanies' Hall, from the 24th to the 29th of November.



THE TWO MOST RELIABLE SELF-STARTERS
No. 29-I.—Self-acting Motor Starter for Direct-current, with interlocked solenoid operated finger contacts. Sure and simple in operation. Requires the least possible attention.
CONTROL IGRANIC ELECTRIC DEVICES
No. 30-I. Self-acting Motor Starter with solenoid operated radial arm and interlocked circuit breaker fitted with magnetic blowout. Ruggedly strong. Built for heavy service.
IGRANIC ELECTRIC Cº LTD 147, Queen Victoria Street, LONDON

SIEMENS

STANDARD
ELECTRIC MOTORS



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ALL OUTPUTS, SPEEDS AND VOLTAGES.

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Telephone: Gerrard 860. Telegrams: "Siembralos, Vic, London."
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Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
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Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs
Sheffield—22, High St.
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Branches in Principal Towns Abroad.

THE DEVELOPMENT OF ELECTRIC POWER IN INDIA.

The following recent comments of "F. L. M." in our contemporary "Indian Engineering" on the above subject, which was introduced by Mr. H. R. Speyer before the Institution of Electrical Engineers last year, are of some interest. "The discussion upon the Paper at the Calcutta Local Centre was published in the Inst.E.E. 'Journal' last June, and our contemporary's comments appear in its September 2nd issue. The Paper when read along with the discussion on it is very interesting, as it tends to show the general dissent of views from those expressed by the author. As these opinions are expressed mainly by representatives in India of British manufacturing concerns, for whose sole benefit (or otherwise) the Paper appears to have been written, it may prove interesting to give the views of an engineer who has had 14 years' experience in the erection and maintenance of both British, American and Continental plant in India and the East, and who has seen things from the purchaser's point of view.

"My first experience of plant in India consisted of Continental prime movers and American generating plant. On the erection of this plant 'money was no object,' and the manufacturers contracted to supply, deliver, erect and run the plant for 12 months. The contractors naturally sent out their best men for the job, and all went well. At the end of the year the plant was taken over by the purchasers, and some (not the best) of the engineers remained back to run the plant as employés of the purchasers. Shortly after this the plant was doubled in capacity, and this time the work was carried out by the purchasers themselves. From then onwards troubles began, and I suppose are still being experienced. From this it might be assumed that the fault lay neither with the plant nor the contractors, but with the purchasers, owing to their not getting the right staff to operate the plant for them.

"My next experience was of a plant in the Malay States, where the climatic conditions prevailing are considerably more unfavourable for electrical machinery than in nearly any part of India. The plant consisted of some very old-fashioned—in fact primitive—British manufactured sets which had been running under practically no supervision at all for several years, and had been most disgracefully erected and neglected. The condition of the plant was such that had it come under the jurisdiction of any electricity act it would not be permitted to operate 24 hours after the first visit of an electric inspector. In addition to these out-of-date British manufactured sets, the power station also contained an up-to-date Continental set put in quite lately. The former broke down *always* with any abnormal conditions. These breakdowns were expected, as the condition and design of the plant were bad and antiquated; the latter seldom broke down electrically (owing, presumably, to the fact that the antiquated plant acted as an excellent safety valve for it). But in spite of the fact that this Continental set was manufactured at a time when the electrical industry had reached a state of very great reliability in this particular kind of apparatus, yet minor electrical and major mechanical defects were continually showing up. The comparison is hardly fair, perhaps, but it should be borne in mind that the British manufactured plant had been built at a time when electrical work, even in England, was in its infancy, whereas the Continental plant was of quite recent design. It is also an interesting fact that at the time the contract was placed for the new set the engineer-in-charge of the plant was an Austrian. On this same system there was a variety of makes of motors installed, and there was nothing to show that the Continental makes were in any way superior to the British makes.

"My next experience consisted of a plant that was essentially of British manufacture, excepting the bulk of the transformers, which were of American make. On this plant I experienced only one serious breakdown, and that was of one of the American made transformers.

"The results of my experiences have convinced me that the defect in the present system lies in most cases neither with the manufacturer nor with the contractor, but with the purchaser himself. I am of opinion that it is essential that the purchaser, in the first instance, engage the services of a fully qualified engineer to advise him on his requirements. With an engineer who possesses these qualifications there is very little doubt that the purchaser will be able to obtain British manufactured plant that will not only give him complete satisfaction, but also prove itself more reliable than any Continental or American plant. There are certain things in the electrical engineering sphere in which it is foolish for engineers to expect British design to compare favourably with Continental and American; mainly among these are water turbines and extra-high-tension apparatus. England, as we all know, has had no opportunity or scope for this particular branch of work, and it is natural that one should go to the country that has had most experience in this particular branch. Here is where the purchaser's engineer 'comes in.' If he is a sound practical man, he will naturally resort to other than British fields for apparatus of this kind. I personally would not think of going to England for insulators for 20,000 volts, for example.

"Mr. Speyer's comparisons of percentages of Continental and British plant installed in India, as has been pointed out in the discussion, is hardly fair, as he quotes cases of large hydro-electric plants (with their almost necessary high voltage); these facts naturally show up favourably for the Continental and American firms, who have had considerable experience in both water turbines and extra-high-tension work.

"Mr. Speyer gives a table which compares the capacity of five of the largest undertakings in India, and states that of these five installations, aggregating in all 66,900 kw. of plant, Switzerland had supplied 54,000 kw., England only 7,500 kw., and the United States 5,400 kw. of the prime movers, whilst Germany had supplied no less than 32,000 kw., the United States 17,000 kw. and England only 7,500 kw. of the electrical generating plant. Of these five plants, it might be mentioned that the two largest are high voltage hydro-electric plants, which for the sake of comparison should be omitted, as explained above. These two plants alone account for no less than 44,000 kw. Of the 32,000 kw. of generating plant supplied by Germany, the whole lot relates to the Tata Hydro-electric Works, and I am inclined to think that had Mr. Speyer written this Paper a year or so later than he did he would be compelled to admit that this 32,000 kw. of generating plant supplied by Germany hardly comes up to expectations, and has caused more than one person not a little anxiety.

"The author of the Paper says that if a firm should get a contract for electrifying a mill, they would have to send out their best engineers to nurse the job for 18 months or two years after starting the plant. If the firm that gets the contract is of the same opinion as Mr. Speyer in this matter, I should certainly consider it very tactless indeed on their part if they did not keep this opinion to themselves, and even went so far as to make a special point of in no way imparting even a hint of their ideas to the purchasers of the plant; because, as one of the speakers in the discussion very rightly remarks, 'Could anyone possibly give a millowner a better reason for declining to electrify?'

"Mr. Speyer remarks: 'Time and again the author, when calling

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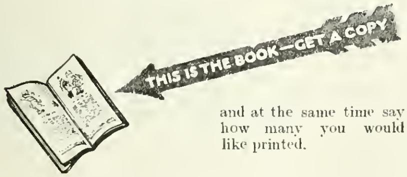
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in tenders for electrification schemes, has had favourable competitive prices from British manufacturers at F.O.B. and C.I.F. rates. These, unfortunately, are quite useless for a country where the application of electricity for power purposes is, practically speaking, in its infancy.' Mr. Speyer's experiences must indeed have been unfortunate. Perhaps he did not send his inquiries to some of the established British firms in India who, from my experience, are always pleased to quote prices either C.I.F., F.O.R., delivery at site, or delivery at site including erection. My experience in this matter has been exactly the opposite to Mr. Speyer's. Some few years ago, when calling for tenders for a complete electrification scheme of a town, firmswere asked to give alternative quotations for C.I.F and delivery including erection. In this instance the British firms without exception quoted for both C.I.F and erection, whereas the Continental firms refused to give a figure for erection and only quoted C.I.F.

"In conclusion, I would like to say that I cannot agree with the general views expressed by the author in his Paper; and, from the purchaser's point of view, I quite endorse the opinions expressed by the members of the Calcutta Local Centre of the Institution in the discussion on the Paper."

WATER AND OIL ELECTRIC HEATING SYSTEMS.

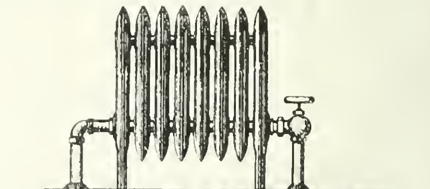
We have frequently commented on the fact that the electric fire as we have now come to know it in this country, is, for a time at any rate, unlikely to make great headway in the United States for three reasons: (1) the cost of electrical energy is comparatively high; (2) the low voltage at the consumer's premises makes the cost (with heavy currents) of cables and switches excessive, and (3) the competition for central heating is very keen.

None the less American electrical men are grappling with the problem of electric heating and are making experiments on a practical scale which are furnishing some most interesting data upon the subject of house warming by electrical means. It must be remembered that there are growing up in many districts in the United States large interconnected steam and hydro-electric power generating and distributing systems. The commercial departments of these undertakings are exceptionally keen on getting new business, and especially consumers who will take energy at off peak times when low rates can be offered as an inducement to "join up." Seattle, Wash., is typical of many modern American cities in respect of its electricity supply system, and Mr. J. D. Ross, one of the superintendents of the city lighting department, has this year published a report (which is abstracted in a recent issue of the "Electrical World") upon the employment of "off peak" energy for heating purposes.

"Seattle is surrounded by water powers which permit the economical generation of electrical energy. With a view to studying the possibility of the heating of dwellings by such low price energy, the writer about four years ago began a series of experiments on electric heating of houses. In order to make electric heating an off peak load, water heat storage is necessary. Electric heaters adapt themselves to hot water, steam, hot air or direct heating or to any combination of these methods. In order to test the possibilities of electric heat, experiments were made with almost every type.

"The first of these installations was in a cottage and included equipment totalling 6,100 watts. Later, an electric water heater was installed to work in connection with the boiler of the hot water heating system. In the coldest weather both electric and coal heaters were used, while in mild weather the electric coil alone was used. This scheme of using electric heat with coal as an auxiliary has some advantage over the use of either alone. The electric heaters need be only half the capacity they would be to do the heating alone in the coldest weather. Since the load connected determines the rate for current, there is a considerable saving in the cost of electricity. At the same time little coal is required because the electric heaters alone are sufficient except in the coldest weather.

"Another method, using electricity for auxiliary heating was tried. This house had a hot-water heating system. The radiators in the rooms most used were equipped with individual electric heaters placed in the basement directly under them. Each heater was connected so as to permit the water in its radiator to circulate through it, and at the same time the circulation from the coal-fired boiler was not interfered with. This method permits the automatic regulation of the temperature in each room by a thermostat working on its individual radiator. Only enough coal was used to keep the entire house at about 60°F., and each electric heater was used to bring its room to the temperature desired.



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"Experiments using electricity as an auxiliary to ordinary furnace heat prove that electric heat is most convenient, but give little information on the economy of using electric heat alone. Data on this point has been gathered from four houses using electricity exclusively for heating. The first of these was fully equipped with heaters, heat storage tanks, automatic heat control, recording wattmeters, and all the apparatus that was needed for a complete test. There are nine rooms, four on the first floor and five above. The downstairs rooms were kept above 70 F. during the day and allowed to run down to 60 deg. during the night. The upstairs part was

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maintained at about 65 deg. during the day. Heat control was entirely automatic; thermostats were used to keep the temperature within 2°F. of the desired mark, and current was turned on in the morning by a time switch so that the house would be warm before time to arise. The installation was made in February, 1914, and the house has been maintained at a comfortable temperature at all hours since with practically no attention.

"The storage tank proved able to take care of the hours when the current was cut off. The temperature at the end of the 4½ hour peaks in December never dropped below 70 deg. On the coldest days the water in the tank dropped from 190 deg. to 104 deg. during the peak, and the usual range of temperature during cold weather was from 170 deg. or 180 deg. in the tank at the time the current was turned off to 110 deg. to 120 deg. at the time it was turned on again.

"Three other houses were equipped with the same system of electric hot-water heat, and data collected for periods covering approximately two years. Synopses showing the current used per year are given in Table 1.

Table I —*Electric Heating Results in Four Seattle Houses, Water Circulation System.*

—	Address.			
	225 37th North	1505 36th	615 Terry	802 33rd.
Number of rooms	9	9	...	7
Kw. of heaters	42	32	12	10
Square feet radiation	690	640	328	350
Consumption, kw.-hours, first year	42,850	39,320	57,210	54,930
Consumption, kw.-hours, sec. year	63,860	41,880	18,100*	23,990*
Average consumption, kw. hours	53,355	40,600	...	...

* Used as auxiliary only, during second year.

"During 1915 a number of heating installations were made with oil-filled, electric-heated radiators. These consist of an ordinary hot-water radiator filled with oil and having a cartridge-type heater inserted in the top. This scheme of heating has the advantage that each room has its own heater, and no piping is necessary. Results obtained with the oil radiators are practically the same in energy consumed and temperatures maintained as with the hot-water system, with the exception that there is very little storage of heat in the oil radiators to tide over the time when current is turned off. Data on two houses using the oil-filled system are given in Table II.

Table II. -*Electric Heating Results—Two Dwellings Using Oil-filled Radiators.*

—	2541 11th Ave. W.	1238 E.Fir.
Number of rooms	5	8
KW. of heaters	10½	31½
Square feet of radiation	160	640
Duration of test	7 months	7 months
Consumption, kw.-hours	9,777	50,960
Estimate for one year, kw.-hours	16,000	85,000

"Sufficient data has now been collected to enable us to make a definite statement as to what can be done on any given case. In the ordinary building with good ventilation the heat loss is about four-fifths through the walls, while one-fifth is used to heat the air. With improved heat insulation in buildings it is conceivable that half the heat now required may do the same work without in any way impairing ventilation, which requires about 30 cubic ft. of air per minute for each person. Any improvement tending to reduce the amount of heat necessary gives a corresponding advantage to electric heat.

"The hot water heating system with ample storage tank seems to present the most advantages for use with electric heaters. This is due to the fact that the heat storage keeps a uniform temperature, for less heat is required for comfort with steady than with intermittent heat. Considerable economy of heat is to be gained by covering the basement pipes, and especially the storage tank, with heat insulation at least two inches thick. The tank, fitted with a small centrifugal circulating pump, will keep the house at an even temperature during the lighting peak when the current is shut off.

"Heating, however, cannot be permanently classed as an off-peak load. This is evident from the fact that about 10 times the capacity of installation is necessary for heating a house that is used for lighting it. When one house in 10 is electrically heated, then the load-curve valleys will be filled up. After that the success of heating by electricity will demand cheap electricity at all times, which is only to be had from water power generated in large units and distributed at comparatively high voltages. It is feasible to serve heating customers at 500 or 600 volts three-wire system, which would materially reduce distribution cost. This would give a voltage for the heating service of 250 or 300 volts."

A NEW CARBON CATALOGUE.

An interesting publication dealing with carbon products of all kinds is being issued by the Electrical Engineering & Equipment Co. The catalogue is an extensive publication of some 40 pp., and it deals with cinema carbons, flame lamp carbons, carbon brushes of all kinds, battery rods and plates, carporous pots, circuit-breaker blocks, lightning arrester carbons, rheostat plates, welding carbons, carbon tubes, furnace electrodes and carbon packing for steam turbines. This covers a very considerable range of carbon materials, and the particulars relating to them will be found of considerable trade interest. In the majority of cases tabulated price lists are included, and in the case of several brands the prices are advanced 25 per cent. Under the heading of carbon brushes some useful notes are given containing suggestions which should be observed in order to save delay and trouble when ordering this class of material. Curves are also shown giving the temperature rise, coefficient of friction and total contact drop for various grades of brushes, at different current-carrying capacities. These enable the brush buyer to see at a glance the behaviour under operating conditions of any particular brush. An example of the particulars given against one of these grades is reproduced herewith. It relates to grade S.121, which, it is stated, "is a very high-class graphite with good carrying capacity, low friction and specific gravity. The contact drop is high enough to make it adaptable to generators and rotary converters up to 500 volts, having high peripheral speed. This brush will also give good results on steel slip rings."

Specific resistance (ohms per inch cube)	0·00695
Normal current density (amperes per square inch)	60
Peripheral speed (feet per minute)	6,800
Hardness (scleroscope)	30
Contact drop at normal current density (positive and negative)	1·9[illegible]
Coefficient of friction at normal current density	0·17
Temperature rise at normal current density	34°F.

The extent to which the manufacture of connectors for carbon brushes has been carried is admirably illustrated in the section dealing with what are known as pigtails. For this class of brush no less than seven different methods of connecting the copper flexible to the carbon brush are shown and offered as standard patterns. In the type A, known as the "Wizard," the pigtail is secured by a conductor which, it is stated, is not affected by heat or by vibration. The company recommend this form of connection because "of its security, perfect contact to the brush and durability."

Many excellent illustrations are included of carbon rods and plates for dry and wet batteries, carbon contacts, carbon tubes and furnace electrodes, and of several patterns of carbon packing, which is suitable for high-speed engines and steam turbines.

The catalogue is excellently printed, and illustrations of the carbon factories appear on the cover and the first white-paper page.

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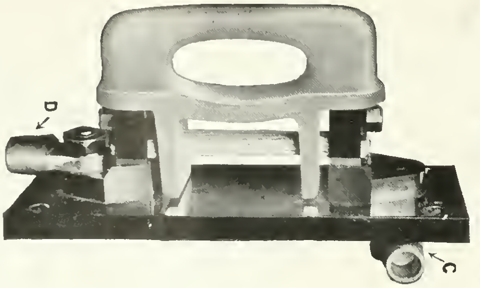

HANDICAPS ON BRITISH TRADE.

Preferential Export Rates.—In Germany, where most of the railways are State-owned, special export rates are given with a view to assisting and developing the export side of industry. Goods marked for export are carried at approximately half the ordinary rates charged for inland traffic. In some cases the export rates on German railways are as low as one-third of a penny per ton per mile, a rate which is considerably lower than the rate for bulked goods, such as coals and minerals, on British railways.

The granting of special rates for export, whilst it has not yet become regularised in England, is in partial operation, as will be seen from the following table:—

From	To	Approx. distance in miles.	Special machinery rate. s. d.	Export rate. s. d.
Bolton	Hull & Grimsby	100-116	24 7	18 2*
Manchester	" "	93-109	21 0	17 6
Rugby	" "	193-209	26 0	23 5
Manchester	Southampton	245	44 7	25 0
Rugby	"	160	30 5	21 8
Glasgow	London	400-440	49 5	41 7†
Manchester	"	183-205	33 10	26 0
Rugby	"	83	21 8	21 8†
Sheffield	"	160	30 11	27 4†
Glasgow	Liverpool	220	24 3	20 10

* Excludes cartage.

† This includes the Port of London dock charges.

In some cases the special export rates are given by the railways because of shipping competition—*e.g.*, from Manchester and Glasgow to London, and from Manchester to Southampton and Hull—whilst in other cases the special rates are on account of the large export trade carried on from particular manufacturing centres. There is, however, ample justification now for preferential rates being demanded from all the principal manufacturing centres to the principal ports, more particularly in those cases where the railway lines run right into the docks, as this eliminates cartage and minimises the amount of handling.

Classification.—Many anomalies exist in the classification of machinery and apparatus which are included under the general term of electrical engineering, due largely to the fact that new apparatus has been called into existence which was not included in any of the original classes. Now that the size and weight of individual pieces tend to increase, the question of classification is becoming more and more serious.

Heavy machinery, including agricultural engines, steam, gas and oil engines, and hydraulic machinery, may be rated under what is called the "mileage" scale of charges instead of under the arbitrary rates charged from point to point for other machinery. Electrical machinery does not come under the mileage classification; hence, in shipping a turbo-alternator, the turbine may be charged at the mileage rate and the alternator at the ordinary machinery rate.

The machinery rate, moreover, is not a level or fixed rate for all classes of machinery, but is subject to percentage additions, depending on the weight of single pieces. As an example of this, taking a case in which the ordinary machinery rate is 20s. per ton, the following percentages are added in respect to heavy weights:—

Pieces weighing	10 to 15 tons,	20 per cent. increase	=24s. 0d.	ton.
" "	15 to 20 "	33⅓ " "	=26s. 8d.	"
" "	20 to 25 "	50 " "	=30s. 0d.	"
" "	25 to 30 "	75 " "	=35s. 0d.	"
" "	35 to 40 "	100 " "	=40s. 0d.	"

Heavy pieces of the above order would generally be put on trucks at a special siding in the manufacturer's works and delivered without transhipment to the docks alongside the steamer. There would be, therefore, an abatement from the above charges of the amount included in the railway rates for cartage, but this abatement becomes of less and less importance as the weight increases.

Assume that a manufacturer wishes to despatch from his works an alternator of which the rotor weighs, say, 21 tons. If the ordinary machinery rate is 20s. the special rate for this rate as shown above would be 30s. per ton, or allowing a rebate of 3s. for cartage the net charge would be 27s. per ton. For an equivalent weight the rate on the mileage scale would be approximately half this amount, namely, 13s. 6d. Hence, whilst a steam or gas engine weighing 21 tons might be carried 80 miles for £14. 3s. 6d., an alternator, or part of an alternator, of the same weight would be charged £28. 7s.! This is by no means an extreme case, as for longer distances and heavier pieces the handicap on electrical machinery would be far greater.

Again, the question of packing in cases or in frames is one which needs revision. It is safer in many cases to bolt certain classes of machinery to stout frames rather than to pack same in frames or cases; that is to say, there is less risk of damage during transit when protected in this way. In the event of damage, however, it would be a debatable point as to whether or not the machinery was sent unpacked at owner's risk or in frames at companies' risk.

Through Rates.—Another and a very serious handicap which the British manufacturer labours under when in competition with German shippers is the enormous advantage which the German manufacturer is able to obtain by means of the low through rates. Cases have come to our knowledge in which this has operated very harshly against the British manufacturer. In one case a British manufacturer having to ship about 500 tons of material to South America, including many heavy pieces of about 30 tons weight, was offered by the representative of a powerful German electrical combination special shipping facilities if he would ship his goods to Hamburg, and then let them go through as part of a consignment from the German firm in question. This, as was clearly shown, would have effected a saving of about £750 in freight, notwithstanding the fact that the North German Lloyd's, who would carry the goods from Hamburg to South Africa, were in conference with the Union Castle Line, the British company operating from our home ports. Whilst it is clear that the German manufacturer can obtain special terms, it is quite possible that an examination of the books would show that the North German Lloyd's receive the full amount of the freight, the difference being made up in some way by subsidy from the German Government. The British manufacturer was prevented from availing himself of the advantageous rates offered by the fact that he would have thereby lost his 10 per cent. rebate on 12 months' shipping.

From an article by Mr. Frank Broadbent in the "BEAMA Journal."

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1, 2, and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, October 13, 1916.

THE ROUND TABLE.

By "KVA."

Event of the Week.—An electrical engineer in Cardiff applies to us for a copy of our 3000th issue.

* * * *

This Week's Paradox.—(Overheard in a munition works.) Foreman to munitioneer: "You have not been very early of late, you've been behind before, but now you're first at last."

* * * *

The "Liverpool Courier," in a leaderette on wireless wonders, says:—

> In the Krakatoa eruption a large part of a huge mountain was blown bodily into the upper regions of the atmosphere. It took no less than 18 hours for the disturbance to travel half-way round the earth and culminate at the opposite point. Wireless signals would only take a small fraction of a second.

Yes; and the War Rumour can beat even this record!

* * * *

"Sniped!"

[From *Glover's Almanac.*

* * * *

A firm of electric sign makers have had a number of their employees join up recently, and they have sent me the letter which one of the lads wrote them, just before "crossing over." The spelling is unique:—

> Dear Sir: Just a line to let you know we are going out on the 26 and thir are to of the boys going out with hus and they would like to here from you before they gee out, and they fort it was very kind of you what you had down for them. So this is all at present to you all.—I reamed.

* * * *

The following items, culled from the official tender form of the Parish Council of the Parish of Glasgow, and the Glasgow District Board of Control, have been brought to my notice by an observant correspondent:—

Item 62.—No. 20 Corporous Lebauche Batteries.
Item 96.—Low-reading Ammateur.
Item 136.—Labauche Jars.

The first Electro-Harmonic this season was not very well attended, but the programme was good and the audience was very appreciative. The two late St. Paul's choristers, Sappers Frank Webster and Joseph Farrington, who both appeared in khaki, were the hit of the evening, being loudly encored both for their solos and duet.

* * * *

"Peter Pan" Walter Churcher, the humorous reciter, was well up to form, and he picked several chestnuts out of the fire, though not without burning his fingers. One of the latter was the story of the man who was shortly to undergo a military medical examination, and asked a friend who had been "rejected" how he had managed to get off. The reply was that he wore a truss. "Will you lend it me to wear when I go up to-morrow," said the optimist, and consent being given he duly presented himself in high hopes before the doctor, who, after a cursory inspection, passed him for "general service." He expressed great surprise at this treatment, when the doctor asked him how long he had worn the truss. Without hesitation, he answered "Nine years." The doctor then laughingly said, "My man, the Army is in need of a man who can wear a truss upside down for nine years!"

* * * *

The Scotch were ever a wordy as well as a hardy race. A writer in the "Kilmarnock Star" lets himself go at two-column length on the subject of increased electricity charges. The opening passages are too good to leave unrecorded.

> I read with considerable interest your leader-writer's parallel between the history of Greece, ancient and modern, and that of Scotland in the 17th century. The point of similarity most clearly brought out was the resistance of both peoples to tyranny—especially in its beginnings. Two weeks ago I called the attention of the ratepayers of Kilmarnock—proprietors of the electricity department—to the arbitrary, despotic and unconstitutional conduct of an oligarchy that had secretly formed itself in the electricity committee; that had, consistently and persistently, refused to give information which the ratepayers were entitled to ask for; and that had given sham answers to real questions.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Oct. 18, 1879.]

India Rubber.—Prices are still ruling upward. Para is being sold at 3s. 2d. per pound.

The Telephone.—The Pittsburgh Southern Railroad, extendgni from Pittsburgh to Washington, Pa., a distance of over 36 miles, has discarded the telegraph instruments for the telephone in the transaction of business, including the running of trains. It is said a whisper in Washington can be heard in Pittsburgh. Severl western railroads have also resorted to the use of the telephone instead of telegraphic instruments.

The Electric Light in the German Army and Navy.—The "Year Book for the German Army and Marine" states that the electric light has been employed for military and naval purposes—among others for lighting up the ground lying in front of a besieged fortress, for the illumination of ships at sea, and notably for carrying on work under water. A transparent bell with an electric lamp has been immersed to a depth of 60 metres, while a magneto-electric machine placed at a distance of 100 metres has been able to maintain a strong unbroken current, so that a brilliant light was maintained for a long time. The same authority states that experiments are now in course of being carried out for the purpose of testing how far the electric light can be usefully employed in marine warfare, and especially as a defence against torpedo attacks.

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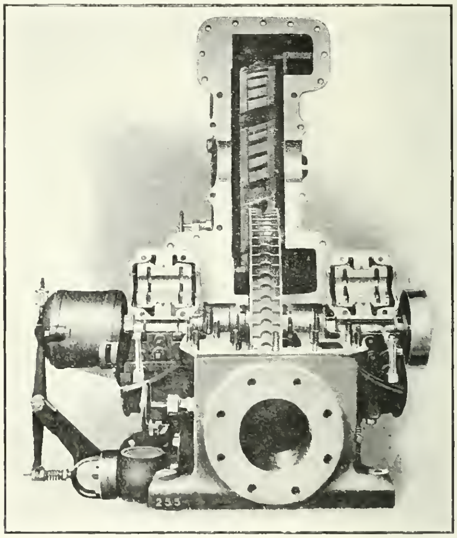
THE "TERRY" TURBINE.

One of the most interesting features of central station work during the past 10 years is the employment of the small capacity steam turbine for the driving of exciters and condenser and boiler-house auxiliaries. Since it was demonstrated in the early days that the steam turbine was most efficient in the large sized machine the reciprocating engine was favoured for the class of service referred to. Attention has, however, been paid to a miniature steam turbo unit, and results have been achieved which has justified its regular employment. So far as the driving of auxiliaries in central stations is concerned, the small turbine can show to advantage, because the exhaust steam can be employed for the heating of boiler feed water. It also has the merit of being extremely compact.

Some interesting particulars of the modern small turbine are given in a bulletin issued by Fraser & Chalmers (Ltd.), Erith, Kent. This publication describes the Terry turbine, which is a specialised product of its class, and of which it is stated 2,500 are in operation in various parts of the world. Many of these turbines have been in constant service from 5 to 10 years. In the design of the Terry turbine high operating efficiency, long life and accessibility are features which have been aimed at as being of greater value than that of first cost. In the non-condensing Terry turbine, short shaft span is obtained by the use of a single wheel; in the condensing machine a composite design of turbine is employed. Small turbines are essentially high-speed machines, and in order to avoid all possibility of shaft whipping large diameters are used, so as to bring the critical speed well above the operating or test speed. By keeping down the weight of the rotating elements and by the use of long bearings, low bearing duties have resulted. The high pressure steam is confined to a small chamber at one end of the machine, and the casing, being subjected to exhaust pressure and temperature only, virtually forms a portion of the exhaust pipe, and is thus relieved of any appreciable strains. For the same reason, packing and gland troubles are minimised. The makers call special attention to the fact that the casing, bearings and housings are supplied on the centre line, thus giving immediate access to every part of the turbine without destroying the alignment or interfering with pipe connections.

The non-condensing Terry turbine is a single-wheel, single-pressure, multi-velocity stage type of machine. The steam is practically expanded to exhaust pressure, and its energy is transformed into velocity, which is absorbed by the several velocity reversals in the wheel. There are several steam nozzles, and each of these acts independently of the others, producing its own proportion of the total power. It is stated that by closing the desired number of nozzles the turbine can be run on low loads at practically full load efficiency. There is, of course, no internal lubrication, and the exhaust is therefore entirely free from oil. When condensed it is practically distilled water, and can be used for ice making. This absence of oil in the exhaust is, of course, a feature of all steam turbines.



VIEW OF TERRY SINGLE WHEEL TURBINE OPENED FOR INSPECTION.

The condensing Terry turbine is of composite design, comprising a single-stage multi-velocity wheel at the high-pressure end, with either multi-pressure or reaction elements at the low-pressure end. The steam leaving the multi-velocity wheel is passed to the opposite end of the turbine casing, and flows from the reaction elements towards the centre of the turbine, whence it passes out to the condenser. The makers state that this return flow feature, which is distinctive with the Terry turbine, entirely eliminates one of the chief troubles with which turbine builders have been confronted, that is the leakage of air through the turbine gland to the condenser. The air leak may be so small as to be unsuspected, and yet cause a serious loss in the operation of the machine. As little as 1/10 in. loss in vacuum will mean perhaps many hundred lbs. difference in a year's working. This return flow feature has the further advantage of keeping both ends of the turbine casing at equal temperatures, thereby removing one of the chief causes of misalignment. The shaft of a turbine of this class has a large diameter, and is stepped down from the centre towards the bearings.

The Terry turbo-generator is built in sizes from 1 kw. to 750 kw.

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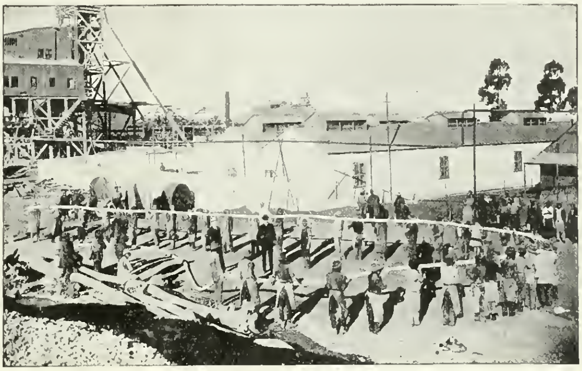

Laying a 20,000 volt Prescot Cable at Langlaagte Mine, S.A.

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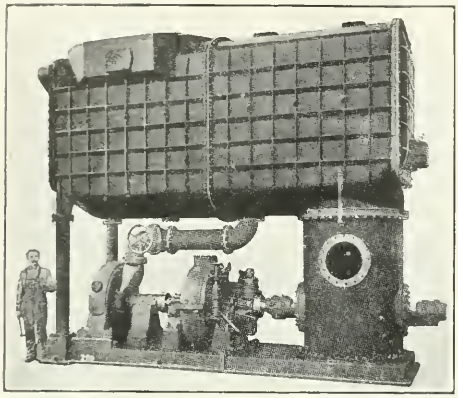
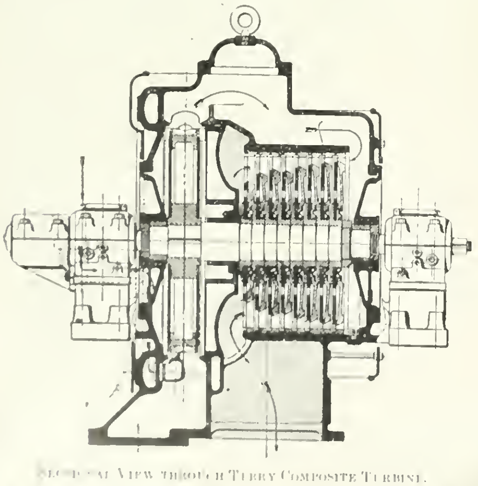
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

For non-condensing work it may be designed to exhaust against back pressure. Condensing sets can be supplied for low-pressure and mixed-pressure service, as well as the usual high-pressure condensing units. On the mixed-pressure machine the Rateaux mixed-pressure governor mechanism is introduced. Terry turbo-alternators are built to run at about 360 revs. per min: the direct-current sets range in speed from 4,000 revs. per min. downward, according to size, and with both types of generator the turbine is directly connected. For the larger size of direct-current units the turbine is allowed to run at its most efficient speed from 3,600 to 4,000 revs. per min., and is arranged to drive a dynamo through special herring-bone reduction gearing, which gives a dynamo speed ranging from about 900 revs. per min. downwards.


Complete Condenser Equipment, Driven by Terry Turbine.


Sectional View through Terry Composite Turbine.

A feature is made in the bulletin referred to of the low pressure turbine and the facilities which it offers for utilising the energy in exhaust steam. It is pointed out that there is as much energy available in a lb. of steam expanding from atmospheric pressure to a good vacuum as from the average boiler pressure to the pressure of the atmosphere. It has not been possible with reciprocating engines advantageously to extract this energy from the exhaust steam. Where there is a satisfactory supply of cooling water for condensing purposes, the output of a non-condensing plant can be practically doubled by the use of a low-pressure turbine and condenser, and this additional output is made available without the introduction of further boiler plant; also there is little or no increase in coal consumption or operating cost. The development of the Terry turbine makes it possible to utilise this exhaust steam energy in comparatively small plants. It is stated in the bulletin that a 300 H.P. low-pressure Terry turbine was installed to take the exhaust steam from a 300 H.P. non condensing engine, and a saving of more than 40 per cent. was effected in the total operating cost.

With low pressure when the turbine takes its steam from a non-condensing engine, and the two generators are connected to the same load the installation is simple and inexpensive, as governor mechanism is not required. The engine governor will automatically divide the load between the engine and the turbine. If the turbine should tend to take more than its share of load its governor will throttle the steam, which has the effect of reducing the supply of exhaust steam. The emergency governor is introduced as a precautionary measure, and is fitted to the turbine in the form of a vacuum breaker, and comes into operation in the case of over speed.

The bulletin on the Terry turbine referred to above is obtainable from Messrs. Fraser and Chalmers, Erith, Kent.

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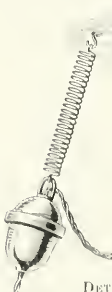
THE NEVAKNOT ADAPTER.

A new form of adapter for use with irons and other electric table utensils is being put on the market by Engineering & Arc Lamps (Ltd.), St. Albans. The illustration explains the construction of this device. The flexible from the ceiling rose is taken into one side of the adapter which comprises a spherical elliptical body containing a cord absorber and a spring attachment for fixing to the ceiling. It is claimed that the flexible is not twisted or knotted under the most severe movement of the utensil or apparatus to which it is connected. Particulars and prices are given in a leaflet which is obtainable from the company on application. The adapter should be most useful with both domestic and laundry electric irons.


Detail View of "Nevaknot" Adapter.

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ORGANISING BRITISH INDUSTRIES.—II.

THE WORKS OF BELLING & CO.

It will always redound to the credit of Britain and the British that the bright cheery fire has been given precedence over the efficient but none the less dull, unwelcome radiator. The term "fire" has happily been passed down the years from its parent in the bush, through wood blaze, the glow of the coals, the gurgle of the gas stove and the steady, silent warmth of the electric fire. They are all fires, and a point is made of calling all by that cheering name. It is the correct term, and to the public mind conveys the right meaning. The British heater is a fire whether it is wood, coal, gas or, finally, electric; it will always remain so.

Mr. C. R. Belling, whose works are made the subject of this article, attributes his initial success to his selection of the term "fire" in preference to that of heater, radiator or stove. He contends that it engendered public confidence in electric heating, and removed the prejudice which for so many years had been cultivated by lamp radiators and convectors. It has proved a great thing for the electric heating business this breaking down of public prejudice. Those who have recently taken up this important line of electric apparatus lie under an obligation to the pioneers whose foresight has helped in the later achievement of such splendid results. The growing popularity of the electric fire is exemplified to a remarkable extent in the works of Belling & Co., Derby-road, Edmonton. An inspection of this interesting factory by a certain class of writer in the gas journals, which constantly endeavours to belittle electrical achievement of every kind, would perhaps give such carping critics pause, and bring them to a realisation of the solidarity of the electric fire business. The works of this pioneer firm in the field of electric heating were first opened in 1912, and at that time gave employment to five men. In the interim the building site has been extended by approximately ten times, and the workshop area has been increased by twenty times. In the early days, when new ground was being broken with the "electric fire," numerous difficulties were encountered, principally with the heating element and the terminal connections between the fire leads and the resistance material itself. It is a tribute to the perseverance of Mr. Belling and his co-workers that these difficulties have now practically been overcome, and a fire bar has been standardised which can be employed in an almost infinite variety of designs of frame to make up the complete fire. From the comparatively modest output of 30 fires per week the operations have been extended, till at the present time the factory is equipped and staffed for the production of 500 per week the year round, besides auxiliary electric heating apparatus.

It is gratifying to note that the output of Belling fires finds its way to quite a considerable extent into the Colonies and numerous foreign countries. In spite of the war, the works have been kept going, although 60 per cent. of the pre-war staff and employés have joined His Majesty's Forces. The company concluded that in "carrying on" they were contributing, if only in a small measure, to the maintenance of British overseas trade. The continuance of business relations with the Colonies is most desirable, quite apart from the enormous strain which the conduct of the war is imposing upon our industrial resources, particularly in the maintenance of munitions output. It must all be to the good of, in this particular instance, the British electric fire business that regular production is continued and the work of standardisation and improvement is still carried on.

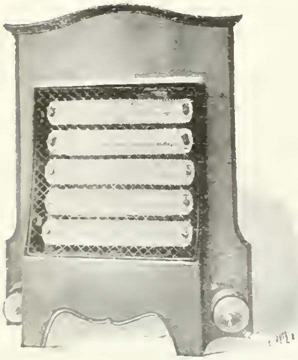
The Man and the Fire Bar; Mr. C. R. Belling and his Standard Bar.

As to the Belling works themselves, the shops would not present to the ordinary visitor certain objects, such as lines of machine tools, avenues of shafting and belts and massive cranes running overhead, which never fail to interest and fascinate. There is, however, an air of quietness about the works which, though it may seem strange, is none the less indicative of continued activity in the various operations which contribute to the production of the completed article. The shops are electrically driven, they are well lighted, both artificially and by day, and adequate accommodation is provided for the comfort and convenience of both the staff and employés.

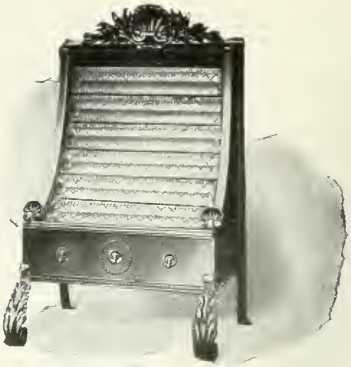
It has not yet been found necessary to put down an iron foundry, as there are a number of quite good firms of founders within easy reach of the works.

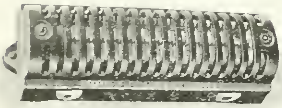
Outside View of the Works from the North End.

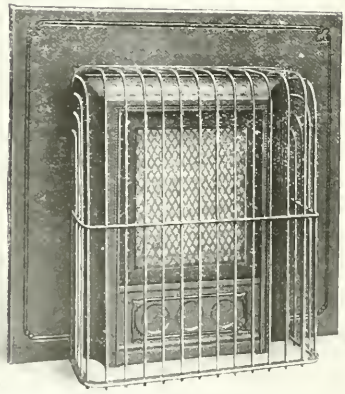
The majority of the metal working operations are divided between the upper and lower floors of the factory, the heavy drilling machines being on the ground floor. On this floor is also the winding department, the test room and the assembly department. The visitor is probably most interested in the winding mandrels, which have been fitted up for spiralling the wire which forms the resistance element of the Belling standard fire bar. Each mandrel is of considerable length, and a large quantity of wire is spiralled on it at one time. When the operation of spiralling is completed, the coils, which for all the world resemble long snakes, are laid on a bench top, and a considerable length is taken by one of the girl operators and pulled out over a given distance, thus evenly separating each of the turns in the spiral. When this has been done the desired length is cut off and wound over the teeth of the fire bar. Each of the ends is brought out under the special large sized terminal and secured in position by a pinching screw. The end of the element itself is

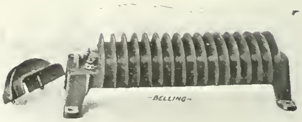

The "Mantel" Fire.

The "Standard" Fire (The Old Original).


A "Boudoir" Fire.

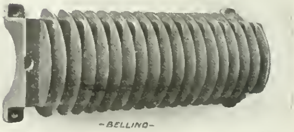

The Single Bar Fire.


Railway Waiting Room Pattern Fire.



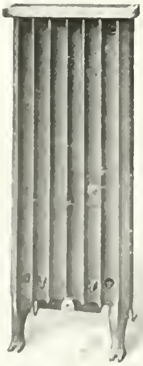
Air Warmer, showing Terminals.

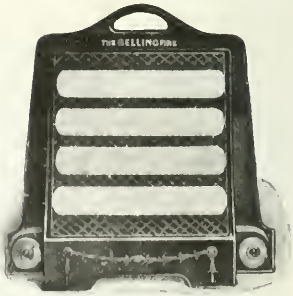
The New Belling Boiler.



Air Warmer.

The "Rebows" Fire.

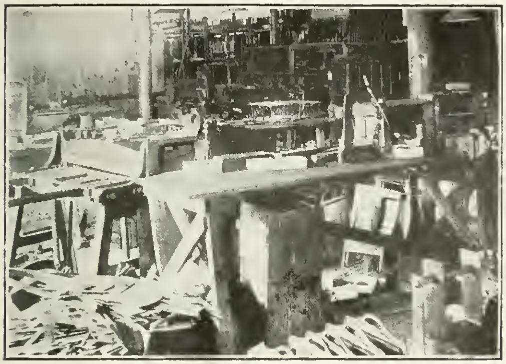

Vertical Pattern Air Warmer.



The "Office" Fire.

TYPICAL EXAMPLES OF BELLING PRODUCTS.

BELLING FIRES IN THE MAKING.



A Corner of the Metal Shop.

In the Frame Fitting Shop.

Winding the Fire Bars.

View in the Assembly Department.

Hot-plates and Fires at the Test Benches.

Packed Ready for Shipment.

gripped between two plates, and not by the fixing screw. The terminal drops into a suitable recess in the fire bar, and occupies a position in which it conveniently accommodates the supporting stud and nut; under the latter is a spring washer, which is introduced to take up the expansion and contraction of the terminal under the varying temperature conditions which naturally obtain in any fire bar. This form of terminal was only introduced after considerable experiment, and it has proved the merit of the design now over several years. After winding, each fire bar is passed along for inspection, and is then tested for "hotspots." In this test the full working voltage is applied to the bar, and the tester observes how the temperature rises by looking through an aperture in a large hood which excludes all external light from the surface of the bar. In this simple way a check is obtained on the manner in which the bar has been wound.

The testing equipment includes instruments and apparatus for running any desired pattern of fire under normal or exceptional working conditions. Every fire manufactured is subjected to a flash insulation test of 1,500 volts alternating, and any fire which fails to pass this test is put back for further adjustment.

We include in this article a number of illustrations which show the principal departments in Messrs. Belling & Co.'s works, and also a selection of the considerable variety of fire designs which are included in the company's normal output.

In the space of a short article like the present it is not possible to describe in detail the work which Messrs. Belling & Co. have done in building up an extensive business in electric fires. We have said enough to show that there exists to-day an increasing demand for this form of heating apparatus, and of course Messrs. Belling are not now the only makers of electric fires. Mr. Belling himself, so he informs us, kept in close contact with the central station engineer in the building up of a public demand for his products. He has received varying degrees of encouragement from this quarter, but in the main the result has proved highly satisfactory for the fire business, and he acknowledges his indebtedness to many progressive central station men, who have made practical suggestions which it has been possible to embody in numerous designs of fires.

View of the Fitting Dept. and Machinery Department.

One of the most instructive features with which we were struck in inspecting the works was the fixing upon a few only of standard designs and the production of these in considerable quantities. This policy has resulted in the marketing of a good fire at a price which has encouraged continuous sales. There has been no tinkering after the designs in any of Messrs. Belling's fires, and this fact will also probably explain their increasing popularity.

A point of no little interest is the standardising, not only of the fire bar itself, but also its capacity. After considerable experiment with various loadings, the company fixed upon 500 watts as being the most suitable bar loading, and to this they now rigidly adhere. Another feature of the "popular" lines of Belling fires is the employment of cast-iron as the principal portion of the framework. This in itself represented a considerable departure from the bent iron and sheet metal of the lamp radiator days. The cast-iron frame gives the fire a stamp of solidarity, and brings it into line with the competitive systems represented by coal, anthracite and gas. Cast iron also lends itself to a great variety of finishes, and there is scope for the display of considerable artistry in the frame itself. The "Office" and "Renown" fires are admirable examples of this.

One of the Charming Little Sketches from Mr. Belling's Fire Lists.

It must not be supposed from the foregoing that the claims of the highly ornamental brass and copper fires are overlooked. The company's catalogue contains boudoir patterns, and by their very name indicate the type of customer to whom they are intended to appeal, and the price which they are likely to command. In all these fires the same attention to structural details as is followed in the cast-iron frame designs is observed. The company also has among its designs a Navy pattern, in which the fire bars are specially insulated and are subjected to 2,000 volts alternating pressure test. The 'bus bars in this fire are specially sprung to withstand vibration and gun fire. The case of this fire is of stout pressed steel, and the front is removable by unscrewing two thumb nuts.

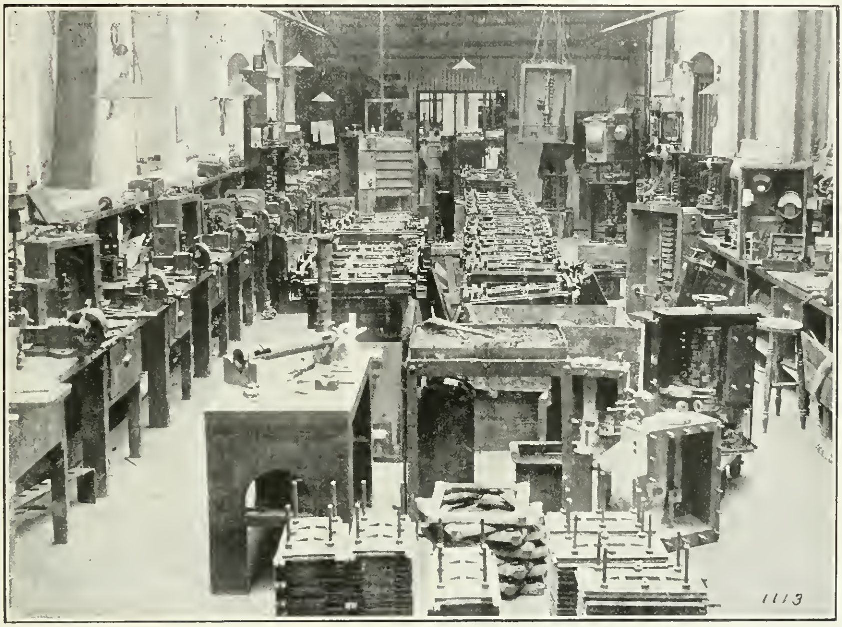
Little or no space remains to refer to other interesting Belling products, but these include a 15s. grill fitted with three 500-watt fire bars, a larger pattern of grill loaded to 3½ kw., and a rapid griller toaster loaded to 1,800 watts. Mr. Belling has been most persistent in his efforts at the production of a rapid boiling ring, and, after turning out several designs, has now settled upon a business-like specimen which is of heavy cast-iron construction, stands on a cast-iron tripod and measures 7 in. in diameter by 4½ in. high, the weight being 4½ lb. This ring is fitted with a single heating element which has a loading of 1,200 watts. A feature of the construction is the CI grid placed immediately above the heating element. This grid is so designed as to give maximum protection with a minimum of covering of the radiant heat surface. Other Belling products which we had the opportunity of inspecting include a standard range of immersion heater suitable for service in conjunction with existing hot water systems, these being made in six different sizes and ranging in loading from 1 kw. to 6 kw. We understand there is already a good demand for these heaters. In the matter of electric ovens, Mr. Belling has been satisfied to proceed, shall we say, warily. He has made numerous experiments, and at present has a standardised oven which is loaded to 3 kw., and is built up in a cast-iron frame, the inner lining being of porcelain enamelled sheet steel. The oven of this cooker measures 14¾ in. wide, 20 in. high and 12 in. deep, and the overall height from the floor of the oven is 27½ in. There is room at the top to make use of a Belling boiling ring and a griller toaster.

Mention must also be made of a quantity of quite specialised work done at the factory in the way of industrial heating devices such as are required to replace gas heated apparatus; in this field electric heat is making rapid strides.

Mr. Belling has achieved something of a reputation for his trade literature and posters, and undoubtedly the issue of these has materially contributed towards the popularising of both electric heating and cooking. Many of our readers will have recently been the recipients of the poster, catalogue, leaflets and booklet which make up the printed matter which the company is issuing for the ensuing season. Needless to say, this matter is always willingly sent on request to interested inquirers, whether in this country or abroad.

Before bringing this somewhat cursory description of an interesting factory to a close, we would express our thanks to Mr. C. R. Belling for his courtesy in showing us round the works, and to hope that before next winter we may be called upon to describe still further extensions to the Edmonton factory.

W. E. W.



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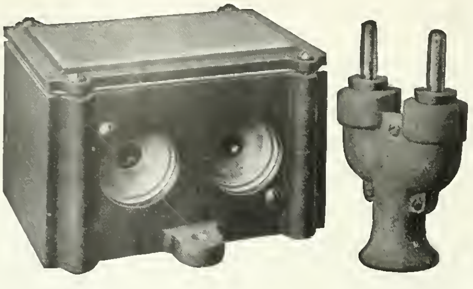

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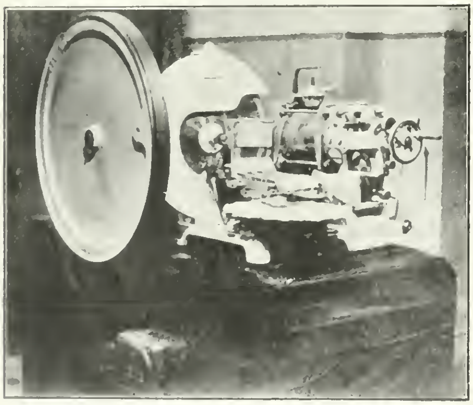
AN ELECTRIC BREAD AND BUTTER MACHINE.

The bacon slicer of American origin with rotary knife and step-by-step movement is now a common enough sight in grocery and provision stores. The fact that it can easily be operated by hand perhaps explains its popularity, even among unpretentious pork pie and sandwich shops. This hand working is facilitated by the use of a heavy flywheel.

Second cousin to the bacon slicer is the bread and butter machine, an ingenious contrivance which we are pleased to note is essentially British. When the war is over it will have a universal vogue; there is no telling, it may even find its way, in a diminutive form, into the every-day household. At present it exists on the grand scale, much as it is depicted in the adjoining illustration, the specimen shown being equal to the slicing and buttering of 3,600 pieces of bread and hour. It is designed for operation by a ¼ H.P. direct current motor which drives it by narrow belt passing round the periphery of the large flywheel, which is shown on the left-hand of the illustraton.



General View of Bread and Butter Machine.

There is a large rotary slicing knife, a cylinder containing the butter, and a long trough which holds the loaf. The mechanism provides for adjustments which make it possible to regulate, as desired, the thickness of the slice of bread and the amount of butter which is spread on the slice. Once the mechanism is set for these, the machine will continue indefinitely to turn out slices at the rate of about 3,600 slices per hour. The butter is quite evenly spread over the slice and it is quite immaterial whether the bread put into the machine is new or stale; the makers of the machine state that "new bread is perfectly cut and buttered within two hours of baking."

Obviously there is no waste of bread or butter, and an immense advantage of the machine is that, where large parties are to be catered for, the bread and butter need not be cut in advance with the risk of its becoming curled and stale after standing some hours. It is of course, also possible to cater for large parties which arrive unexpectedly, and to supply bread and butter to meet all requirements with practically no delay.

We have seen one of these machines in operation at the Empress Winter Gardens, Watford, and were much impressed with its silent movements and the rapidity with which the buttered bread is delivered on to the plate. The general mechanism does not call for any particular comment except perhaps that the wearing parts are substantially designed and that none of the details incidental to the regular running of a machine of this class have been overlooked. By this we mean that the machine has been well tried out under practical service conditions and embodies a number of distinctive features which have been introduced as a result of this experience. A description of these features is of no particular electrical interest and need not be entered upon here. One of the features of the machine which struck us particularly, however, was the device to ensure that each piece of buttered bread falls buttered side up and also the neat conveyor by which the buttered slice is delivered on to the plate.

We understand that the makers are busy on machines of this class for munition caterers, and Messrs. Kynochs (Ltd.), Component Munitions (Ltd.) and a number of large shipbuilding works on the Clyde have been supplied with machines. In some of these works stale bread is cut in slices a full ½ in. thick!

To those who are interested in this class of machine we would recommend that they apply to Mr. Geo. Blake, managing director of the B. & B. Machine Co., 36, Camomile-street, London, E.C.

COVENTRY DRIVING CHAINS.

"The Coventry" Handbook of Chain Gearing is a complete symposium on the subject of the power chain and its application to the driving of all classes of machinery. The development of this form of power transmission is one of the most interesting features of specialised engineering production during the past 15 years. The motor vehicle can probably claim credit for the development of the power chain. It proved so satisfactory in this class of service that its extension to the driving of machinery, especially in conjunction

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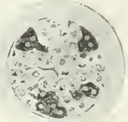
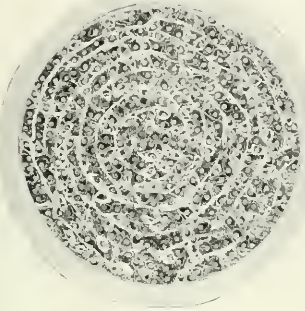
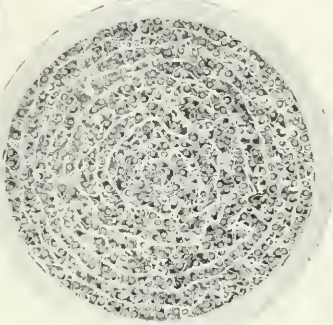


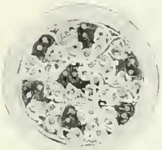
42 WIRES
EACH
20 lbs.
PER MILE.



408 WIRES
EACH
20 lbs. PER MILE.



612 WIRES
EACH
20 lbs. PER MILE.



56 WIRES
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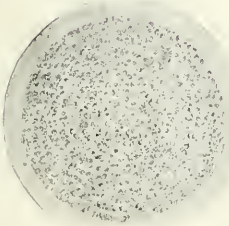
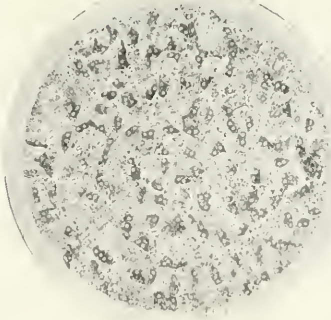
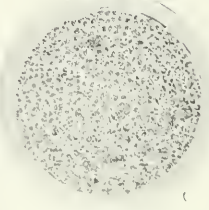


600 WIRES
EACH
10 lbs. PER MILE.



1212 WIRES
EACH
10 lbs. PER MILE.



500 WIRES
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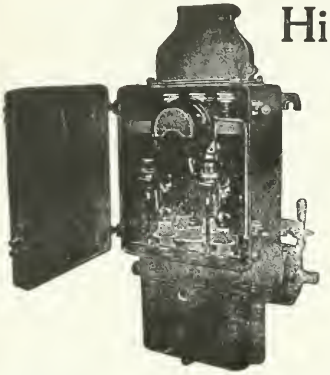

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with the electric motor, was a perfectly logical development. As a result of the early experience of manufacturers in this field, the capacity of the power chain has been steadily raised until at the present time quite considerable drafts of power are transmitted by its means.

A glance through the pages of the handbook above referred to, which is issued by the Coventry Chain Co. (Ltd.), Coventry, England, furnishes an instructive survey of the design and construction of the standardised chain which this company have developed, and have had in service for some years past. In the opening pages the principle of noiseless chain gearing is set out, and its advantages are given in some detail. The illustrations which accompany this description are most lucid, and serve to emphasise points made in the text. The chain is built up of a number of specially shaped links, which enter and leave the wheel without any sliding friction between the links and the teeth during the period of engagement. A feature of this class of chain is the manner in which as the chain inevitably stretches on account of wear, the links automatically accommodate themselves to the teeth of the wheel, there being still an equal distribution of the load between all the teeth just as there is when the chain is new and lies compactly between the teeth of the wheel. It is claimed for this form of chain that noise and wear are reduced to a minimum, the driving efficiency is high, being as much as 98 per cent. at full working load, journal pressure is reduced to a minimum, the chain will run in either direction, it can be used in hot or damp places, and it gives no eccentricity between driving and driven wheels. The chain may also be run at a high speed without undue noise, 1,400 ft. per minute being the maximum usually recommended, unless the chain is entirely enclosed in an oil case, when a higher speed is permissible. The chain is made in two forms: (1) with outside guide-plates; (2) with centre guide-plates for running on grooved wheels. The links are arranged in pairs, and are held together by a dead hard bush which is forced into reamered holes of each link, thus ensuring stationary and hardened bearings where most of the wear takes place. It is claimed that this form of manufacture produces a strong and rigid chain and eliminates the risk of bearing parts becoming loose. The double links are assembled alternately to form the various widths in combination, the whole of these being kept together, and they work on hardened steel rivets having washers at their extremities. Attention is called to the fact that the wearing surfaces are dead hard, except the faces of the link which engage with the wheel teeth.

The handbook under review contains a number of interesting tables, giving statistics of the various sizes in which these two forms of standard chain are supplied. There is a useful section on chain-wheel cutters, which are designed for the production of the correct form of tooth to be used in wheels on which these chains are employed. Tabulated particulars are also given of a considerable number of chain wheel designs, which are made up in various sizes. Then there is a section which gives valuable hints to users and a description of a shock-absorbing wheel, which has been developed for use in certain classes of drive with power chains. The concluding pages of the handbook contain a number of instructive illustrations depicting the practical application of noiseless chains for the driving of printing machinery, shafting, colliery plant, fire pumps, &c., all from electric motors. Interest also attaches to the Coventry noiseless chain-gear boxes for reducing and increasing speeds. These are offered for a variety of ratios and speeds, both on the first and second shafts. They are designed to run entirely in oil, and can be relied upon to do duty for long periods without attention. It is claimed that the life of one of these chain driven reduction gears is considerably longer than that of similar gears using spur and worm gearing; the principal wear is on the chains, and the renewal of these only is necessary to make the gear equal to new. The manufacturers direct special attention to the small amount of space occupied by these gear boxes.

Printed and Published by the Proprietors "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2, and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, October 20, 1916.

THE ROUND TABLE.

By "KVA."

"Electric Plant Run Out," says a headline in the "Labour Leader," anent the occasional stoppages of the Birmingham trams. Leakages of this kind ought to be notified to the War Savings Committee.

* * * *

THIS WEEK'S QUERY.—Why did the half watt holder?

* * * *

> "What, one wonders, will be the nature of the illuminations when peace is at last declared? Will there be an attempt at a co-operative effort worthy of the occasion? Or will we once more fall back on the old studded lights, crowns and similar time-honoured devices which have done service in times gone by?"

The above is from the "Illuminating Engineer." Our contemporary forgets that all these things have long since been converted into munitions.

* * * *

[From Glover's Almanac.

How to Screw Tubing.

The collapse of a roadway lands one of Mr. Chattock's new generators weighing 54 tons in the front rooms of a small house. It is a little early yet, after Mr. Chattock's recommendations to conscript electric power consumers to find one of his own main generators among the conscientious objectors!

* * * *

The writer of the Electrical Notes in the "Sheffield Telegraph," dealing with the oscillograph, says:

> "The records obtained by the aid of the oscillograph have enabled designers of alternators to practically suppress the third harmonic."

He's wrong, though, because I find that the third Harmonic will be given on December 15th, usual time, usual place!

* * * *

The "Birmingham Gazette" has discovered the secret of the occasional lack of electric power for the city trams. It says of a "bureaucratic City Council":—

> "This fiasco is only the nemesis of the caucus rule which distributes chairmanships and packs committees under political influence."

In other words, the slide rule would have avoided all this trouble which the "caucus rule" has brought about!

A couple of typists' errors have just been sent in to me by "Round Table" readers. In the first the young lady called them metal "philliment" lamps, and in the second another "over-anxious to please girl," in concluding a letter to a well-known firm of Swiss electrical engineers, who have offices in London, asked for the delivery of the goods at your "Oerlikon-venience!"

* * * *

Sheriff Fyfe, at a Munitions Tribunal recently held in Glasgow, in trying a case of a man who had been the worse for drink at his work on board ship, inquired "why it was that the men who took a dram too much were always the best workmen." To save the trouble of turning up a number of historical instances, I refer the Sheriff to the author of a "A Wee Deoch an' Doris."

* * * *

A writer in the "Glasgow Herald" under the heading Motoring Notes says: "One of the funniest things in connection with motoring to-day is the industry that has grown up around and in connection with the disguising, the aiding and improving the Ford car." Equally funny is his concluding comment: "Nothing in the world could dissemble its identity, and only the owner, poor man, has any desire to attempt it!"

* * * *

If you are in financial difficulties, if your creditors flock round you like legion, if you are continually haunted with visions of not more than 5s. in the pound, take heart of hope, for—

> A judgment debtor at the City of London Court said he was about to bring out a new electric gun to bring down Zeppelins, and would so get rid of all his debts.

* * * *

OUR HOT PLATES.

No. 218 to—

Prof. D. Robertson for his "Tidal Electric Power" address to the Birmingham Local Section of the Institution of Electrical Engineers.

No. 219 to—

Prof. P. B. Cohen for the following in his presidential address to the Leeds University Cavendish Society: "The secret (of our national indifference) lays in the existence of a vicious circle which had grown up around us and had linked in a closed chain the big public schools, the older universities and the Civil Service, in all of which science had been far too long taboo."

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Oct. 25, 1879.]

TELEGRAPHY IN WAR.—(*A correction.*)—The accuracy of "The Times" in its reports is generally acknowledged, but we find "The Times" is liable to error. In our last issue we quoted a paragraph from Sir E. Wood's speech, in which a Mr. Wright was credited with great activity in telegraph matters in South Africa. A number of correspondents remind us that the gentleman who has shown so much energy is Mr. Sievewright.

THE ELECTRIC LIGHT ON THE THAMES EMBANKMENT. The first experiment with 20 lights was commenced on December 13, 1878, the second with 10 on May 16th last, the third with 55 lights on October 10th. The length of the circuit on the west side of Waterloo Bridge was 6,000 ft., of that on the east side 6,092 ft. Since December 13th last to the 9th inst. the lights have been burning 1,374 hours, during which time there was consumed 29,997 candles. The total length of conducting wire is 17 miles 361 yards, to be increased when the Board of Works room is lighted to 18½ miles. The 10 new lights on Waterloo Bridge are worked by a 20-light Gramme machine in two circuits.

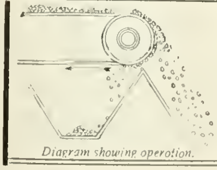
Diagram showing operation.

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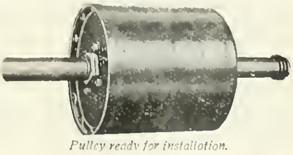
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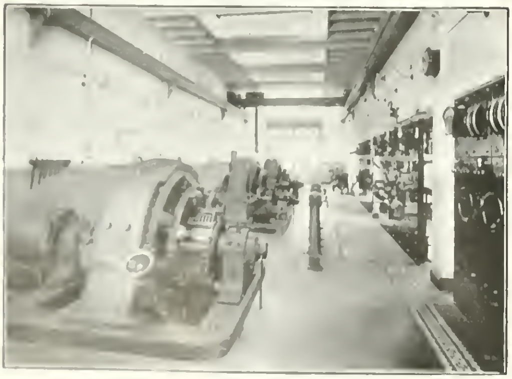
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

ROTARY CONVERTER EQUIPMENT IN BARCELONA.

Electrical enterprise in Spain was up to recently in the hands of the Germans, and to a great extent of the Americans, therefore some particulars of an important traction undertaking installed by the General Electric Co. (Ltd.), of Witton, Birmingham, and 67, Queen Victoria Street, London, is of some interest. The installation, which



[illegible] the Barcelona Tramways Co., [illegible] "Witton" Rotary Converters from the [illegible]

[illegible] comprises the electrical [illegible] of the Barcelona Tramways Co., [illegible] phase power is received at 6,000 volts, [illegible] cooled transformers [illegible] between the machines. To gain access to each transformer a removable checker plate is let into the floor, which can be lifted when the transformer needs attention or inspection. The converting equipment comprises three 500 kw. shunt-wound Witton rotary converters running at a speed of 750 revs. per min., fitted with interpoles, and generating continuous current at 600 volts. The energy so produced is used entirely for traction purposes.

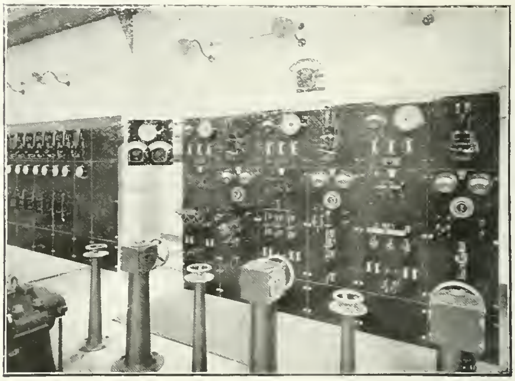


Fig. 2.—Low-tension Switchboard for Controlling Alternating and Continuous-current of the Rotary Converters.

Each rotary converter is provided with a slip-ring starting motor for running up to speed, synchronising being effected by operating the rotor rheostat of the slip-ring motor. The motor is carried on an extension of the converter shaft. Suitable pillars for controlling the regulators are mounted near the switchboard, as shown in Fig. 2. In addition, each rotary may be run up from the continuous-current side by means of a change-over switch and starting resistance, which is similarly operated from a hand-wheel pillar. For the front of the board a double-pole change-over switch is also provided to reverse the shunt coil of the reverse-current trip when starting in this way.

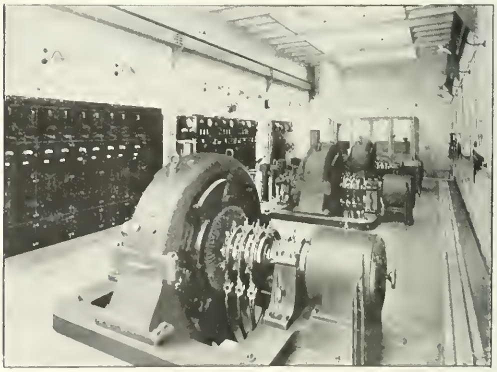


Fig. 3. Alternating-current Side of Rotary Converters containing the Feeder Switchboard.

In the illustrations, Fig. 1 shows the continuous-current side of the rotaries. That portion of the main switchboard controlling the low-tension side of the station is seen in Fig. 2, where all the regulating pillars can also be discerned. In Fig. 3 a view of the alter-

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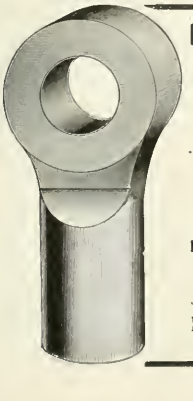
Thermostatically controlled apparatus to keep either water or air at any desired temperature.
Electric Toasters, Water Boilers and Grillers for Mess Rooms.

We have had large experience in adapting electricity to many novel manufacturing processes, and are prepared to submit quotations and drawings to meet any given conditions.

BELLING & CO., Electric Heating Specialists, Derby Road, EDMONTON, LONDON, N.



E. SHOWELL & SONS, LTD.

STIRCHLEY, BIRMINGHAM.

Cast Cable Sockets.

Suite E74. Made in all Sizes.

Type A.—Straight.
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Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.

Sale Agent for the Electrical Trade:—

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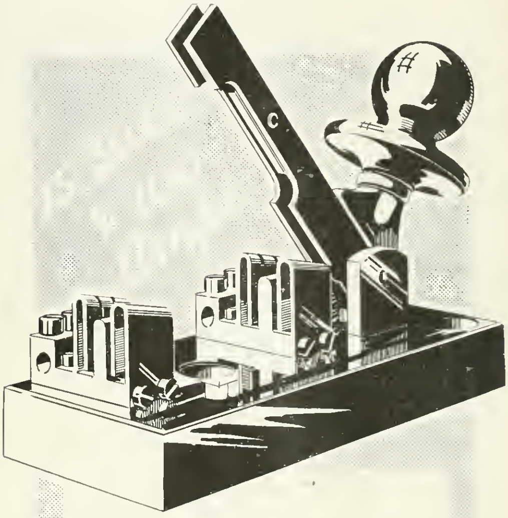
TELEPHONE: *Holborn* 6323.

Simplex Switches



Quick Break.

Blades dead when Switch is open.

Maximum Contact Surfaces.

Liberal Current Carrying Parts.

Sizes:
15, 30, 60 and 100 amperes.

SIMPLEX CONDUITS, LTD.,
Garrison Lane, Birmingham.

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113-117, Charing Cross Rd. W.C.
MANCHESTER—
16, Corporation Street.
GLASGOW—
72a, Waterloo Street.
BRISTOL—
10 & 11, Denmark Street.
NEWCASTLE—
61-65, High Bridge.

LEEDS—
6, White Horse Street.
LIVERPOOL—
96, Whitechapel.
SWANSEA—
14, Heathfield Street.
CARDIFF—
4, Westgate Street.
ABERDEEN—
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AN OPPORTUNITY.

We have a quantity of new

ELECTRICAL HEATING UTENSILS

of the "Elektra" make, which we desire to clear, and should be glad to hear from firms willing to entertain the purchase of these, either in bulk or part, at particularly low prices (much under actual cost). Enquiries invited.

ISENTHAL & CO., (Dept. 4.) Denzil Works, Willesden, London, N.W.

nating-current side of the rotaries and feeder switchboard is shown. On the controlling switchboard shown in Fig. 2 each rotary converter alternating-current panel is fitted with ammeter, power-factor meter and switch and fuses for the starting motor. Adjacent to each alternating-current panel is the corresponding continuous-current panel, on which is mounted a circuit-breaker having overload trips as well as a tripping coil operating in conjunction with an over-speed device for each converter, in addition to the change-over switch and the single-pole main switch for starting from the continuous-current side.

A synchroscope with machine and 'bus-bar voltmeters is carried on a swinging bracket at the end of the board. The feeder panels are each fitted with a single-pole circuit-breaker main switch and ammeter. The complete installation, as described, was supplied by the General Electric Co. (Ltd.).

"Z" LAMP LITERATURE.

The winter campaign for lamps and lighting has now commenced, and we are receiving specimens from various lamp manufacturers of their catalogues and other advertising matter which is available for distribution and circulation by the trade. One of the first lamp lists to reach us is that of the "Z" Electric Lamp Mfg. Co., Southfields. This has been drawn up on an elaborately artistic scale and is printed on rough paper, with the text matter and illustrations in black and ornamental head and footlines with sketches in a light green tint. The effect is distinctly novel and striking. The list deals with the Company's products in the way of ordinary incandescent lamps, plain and twisted candle lamps, "Zedlite" candle lamps, tramway, traction and tram lighting lamps, half-watt lamps, motor-car lamps, and miniature lamps. Prices are set out in table form, with a clear illustration of each type of lamp adjoining. The thumb nail sketches show the spheres of illumination in which electric lamps generally are employed. "Z" lamps are made with drawn wire filament and are produced entirely at the Southfields factory.

Considerable interest attaches to the sign and illumination lamp, which is fitted with Downe's automatic series device, which is contained within the lamp cap. At the time of its introduction some few years ago we commented upon this extremely simple form of "cut-in." The incoming leads in this form of lamp are brought into contact, but at the point of contact they are covered with an oxide which acts as an insulator up to the voltage of the lamp itself. Should the filament of the lamp break the oxide insulation is broken down and the leads automatically weld up with the heat of the small arc produced. The difference in line voltage is distributed throughout the remaining series of lamps on the circuit. This neat contrivance is a practical solution of the problem of series burning lamps, and we understand the lamp has been used with complete success for outline lighting, festoons and similar classes of outdoor decorative illumination.

In the last page of the list is an illustration and description of the "[illegible]" pocket torch, which is fitted with a "Z" drawn wire half-watt lamp. This is provided with a small dry battery, and the makers claim that it is the smallest electric torch on the market. It resembles an ordinary fountain pen, and has a safety pocket clip. It is very little larger than a large-sized fountain pen. In addition to the foregoing, the Company is sending out desk blotters bearing an illustration of the "Z" lamp and suitable letterpress emphasising its merits. These blotters can be supplied to contractors overprinted with their name and address. Those of our readers who have not received copies should make early application.

CANADIAN ELECTRIC FARMS.

Writing of the prosperity consequent upon profitable crops and of the manner in which cheap machinery and cheap power are enabling farmers to equip their homes and their farms with most of the conveniences which are generally thought to be special advantages of urban life, the Calgary "Albertan" says that many Alberta farmers, with their electric light, motor-driven farm and household machinery, furnaces, water plants and motor cars, will live in greater comfort this winter than their fellow business men in cities. Within the past three months over 50 farmers in the Calgary district have purchased and installed electric light plants and motors to operate churns, sewing machines and feed cutters. In the Lethbridge district over 100 farmers, within a radius of 50 miles of town, have installed these small plants. The automobile and the furnace have for years been fairly common in the average farmer's equipment, but the general application of electricity to farm domestic use is a comparatively recent development. These small electric plants cost from $200 to $700 to install, and are almost as cheap to operate as the inferior lighting systems of the past. Many farmers who have enjoyed two good crops recently are building splendid residences of stone and brick, and are installing lighting fixtures which are the last word in luxury. As an instance of what electricity means to the farmer, and how attractive farm life can be made by these modern devices, it is mentioned that there will be at least 100 more farmers' wives in the Calgary district who will be ironing and churning with electricity next year. Within the last two months one agency has installed in farmhouses 25 of these small lighting plants with motor attachments for operating washing machines, vacuum cleaners, irons, toasters, hot plates, sleeping blankets, fireless cookers and sewing machines. Every electrical device used by the town housekeeper can now be used with equal ease by the farmer's wife, and the cost is so reasonable as to be within the reach of the average farmer. An outlay of $500 to $600 is sufficient to cover the entire expense of the lighting plant, fixtures, installation and supplementary machinery. For $200 a six or seven-roomed house can be modestly equipped, and this cost is reduced by about $65 if the farmer already has a petrol engine for his farm equipment. These things are signs that Alberta is becoming a country of good, solid, comfortable homes, and of the home spirit which is so important an asset in the happiness of a people.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
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Aerial Cables.
Joint Boxes and Pillars.
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Primary Batteries.
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Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
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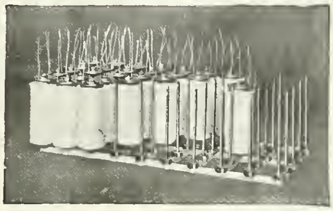
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

HELSBY CONDENSERS.



Helsby Power Condensers for the Improvement of Power Factor are made up in units of about One Microfarad, and our illustration shows just how this is done.

See Pamphlet H 75.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

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AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
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SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

"THOR" High Grade Specialities
CASING and CAPPING CABLE CONNECTORS
CONDUIT COMMUTATOR COMPOUND
CABLES WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
WRITE FOR PRICES & DISCOUNTS.
HASLAM & STRETTON, Ltd., Windsor Place, CARDIFF & Bristol Bridge, BRISTOL.

One, Two & Three Phase
MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

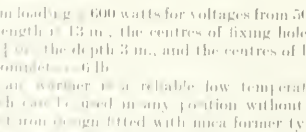
NEW BELLING LISTS.

We have just received advance copies from Belling & Co. of several new lists, which describe, illustrate and price this season's designs of boiler, two fresh patterns of air warmers, and a single bar fire. The rapid boiling ring, illustrated herewith, is 7 in. diameter, 4½ in. high, and weighs 4½ lb. It is fitted with a circular fireclay block suitably recessed to receive the spiralled nichrome element, the construction making the device "slop-proof." The element glows a bright red, so that indicating lamps are not needed, as is the case with "black" plates. The ring is made for single heat, the standard loading being 1,200 watts; lower loadings will be supplied on request. Existing utensils can, of course, be used on the ring. It is being put on the market at 15s. (plus 10 per cent. advance), with 4 ft. of flexible cable.

Latest Pattern Belling Boiling Ring

The Belling single bar fire is intended to supersede the bar pattern fires previously made. It is made in "single bar" size only, but two or more can be grouped together by the purchaser if required. The frame is made up of two light, but strong iron castings, giving ample ventilation. Two porcelain inlet bushes are fitted, through which the connecting leads are taken to the terminal screws. Sockets are provided for these bushes on both sides, so that one or both can be placed at the top, instead of at the bottom, as shown in the illustration, and after the base is fixed, if found more convenient when connecting up. No flex is provided with these fires, as they will usually be permanently fixed in position and connected by permanent wiring.

The design allows of free ventilation behind the base, but when the fires are fixed to wood partitions a sheet of uralite can, with a view to absolute safety, be placed behind them: the uralite being spaced from the woodwork by distance pieces, so as to allow air movement behind it. Provision is made for mounting the fires on insulators if required. These single bar fires have a wide application for the heating of workshops, garages, basements and the like, and are also extensively used for "converting" large ovens, hot cupboards and similar apparatus.



Single Bar 500 watt Fire.

The maximum loading is 600 watts for voltages from 50 to 500.

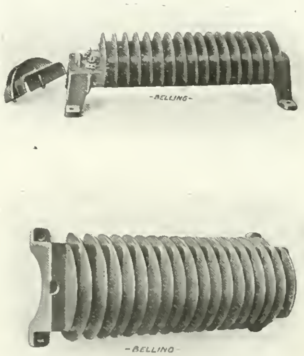
The overall length is 13 in., the centres of fixing holes 12 in., the width of base 4¼ in., the depth 3 in., and the centres of bushes 7½ in.

The weight complete is 6 lb.

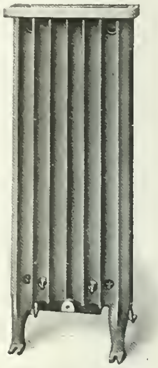
The Belling air warmer is a reliable low temperature heating appliance which can be used in any position without risk of fire. It is a light cast iron design fitted with mica former type elements, and it can, therefore, be considered almost everlasting. The illustrations show the arrangement for connecting up, which can be done after the apparatus is fixed in position. A porcelain bush is provided, but the barrel containing the connecting wires can, if desired, be terminated in the socket which holds the bush. This air warmer should have a wide field of usefulness, in train and tram car heating, in all positions where a "black heat" is preferable, and as a foot warmer that cannot be damaged.

The loading is 500 watts and the warmer measures overall length of base, 15½ in.; width of base, 6½ in.; depth, 4½ in. The weight is 12 lb.

Wherever a source of heat at low temperature is required the vertical type of air warmer is applicable. It is a substantial and neat cast-iron design, so proportioned as to limit the surface temperature to about 100 deg. above the surrounding air, when loaded to its normal maximum of 1½ kw. It can be screwed to the floor at either the centre or sides of a room, provision being made for the connecting leads at the bottom. This air warmer is fitted with two switches, each controlling half of the loading. Its application is recommended for churches banks, theatres, stores, all places containing inflammable goods, and restaurants, public halls and dining rooms. The finish is matt black, and the overall width is 12¼ in., depth 7 in., height 30 in., and weight 60 lb.



New Horizontal Air Warmers.



Vertical Pattern Air Warmer.

Two nickel-plated rods supported on side brackets can be fitted if required for supporting towels, &c., for drying or "airing."

Copies of the leaflets can be obtained of Belling & Co., Derby-road, Edmonton.

DEVELOPMENTS IN INCANDESCENT LAMP MANUFACTURE.*

During the period when the squirted tungsten filament was used in lamps there were constant endeavours to produce a filament by a process of mechanically working the metal. Many difficulties presented themselves and had to be overcome. Tungsten had long been regarded as a non ductile metal. All efforts to roll or draw it had proved futile, and it was only after wonderful perseverance that the problem was solved.

Yellow oxide of tungsten, which is an article of commerce, is the

---

* A. R. Dennington, in Canadian "Electrical News."

QUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phones: Victoria 4026 Grams: Vicminster, Sowest, London

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

C.A.V

BRITISH BATTERIES for AMERICAN CARS

"Manufactured by the Vandervell Company, one need scarcely add that these batteries are built for service, yet their prices will be found to compare favourably with any others, made either here or abroad."
—*Extract from "Sporting Life," 14/6/1916.*

THE unit most likely to require renewal in an American automobile is the Battery. We therefore designed and now offer British Batteries of correct shape, dimensions, voltage and capacity for every make and model of American automobile which is or ever has been in general use.

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THE MOTOR TRADE ASSOCIATION

Four page Art Leaflet just published. Electricians are invited to write for a copy.

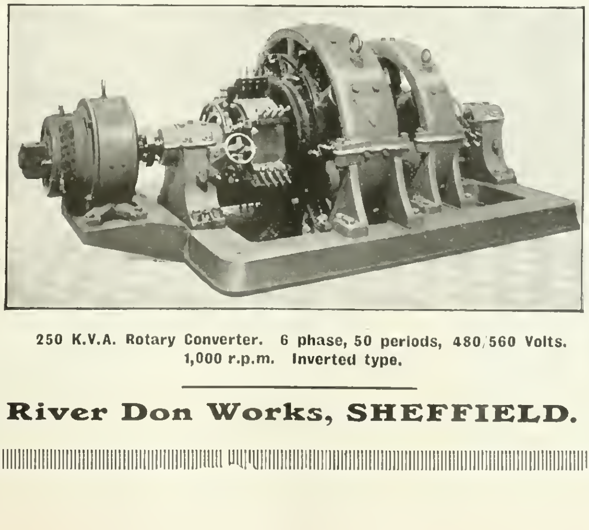
C.A. Vandervell & Co; Ltd.
Electrical Engineers, ACTON, LONDON, W.

VICKERS LIMITED.

Motors and Generators of all types.

Rotary Converters.

Complete equipment for the electrical lighting and driving of Machine Shops, Factories, Mills, etc



250 K.V.A. Rotary Converter. 6 phase, 50 periods, 480/560 Volts. 1,000 r.p.m. Inverted type.

Patent Automatic Reversing Drive for Machine Tools.

River Don Works, SHEFFIELD.

D. & S. "HANDLE" FUSES.

50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.

DORMAN & SMITH Ltd.,

Ordsal Electrical Works,

SALFORD,

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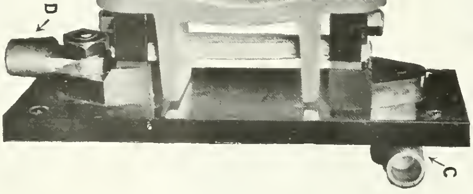


raw material from which ductile tungsten is made. The oxide is purified, then given a heat treatment, and finally is reduced to pure metallic tungsten in a furnace filled with hydrogen. A weighed quantity of the powdered metal is spread evenly in a mould in a hydraulic press and is compressed into a stick or slug. This slug is very fragile, as no binding material is used, and it must be supported along its entire length until after it is heated in a furnace. The heating sinters the particles of tungsten slightly, and the slug is strengthened sufficiently to be handled easily. The next step in the preparation of the material is heating the slug to a very high temperature by passing electric current through it in a closed chamber filled with hydrogen. After this treatment the slug is converted into a coherent bar and is ready for the mechanical working which is necessary in order to develop the property of ductility.

The square slug is converted to a round section and is reduced in diameter by a swaging process. A swaging machine consists of a cast iron case, within which is a rotating head having cams which throw a series of hammers towards the centre opening. The hammers are arranged to act upon split dies, which are selected to give the size of bar desired. The slug is heated to a high temperature, and is inserted quickly into the swaging machine and quickly withdrawn. Special care is necessary in the swaging operation to prevent breaking the slug. Reductions in size are made very gradually and the temperatures at which the metal is worked are carefully controlled. With continued working the metal becomes more ductile, and at the stage where the swaging process is abandoned and the drawing process begins the wire can be bent at ordinary room temperature.

In the drawing of tungsten wire the methods which had been used previously for wire manufacture were found inadequate. The production of wire of 1·5 mils diameter was considered as proof of excellent workmanship and methods, and such wire was exhibited as a curiosity. When it is considered that filament for a 25 watt lamp is only about 1 mil in diameter and that for a 10 watt lamp is only slightly more than one half mil, the problem encountered in the commercial production of tungsten filament may be appreciated.

The wire is drawn through dies made of pierced diamonds. Both the die and the wire are heated, and the reduction in size or draft at each die is very small, being 0·1 mil, or even only 0·05 mil for the smaller size of wire. With repeated working the strength of the tungsten wire increases so that in sizes used in lamps the tensile strength of the filament is equal to that of the finest steel. After a lamp has been burned for some time the filament tends to become more brittle, but it rarely, even under the most severe conditions, becomes as brittle as the pressed filament of the tungsten lamps first made.

The wires for supporting the lamp filament are now made of molybdenum or tungsten, in place of copper, nickel, or special alloys, which were formerly used. The change in the material makes possible the use of small flexible supports, as they will not cause discolouration or give other troubles because of contact with the heated filament. Also the filament is cooled less by the small supports than it would be by the larger ones, thus making the lamp more efficient. The fact that the supports are flexible is also an advantage, as the filament is protected somewhat from shocks and is permitted to expand and contract freely.

By far the greatest change which has been made in incandescent lamps recently is the use of an inert gas in the bulb. This has made possible the construction of lamps of high candle power and low specific consumption, and has very materially broadened the field of usefulness of incandescent lamps.

There are two main effects produced by an inert gas in the bulb of a lamp. The first of these effects is the reduction of filament evaporation at extremely high temperatures, thus very largely eliminating the blackening of the bulb and the disintegrating of the filament. The effect of the gas pressure on the evaporation of the tungsten filament is analogous to the effect of atmospheric pressure on the boiling point of water—the greater the pressure the higher the temperature required to produce boiling.

The second effect of the gas is the carrying away of the heat of the filament by the convection currents set up in the gas. This effect is undesirable, and should be minimised as much as possible. If steps were not taken to reduce the cooling effects of the gas the temperature of the filament could not be increased enough to offset the convection loss, and the gas-filled lamp would be less efficient than the vacuum lamp. By coiling the filament into close spirals the area exposed to the effective cooling action of the gas is greatly reduced and the efficiency of the lamp is increased.

The coiling of the filament is done by means of a special machine. The spool of filament is carried on a rotating head, through the centre of which passes the mandrel wire from the spool and pulley. The mandrel is pulled continuously through by a drum, the speed of this drum relative to the speed of the head determining the number of turns per inch of the spiral. A heater is provided for annealing the coil as it passes to the drum, which is driven by a friction spring. The winding machine is arranged to give a space between coils or sections of coils, and in this way the length of the coil can be accurately determined, as the space is made after a definite number of turns.

Where the length of the coil is not too great the simplest form for mounting it in a lamp is the arc of a circle, with the coil supported at a number of points by radial anchors inserted in a central glass button. Long coils, such as are used in lamps of high wattage, cannot be conveniently mounted in this form, as the diameter of the circle that the coil would form would be so great that it could not be passed through the neck of the bulb. Large coils are therefore shaped into a series of loops arranged in a vertical position and mounted on an arc of suitable diameter.

Jas. Jaquet, Ltd., Basle

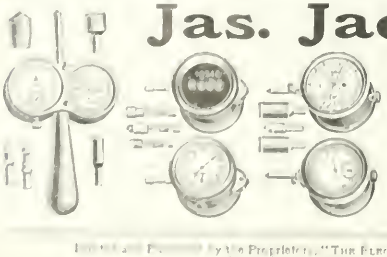
Switzerland.

Combined Revolution Counters, with Chronograph.

Very Accurate Timekeepers.

CHRONOGRAPH AND STOP WATCHES.

Lists on Application.



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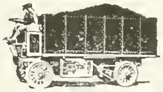
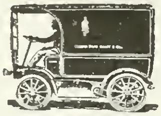
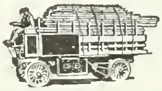
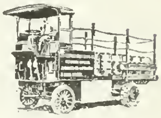
ELECTRIC VEHICLE PROGRESS





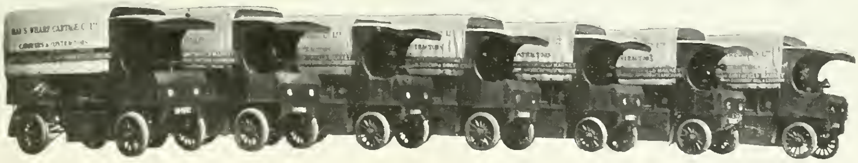




G.V. ELECTRICS FOR TRANSPORT WORK.*

During the past two years there has undoubtedly been a considerable increase in the popularity of the electric vehicle for general purposes. This has principally been in the direction of its use by municipalities and electricity undertakings where it is obviously to the interests of the purchaser of a motor vehicle to make use of the electric power which can be so readily and cheaply obtained. For the same reason these bodies have been advocating the use of electric vehicles, and dwelling upon the advantages of this method of traction at their meetings, and at special conferences.

Apart from this, however, the use of electric vehicles by private traders has considerably increased, and we now see well-known firms employing such vehicles in steadily increasing numbers. Some eighteen months ago we gave a descriptive article on the use of these vehicles by Messrs. Hay's Wharf Cartage Co., Ltd., who were using them in connection with the meat-carrying branch of their extensive business. Eighteen months have elapsed since that article was written, and we were interested to know whether the G.V. electrics had stood the further test of constant service during this period. In order to find out we took the opportunity of interviewing Mr. Wentworth, the manager and director of Hay's Wharf Cartage Co., Ltd., and we were glad to learn that he is well pleased with the work which his fleet of G.V. Electrics has done since he commenced using them. Seven vehicles are employed instead of the four with which the firm commenced operations, and this fact by itself shows appreciation of their good qualities.



[From "The World's Carriers."

The Fine Fleet of G.V. Electrics recently increased from Four to Seven Vans, and operated in London by the Hay's Wharf Cartage Co., Ltd.

An advantage which was strongly emphasised was the simplicity of the electric vehicle in general, and the G.V. Electrics in particular. An important point, and one which should have due weight with all engaged in the carrying trades, as Mr. Wentworth pointed out, is that there is practically nothing to go wrong, and no repair works are required, with the necessary staff of engineers and mechanics, as is sometimes the case with other vehicles. A carrier who has been used to horse transport is apt to fight shy of any new development which he does not thoroughly understand, and therefore electric vehicles have an advantage in this respect.

This is another strong point in favour of electric vehicles, and one which is closely associated with the question of simplicity already referred to. It it quite possible to use these vehicles six days a week, as they do not require the amount of overhauling and repairs which are necessary with other types. For instance, the G.V. Electrics run by Messrs. Hay's Wharf Cartage Co., Ltd., have not been laid up, except for accidents, since they commenced running.

Adaptability is the third quality which can be placed to the credit of G.V. Electrics. They are not dependent upon the weather conditions, but are just as serviceable in the winter time with snow on the ground as at any other period of the year. A fourth quality of special importance to carriers and all concerned with the transport of goods is that of cleanliness, and electricity undoubtedly scores one in this respect over rival methods of traction. In fact, many testimonials have been received speaking in appreciation of the appearance and general condition of the vehicles when engaged in delivering meat from Smithfield Market.

Everything else being equal, the question of running costs is a very important feature, and one which has the first consideration of all carriers. It is not practicable to give detailed figures in this connection because each firm has its method of calculating costs, and includes in its figures certain items which may not be allowed for by other firms, but Mr. Wentworth was able to inform us that the total running costs of his G.V. Electrics compared favourably with petrol-driven cars. Two minor points which should be borne in mind are that the fire risk is smaller for electric vehicles than for other forms of traction, and that the licence fee is only £1 per vehicle, a consideration when a fleet of vehicles is employed.

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* Abstracted by permission from "The World's Carriers," October, 1916.

For Motor Car Lighting

Made at the Osram-Robertson Lamp Works, Hammersmith, London.

Osram
G·E·C
DRAWN WIRE
Lamps

Manufacturers & Designers of Electric Vehicles
should get full particulars of
"IGRANIC" VEHICLE CONTROLLERS.
They are models of strength and lightness. The drums are of unique design with contacts of ample capacity, and are extremely simple and easy to operate. Forward and reverse control by one lever. A separate safety switch is provided to cut off the current independently of the control lever, and so prevent tampering. A full description is given in pamphlet No. 624.
G6 Controller.
IGRANIC ELECTRIC Co. LTD. 147, Queen Victoria Street, London.

The chassis, which is substantially constructed, is of the General Vehicle Company's standard design. The Ironclad Exide battery is carried below the chassis, between the wheels, and is easily accessible for inspection. The drive from the motor is by a silent Morse chain to a differential countershaft, thence by roller side chains to the rear road wheels. Both the silent chain and motor are entirely enclosed. By means of removable covers both the chain and commutator brushes are of easy access. A lever by the side of the driver controls the speed. Four speeds are provided forward and two reverse. Two pedal brakes of ample power are provided, one operating on rear wheels and the other on the countershaft. The main features claimed for this type of van are its quietness, simplicity of control, economy and freedom from fire risk. The average speed on good roads is about twelve miles per hour. The daily mileages of the vehicles average from 40 for single journeys and 70 to 80 for double journeys. The normal mileage of this type of vehicle per charge is 45 miles, but by means of a boost or quick recharge of the batteries, generally of from one to two hours' duration, sufficient power is acquired for an additional thirty miles or so.

[From "The World's Carriers."

HAY'S WHARF CARTAGE CO.'S G.V. ELECTRIC DELIVERING MEAT AT SIDCUP.

The illustration shows how the complete fleet of G.V. Electrics running in the service of Messrs. Hay's Wharf Cartage Co., Ltd., and one of the vehicles engaged in delivering meat at Sidcup. It only remains to be said that these vehicles are steadily pushing their way to the front in the country, and are sold by the General Vehicle Company, Ltd., Imperial House, Kingsway, W.C.

MECHANICAL TRACTION FOR MUNICIPAL PURPOSES.*

The vehicles in use differ considerably as to the means by which they derive their motive power, such as steam, petrol, electricity and petrol-electricity. Each of them has its advantage and disadvantage when compared with the others, according to the particular kind of work required to be carried out.

The question of whether steam, petrol, electric or petrol-electric vehicles should be adopted still remains open. The first named has done, and continues to do, excellent work, and the tendency to fit rubber tyres to the wheels is becoming more customary. Petrol vehicles have a large following, and still meet all expectations. As regards electrical machines, the type naturally recommends itself to those responsible for electricity departments, partly because they are specially conversant with its principles, but particularly because, intelligently applied, it can be utilised to equalise the load at the power station, and becomes a profitable consumer. Again, in connection with such work as the removal of refuse, the electric vehicle has strong points. Thus, for instance, in Paris a large fleet of heavy electric lorries is employed for refuse removal, the power required for charging the batteries being obtained from the destruction of the refuse itself, and consequently in a sense is available without charge for fuel.

With reference to petrol-electric vehicles, these are being used to a great extent in connection with omnibus companies, and to some extent by municipalities, and I believe give satisfaction. The electricity is derived from a petrol-driven engine.

In the Royal Automobile Club's trials over 1907 it was shown that excellent results were obtained from petrol vehicles up to 3 tons capacity, but for heavier loads steam had the advantage.

The following are a few of the points in regard to steam, petrol and electric vehicles, illustrating to some degree the advantages and disadvantages which it is advisable to note:—

STEAM.

Substantial and simple in construction, easily worked.

Reserve of power, which is useful on a steep gradient or bad road.

Only in rare cases is it impossible to complete a journey with this kind of machine through breakdown.

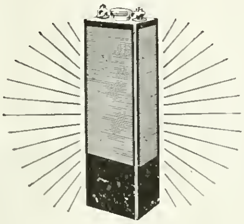
---

* From a report presented by Mr. H. Shaw to the Works Committee of the Ilford Urban District Council.

SIEMENS BROTHERS & CO., LTD.
WOOLWICH.
ESTABLISHED 1858.
Telegrams: "Siemens Woolwich."
OVER 4,000 EMPLOYEES.
Telephone: City 6400 (7 lines).
CABLES & WIRES,
MOTOR-CAR LEADS
(Weatherproof, Strong, Flexible and Durable),
BATTERIES
&c., &c.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!



Some of the Reasons:

Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte**; and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES,
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AGENTS:—

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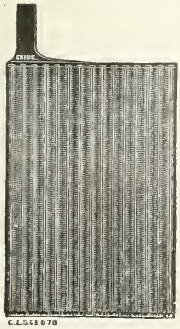
DRAKE & GORHAM, Ltd.,
47, Spring Gardens, Manchester.

Glasgow:—
J. HALLY CRAIG,
45, Hope Street, Glasgow.

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



Several sets in service have completed

26,000 MILES

on the road without a single cell having to be removed from the vehicles for any electrical defects whatever, and the capacity is still in excess of the catalogue output.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION,
MANCHESTER.

LONDON OFFICE:
39, VICTORIA STREET.

"CONSULT KEMP re ELECTRICS."
FACTORY TRUCKS & COMMERCIAL VEHICLES WITH EDISON ACCUMULATORS.
The Simplest and Most Economical Forms of Industrial Transport. Can be driven by UNSKILLED Men and Women at less than ONE-THIRD the cost of Petrol.
Each Factory Truck costs less than 6s. per week for Electric Power, and saves the labour of over 7 men.
J. P. KEMP, Grand Hotel, BIRMINGHAM. 'Phone: CENTRAL 7301.

Heavier owing to weight of boiler and storage of coal.

Not available at short notice, as it takes about 60 to 75 minutes to get up steam.

Whilst standing there is a wastage of fuel, as steam must be kept up, and the driver, in addition to the machine, is standing idle.

A supply of water is necessary to be at hand, as it is only possible for this vehicle to run between 15 and 20 miles.

Boilers require to be washed out weekly and scaled frequently, thereby losing at least one day's work each week, in addition to about one hour per day (getting up steam).

Two men required to work the vehicle (driver and stoker).

The former must be an engineer.

Annoyance from steam and noise, vibration of properties and consequent complaints.

Oil troubles and quick-wearing bearings from leakage of steam into oiled parts.

Heavy price of coal in this district.

PETROL.

Speedy, and can be turned out at shortest notice.

Quieter running.

Only one man required to drive.

Easier wear on tyres than steam vehicles.

Self-contained.

Not as simple in construction, more easily damaged, and running costs increased by careless driving.

Can be used to best advantage over long distances.

Running costs are increased where continually stopping by wastage of fuel unless engine is stopped, and strain in starting on working parts.

Slow driving a disadvantage in many ways.

TUDOR
ACCUMULATORS
FOR ELECTRIC VEHICLES.

AMBULANCE WITH TUDOR BATTERY.
Port of London Authority 4 Vehicles. City of London Corporation 2 Vehicles.
BATTERIES FOR COMMERCIAL VEHICLES,
PLEASURE CARS, OMNIBUSES, &c.
LIGHTEST IN WEIGHT—HIGHEST IN EFFICIENCY.
Maintenance undertaken at Moderate Mileage Rates.
THE TUDOR ACCUMULATOR CO., Ltd.,
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Works: DUKINFIELD, near MANCHESTER.

ELECTRIC.

Mechanism simple in character.

Only one man required to drive this type of vehicle.

Quietness in travelling.

Reduced fire risks.

Suitable for short distances, as the constant stopping and starting causes no wastage of power or straining of mechanical parts.

For certain service, where the stopping distances are comparatively short and frequent, electric vehicles are found to be cheaper.

Easy wear on tyres and vehicle.

Use of our electricity.

Speed slower.

In considering this type the least size of battery to obtain efficiency, because of weight, is an important point.

If battery is run down through oversight, damage might be done to cells, and vehicle might also be left stranded.

It is necessary here to deal briefly with a few of the points previously noted. In respect to the steam vehicle, some of the makers say it is only necessary to have one man for driving, and that an assistant is unnecessary; also that the boiler need only be washed out once in 12 days, and that it is quite possible to obtain the necessary steam from coke fuel. These statements are open to considerable argument, and if assuming the second man is necessary an outlay has to be made without any equivalent advantage. It is only possible for a steam vehicle to run 15-20 miles with one fill of water, and it is, therefore, easy to assume that the driver may misgauge his distance and find himself stranded.

Adverting to the petrol vehicle, the makers inform me that the wastage of fuel during stoppages can easily be lessened by running the engine on a smaller carburettor jet, an improvement they are now effecting in lorry chassis. Also, having regard to the high price of petrol, it is possible for a vaporiser to be fitted, so that the engine can be run on a lower grade or heavy spirit.

With reference to the electrically-driven vehicle, the question of battery is of great importance, and requires to be very carefully considered in conjunction with the item of cost of current and adaptation or provision of plant or cable, &c., and wastage in voltage. (Electrical firms base their estimate of an "all-in" current cost of 1d. per unit.) I have not deemed it advisable to make any allowances in my figures for the above-mentioned eventualities, and have assumed current price at 1d. per unit.

In regard to the running costs of the four vehicles there seems to be very little difference.

The electric vehicles in the first case are exceedingly dear, with the steam, petrol and petrol-electric vehicles taking second place. The running costs in the three last cases so far as can be gathered are slightly more. The electrical vehicle may have an advantage in this matter if the "all-in" price of current can be guaranteed not to exceed the price mentioned above, delivered in the vehicle at the requisite voltage with a full unit

Statements of running costs and comparisons between motors and horses are often misleading unless due consideration is given to local conditions. It is necessary to take into one's calculation the cost of labour, coal, petrol and horse hire in the particular locality; also the nature of the work to be done and conditions under which it will be carried out. Some drivers will use 50 per cent. more coal, oil, &c., than others in doing the same amount of work, and the wear and tear, as well as the work done, will vary considerably according to the varying capabilities of the men employed.

It is clear from the published statistics that motor vehicles have been adopted to an unexpectedly satisfactory extent by local authorities for miscellaneous services, such as sweeping and watering of streets, the removal of refuse, haulage, &c., and the fact seems now to be clearly established that in services of this sort in the great majority of districts motors show a better economy than horse haulage, and this irrespective of the subsidiary advantages of being able to complete a given piece of work in a shorter time, with the consequent power of selecting the most convenient hours for any particular work, and frequently duplicating the employment of a motor by providing alternative bodies for it.

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1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, October 27, 1916.]

THE ROUND TABLE.

By "KVA."

Event of the Week.—"Tricity" Berry prophesies the return of the lamp radiator, but in a lively form!

* * * *

Bon Mot of the Week.—"If people of other nationalities come amongst us for their own profit, let them carry on their business above-board and without any attempt to hide their nationality."—"Daily Telegraph," November 1st.

* * * *

For electrical spun yarns you may go either to Lancashire or —— well, to the Electro-Harmonics, though the latter are getting a little thin.

* * * *

A correspondent informs me that though the spirit of cooperation is now very much abroad in the electrical industry, his experience is that it is not to be had in prohibited hours.

* * * *

"Coal gas about to confront electricity," says a bold headline in the "Commercial Motor." And the result will be always as before; the electric spark always makes coal gas go off with a bang every time! It's in the nature of things!

* * * *

The way these lady typists have got the war and munitions on the brain is really surprising. A correspondent tells me that he was asked to sign a letter in which the following sentence appeared: "Owing to a *foresight*, we omitted to answer your favour," &c.!

* * * *

Edinburgh's traffic query at the moment:—To cable or not to cable, that is the question, whether 'twere better that fair Princes-street be given o'er to bare poles and naked wires or that the Athenians of the North go on the 'bus(t), and by strafing slot and conduit, end it?

* * * *

"The Engineer" pointedly asks, under the heading "Random Reflections": "Is it not time the absurd title Semi-Diesel were given up?" It then suggests that "What is wanted is a portmanteau word meaning low air compression, oil injection, hot bulb ignition, internal combustion engine." Why not call it the "Not-'arf-Diesel"?

* * * *

The industry concerned with power generation and distribution is now strongly identifying itself with the gasification of coal, its burning under boilers and conversion via thermo-turbo plant into electrical energy. All of which means that the well-worn saying "The nearer the bone the sweeter the meat" must now be made to read: "The nearer the Bone the cheaper the unit."

* * * *

If you are likely to be called up and find yourself among the boys who are doing their bit you will in time learn to dodge "fatigues." A friend in the R.F.C. told me recently that it was not unusual for the sergeant to call on parade: "Fall out, silversmiths." A few of the lads, scenting a cushy fatigue, stand out, and are duly counted by the sergeant. "All silversmiths," inquires that dignatory. "Yes, sergeant." "Then go down to the cook house, and polish those 'dixies' till they look like silver!"

It is good to look on a cheery face like this in war time, and I cannot let the opportunity pass without reproducing it. I have taken it from the front cover of a booklet, "Lighting in Photography," just issued by the Westinghouse Cooper-Hewitt Co., to whom I am indebted for the loan of the illustration. I have seen the original somewhere but cannot remember where. Of whom does it remind you?

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Nov. 1, 1879.]

The Pullman Dining Car.—To-day the Great Northern Railway commence running with the Leeds express a Pullman car fitted up as a dining room. Dinners, similar to those obtained in an ordinary restaurant, can be obtained in this carriage any time during the journey. We noticed during the recent trial trip to Peterborough that the car was fitted with electric bell apparatus.

Telegraphing Without Wires. Our American contemporary, the "Journal of the Telegraph," states that Prof. Loomis continues his experiments in the mountains of West Virginia to demonstrate the theory that at certain elevations there is a natural electric current, by taking advantage of which telegraph signals may be sent without the use of wires. It is said that he has telegraphed a distance of 11 miles by means of kites flown with copper wires. When the kites reached the same altitude, or got into the same current, communciation by means of an instrument similar to that of Morse was easy, but ceased as soon as one of the kites was lowered. He has built towers on two hills about 20 miles apart, and from the tops of them has run up steel rods into the region of the electric current.

L. P. S.
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THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

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Free Sample on application.
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Southampton—46, High Street.

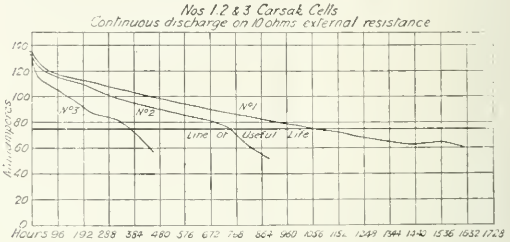
Branches in Principal Towns Abroad.

G.E.C. PRIMARY BATTERIES.

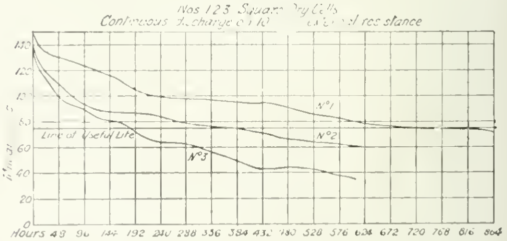
The primary battery is an article which most people take very much for granted. It does not receive as much care in selection as apparatus of a more recent and more complicated character. This is especially the case with the ordinary wet Leclanché cell. There are, however, substantial differences in cells which are apparently identical, and there are also several varieties each adapted to a specific purpose. Long experience in the manufacture of these cells in large quantities leads to a high standard and to uniform results.

In the Witton porous pot type of Leclanché cell we understand that the positive pole consists of a carbon plate surrounded by a mixture of [illegible] carbon and manganese dioxide contained in a porous [illegible] pot. Special care is taken in the selection of the materials, and in the proper grading and composition of the mixture. Mechanical means have also been devised to insure the thorough and uniform filling of the pots. These precautions tend to lead to the production of a porous pot giving the best results obtainable with this type of Leclanché cell. The cell is made in three standard sizes, the capacity of which ranges from 8 ampere-hours to 40 ampere-hours, and the internal resistance from 0·9 to 0·[illegible] ohms. The E.M.F. in all three sizes is as with all wet Leclanché cells, from 1·5 to 1·6 volts. The porous pot Leclanché cell is generally used with a rod zinc, but a special type has been developed for railway work, which is known as the "Railway pattern," and which is suitable for heavy duty. In this the rod zinc is replaced by a circular zinc, thereby lowering the internal resistance.

The most recent development in wet Leclanché cells is represented by the Witton Carsak cell, which has been designed to meet all conditions of work for which Leclanché cells are suitable, and more particularly those, such as railway signalling work, where the duty is heavy and more or less continuous. In the Carsak cell the depolarising mixture of manganese and carbon is in the form of a tightly compressed block contained in a canvas sleeve. The Carsak cell is made in seven sizes, three of which correspond exactly with the standard sizes of porous pot. There are two larger sizes for heavy work and two smaller sizes for medical and similar purposes. The capacity of these cells, not counting the two smallest sizes, ranges from 40 to 175 ampere-hours, and the internal resistance is in the neighbourhood of 0·5 to 0·1 ohms, the E.M.F. being as before, 1·5 to 1·6 volts. The Carsak cell has from twice to four times the capacity of a porous pot of corresponding size. Weight for weight, the capacity is from two to three times as high. These advantages are of importance for export work when the question of freight is a consideration. To obtain the best results from the Carsak cell the makers state that a circular zinc should be used and is generally supplied, though there is no fundamental objection to the use of the rod zinc.



In the dry type of Leclanché cell one of the most important qualities, from the trade point of view, is the absence of deterioration while the cell remains idle in stock. As a result of accumulated experience in manufacture, The General Electric Co., Ltd., is able to guarantee satisfactory results from their cells in this respect. The G.E.C. type of dry cell is made in eight different sizes, each giving 1·50 volts, and ranging in capacity from 5 to 120 ampere-hours, with internal resistances varying between 0·10 and 0·30 ohms. The "Century" dry cell is a cheap form for general work, but with a somewhat lower capacity than the G.E.C. type. For hot climates and other situations where the conditions are too severe for the ordinary dry cell, the "Extra Sec" cell is manufactured. In this the electrolyte is in the dry state and is inactive until the cell is filled with water. This cell can therefore be kept in stock for an indefinite period. Its capacity is slightly lower than that of the G.E.C. dry cell, the highest being 24 ampere hours, with an internal resistance of 0·15 ohms, and an E.M.F. of 1·55 volts.



The curves reproduced show the performance of the different types of cell on continuous discharge through a circuit of 10 ohms external resistance.

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Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
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Shot Firing Cables.
Window Lead.
Cable Racks.
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Pole Line Steelwork.
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Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
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Overhead Equipment.
Electricity Meters.
Knife Switches.

HELSBY RUST-PROOF CABLES.

These will be found pretty useful where the rubber insulated conductors are exposed to iron rust as in iron pipes or conduits, or in chemical works, dye houses, or other damp, steamy situations.

In many cases the timely use of these cables would save a lot of heart burning in the present, and—quién sabe?— soul burning later on!

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SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

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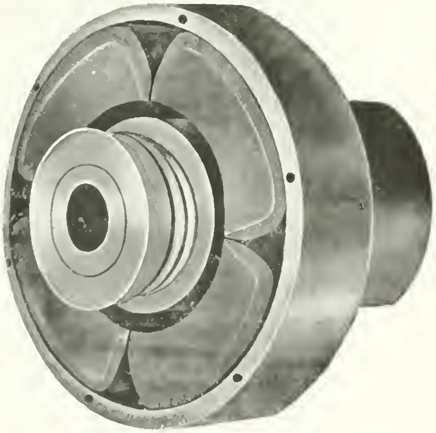
THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

THE WOODHOUSE CLUTCH PULLEY AND COUPLING.

When a motor is coupled to a machine which it is to drive either by belt or by direct coupling, the two rotors become one load, the inertia of which has to be overcome by the employment of a starting device and a heavy starting current considerably larger than the running current at full load. The overcoming of the inertia of the driven machine is necessary at the time the driving motor is least able to stand it, viz., when it has its own inertia to overcome. For this reason it has hitherto frequently been necessary to instal a motor, equal not only to the full load capacity, but having a starting torque calling for anything up to 2½ times the full load current, all of which has to be dealt with by an expensive starting device.

By means of the Woodhouse automatic clutch this difficulty is overcome, as the driving motor has only the inertia of its own rotor to overcome, and it does not pick up the load until it has itself reached full load speed and is then capable of developing its full horse-power. The starting current is never greater than the full load current, and a much smaller motor and starting device can be employed. Again, a starting resistance is an extravagent piece of apparatus, but when used with a Woodhouse clutch the rotor is unloaded and a cheaper resistance can be employed. A wound rotor, whether fitted with commutator or slip rings, is, of course, much more likely to go wrong than a squirrel cage motor, and it is not as efficient.

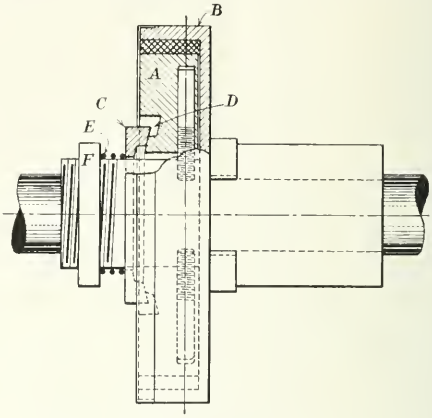


INTERIOR OF WOODHOUSE CLUTCH SHOWING CENTRIFUGAL BLOCKS.

(In the latest form the lining material is placed inside the housing and not on the blocks as shown.)

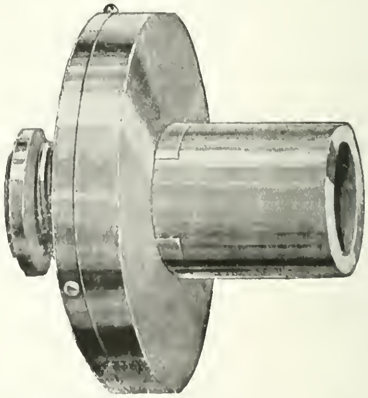
The clutch has a wide range of setting and can be adjusted in position to pick up at practically any speed, when it comes gently in and the load is picked up with a slight slip which becomes a solid grip as the speeds of the driving and driven members become identical. The speed in fact governs the clutching, which, however, does not release until the motor is at the point of stopping.

After having been thoroughly tested the clutch is now being placed on the market and is supplied either as a pulley or coupling. It has been specially designed for use with polyphase squirrel cage or single phase motors, petrol engines, and similar machinery in which it is desired that the load be not applied until a predetermined speed has been reached. In this clutch the critical speed can be altered at will by means of an adjustable nut.



SECTIONAL VIEW THROUGH WOODHOUSE CLUTCH.

There is no reason why a motor and its load should be started up *simultaneously*, as so many advantages are obtained by starting them in *succession*. By starting in this manner any self-starting motor can start up the maximum load that it is capable of running at full speed. Three-phase motors can easily be started up on full load without a starting switch.



THE WOODHOUSE CLUTCH AS COUPLING.

The construction of the clutch, which is of the centrifugal type, is simplicity itself. The driving members consist of quadrant shaped

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SWITCHGEAR, TRANSFORMERS, METERS,
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INSULATION BEADS
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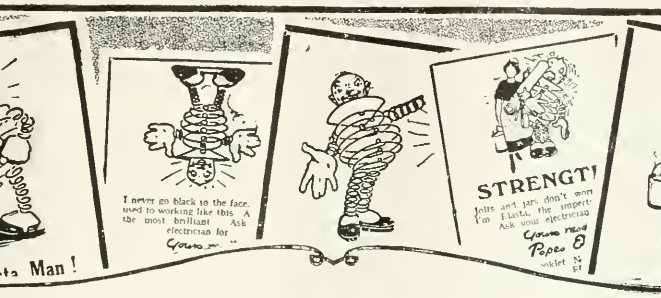
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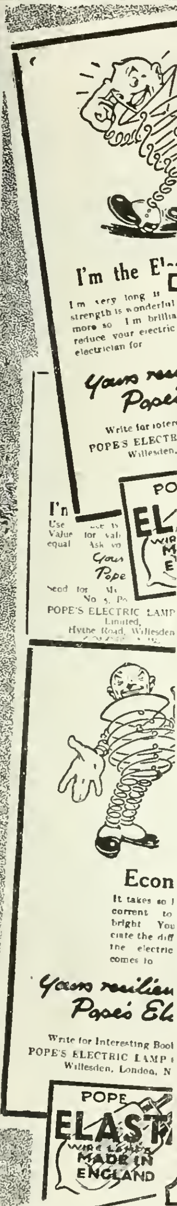
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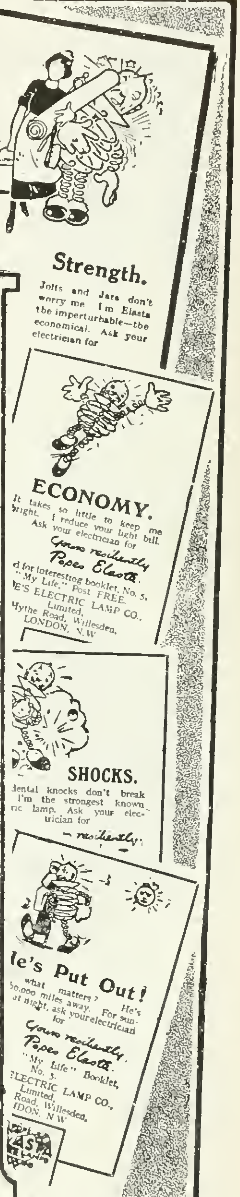
POPE ELASTA WIRE LAMPS MADE IN ENGLAND


Strength.
Jolts and Jars don't worry me I'm Elasta the imperturbable—the economical. Ask your electrician for
ECONOMY.
It takes so little to keep me bright. I reduce your light bill. Ask your electrician for
Yours resiliently Popes Elasta.
d for interesting booklet, No. 5, "My Life," Post FREE. E'S ELECTRIC LAMP CO., Limited, Hythe Road, Willesden, LONDON, N.W.
SHOCKS.
dental knocks don't break I'm the strongest known ric lamp. Ask your electrician for
resiliently
He's Put Out !
what matters? He's 0,000 miles away. For sun- at night, ask your electrician for
Yours resiliently, Popes Elasta.
"My Life" Booklet, No. 5. ELECTRIC LAMP CO., Limited, Road, Willesden, DON, N.W.

A Profitable Proposition for every Contractor

TWO MILLION people are being told every week of the merits of Pope "Elasta" British Made Wire Lamps. These advertisements are appearing in both "dailies" and "weeklies." A demand is being created in all parts of the country.

POPE
ELASTA
WIRE LAMPS

have built up a reputation on sheer merit. They withstand vibration. Can be handled without risk. Impervious to reasonable knocks. The special "Elasta" filament never becomes brittle. Gives maximum light with minimum consumption. "Elasta" is the long-service lamp that retains its brilliance to the last. Get in touch with us at once.

Write to-day for Booklet No. 8, entitled:—"MY LIFE."

POPE'S ELECTRIC LAMP CO., Ltd.

Also Makers of Carbon, Radiator and Resistance Lamps.

Hythe Road, Willesden, LONDON, N.W.

Telephones:—Willesden 1170.
" " 1224.

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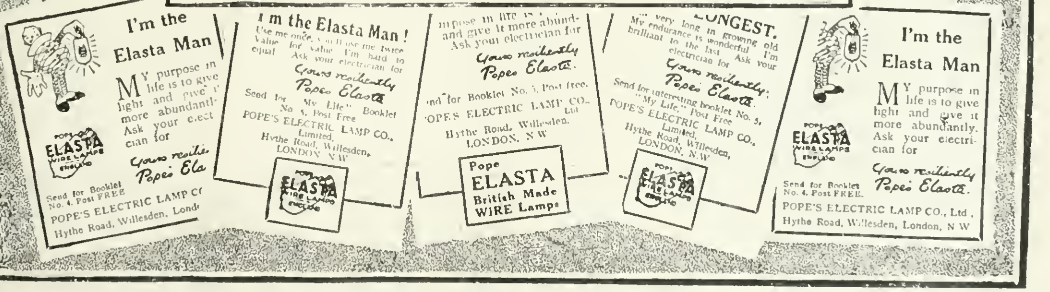
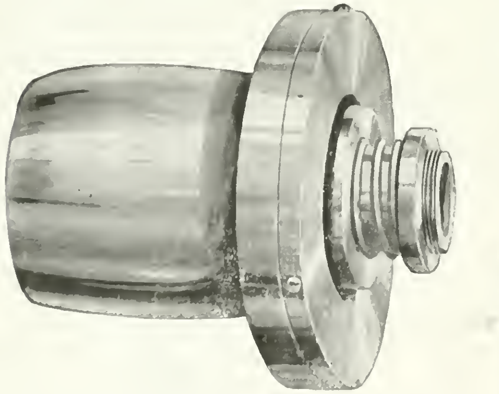

I'm the Elasta Man
MY purpose in life is to give light and give it more abundantly. Ask your electrician for
Yours resiliently Popes Elasta
Send for Booklet No. 4, Post FREE
POPE'S ELECTRIC LAMP CO Hythe Road, Willesden, London
I'm the Elasta Man !
Use me once, you'll use me twice. Value for value I'm hard to equal. Ask your electrician for
Yours resiliently Popes Elasta
Send for "My Life" Booklet No. 5, Post Free POPE'S ELECTRIC LAMP CO., Limited, Hythe Road, Willesden, LONDON N.W.
ELASTA WIRE LAMPS ENGLAND
and give it more abundantly. Ask your electrician for
Yours resiliently Popes Elasta.
Send for Booklet No. 5, Post Free. POPE'S ELECTRIC LAMP CO., Ltd. Hythe Road, Willesden. LONDON, N.W.
Pope ELASTA British Made WIRE Lamps
LONGEST.
very long in growing old My endurance is wonderful I'm brilliant to the last Ask your electrician for
Yours resiliently, Popes Elasta.
Send for interesting booklet No. 5, "My Life," Post Free POPE'S ELECTRIC LAMP CO., Limited, Hythe Road, Willesden, LONDON, N.W.
I'm the Elasta Man
MY purpose in life is to give light and give it more abundantly. Ask your electrician for
Yours resiliently Popes Elasta.
Send for Booklet No. 4, Post FREE.
POPE'S ELECTRIC LAMP CO., Ltd., Hythe Road, Willesden, London, N.W.

H. Weidmann, Ltd., Rapperswil, Switzerland.
MAKERS OF PRESSPAN AND INSULATING MATERIAL.
Pressboard (Presspan) in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.
Amianite (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.
Bakelite & Cornite (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.
Asbestos-Cement in Plates, Arc Shields for Controllers, &c.
Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.
(1)

cast-iron blocks *A*, all turned out of a single piece, and which tend to move radially outwards against the inside of the containing case *B*, which constitutes the driven member. The outward movement of the blocks is prevented by a steel collar *C* (the sectional drawing shows the position of weights and collar when at full speed), which is retained in the groove *D* by the pressure of a spring *E* which is regulated by the nut *F*. It is quite easy to set the clutch to pick up the load at any speed desired. The heavier the load the more gently is it started. *F* is a lining of Ferodo which can be easily renewed when worn. When the motor is on the point of stopping the cast-iron blocks lose their centrifugal force and the spring is therefore able to push the steel collar *C* completely home into the groove (over the shoulder). It is this shoulder which retards the outward movement of the blocks in speeding up.


Woodhouse Clutch as Pulley.

The Woodhouse clutch is made entirely on the lathe and is completely balanced and therefore suitable for high speeds. With this clutch it is as easy to start up, for instance, a squirrel cage motor either single or polyphase with an overload, as to start the empty machine.

The following advantages are claimed for the clutch :—

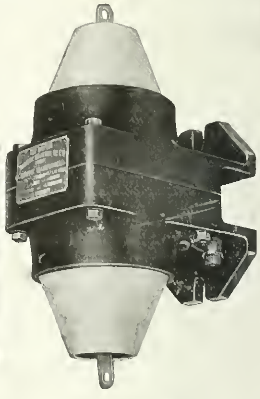
1. All parts of the clutch completely balanced, therefore no vibration set up even at high speeds.
2. Can be used equally well as pulley or coupling, or a combination of both.
3. Price of clutch with suitable starting switch and motor usually less than when clutch is not used.
4. Motor starts up with no load, therefore cheaper type of machine can generally be used, such as squirrel cage motor instead of a slipring or commutator type machine, with all its advantages.
5. Clutch is much more robust than brush gear, which is unnecessary.
6. Larger motor for starting up against heavy load not required.
7. Load started up when motor is in most efficient running position.
8. As motor and load are not started simultaneously, starting current much reduced.
9. Owing to reduced starting current much less resistance wire is required and cheaper starting switches can be used.
10. Practically fool-proof starting, as only empty motor is started by operator.
11. Flywheel effect (small) assists motor over peaks of load.

Prices of this interesting clutch can be obtained from the makers, the Victoria Dynamo & Motor Co., Craven House, Kingsway, London, W.C.

B.T.-H. INSTRUMENT TRANSFORMERS.

Current and potential transformers for various classes of service up to 3,000 amperes and 11,000 volts for use on circuits of 25 cycles and upwards are described in price list 4,591, just issued by the B.T.-H. Co. They are suitable for operating any usual combination of instruments within their volt-ampere ratings, and will give good commercial accuracy at full load.

Potential Transformer 6,600/110 Volts.

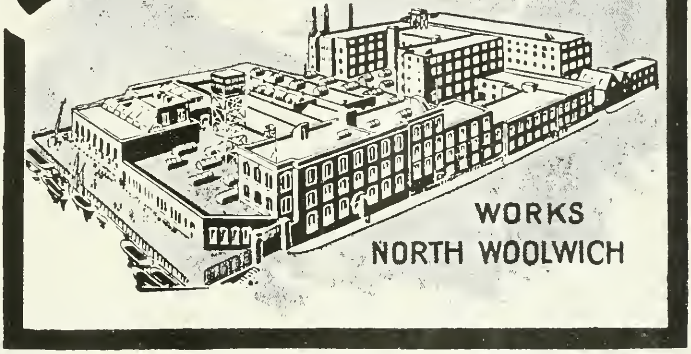

Type C. Current Transformer.

The load on a current transformer can be considerably increased when the transformer is used with the trip coils of oil switches, or with contactor coils, where a ratio error of 5 per cent. or more is permissible. Potential transformers will carry overloads of 100 per cent. in the case of air insulated, and 200 per cent. in the case of oil-insulated transformers, with a temperature rise not exceeding 50 C. Standard current transformers are wound for 5-ampere secondary currents, and have a rating, in most cases, of 15 volt-amperes. Potential transformers are wound for a secondary voltage of 110, and have a rating of 200 volt amperes for single-phase (except the

BURNER & HEAT CONTROL
Equipment for Lead Presses
(HALL'S PATENTS).
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicminster, Sowest, London.

Western-Electric



TELEPHONE
AND
CABLE WORKS
ARE THE
BEST EQUIPPED IN
THE UNITED KINGDOM.

BRANCHES AT
BIRMINGHAM, LEEDS, JOHANNESBURG,
GLASGOW, SYDNEY, BUENOS AIRES.

The Safest Surest & Simplest Earth

A *certain* and *permanent* earth is essential under all conditions.

THE
PARAGON Earth Cone

Is safest, because the earth around the cone is always kept moist and there is no risk of it drying—shrinking away from cone—and destroying contact.

Surest, because the cone is made of pure copper which resists corrosion to the last.

Simplest, because it needs no large excavations to install. Simply make a hole with a post augur and drop it in.

Write to-day for a copy of our illustrated Pamphlet and terms.

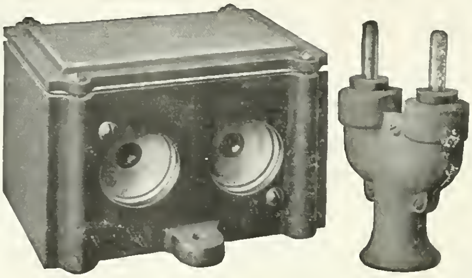
SCHOLEY & CO., Ltd.,
56, Victoria Street,
LONDON, S.W.

EDISWAN EVERYTHING ELECTRICAL

THE LAMP FOR ALL-ROUND EFFICIENCY
ROYAL
EDISWAN
DRAWN WIRE LAMPS
STRENGTH BRILLIANCY ECONOMY DURABILITY

THE
EDISON SWAN
ELECTRIC CO., Ltd.,
PONDERS END,
MIDDLESEX.
'Phone 520 Enfield.

FULLY LICENSED UNDER BRITISH PATENTS Nos 21515/06 · 27712/05 AND OTHERS



IRONCASED SOCKETS & PLUGS
FOR HARD SERVICE.
Sizes up to 200 amps.
D.P. and T.P. 500 volts;
with "earthing" connection.

Also Combined Switch and Plug Boxes.

DORMAN & SMITH, Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

50 volt-ampere transformers, Form B S) and 600 volt-amperes for three-phase.

The type C current transformers listed are designed to withstand the maximum voltage and temperature rise which may be reached should the secondary circuit be defective, or accidentally broken; and are subjected to an over-voltage test between turns before despatch. Throughout the entire line of Type C transformers the cores are built up of laminations of high resistance iron having low hysteresis loss and high permeability. The accuracy of the transformers is not impaired by the presence of stray magnetic fields, and they do not themselves produce stray fields which would affect neighbouring instruments. All transformers of the same ratio and "Form" are interchangeable; transformers of the same "Form," but of different ratios may be interchanged if the instrument be re-sealed, the secondary windings being uniform throughout.

All current transformers are tested before shipment, with an alternating current of 2,000 volts applied for one minute between secondary and earth. Between primary and secondary an alternating current is applied for one minute at 10,000, 20,000 or 30,000 volts, according to "Form."

The "CS" transformer is suitable for circuits where the primary current does not exceed 300 amperes, and the voltage between any phase and earth does not exceed 2,000 volts. The primary winding is assembled between two secondary windings on a laminated iron core, the laminations of the core being interleaved to avoid butt joints. The primary terminals consist of tinned copper strips rigidly connected to the ends of the primary winding and drilled to suit bolted connections. The secondary terminals are mounted in convenient positions on the frame castings. If it is desired to increase the distance between the primary terminals and the surface upon which the transformer is mounted, a cast-iron stool can be supplied for fixing under the frame castings, thereby increasing the height of the terminals to 5 in.

In the "CP$_1$" transformer, which is suitable for primary currents of 100 to 1,000 amperes, where the voltage between any phase and earth does not exceed 2,000 volts, the primary comprises a straight copper rod, having a terminal at each end suitable for a bolted connection. This transformer is of the ring core type. The secondary coil is wound round a laminated core, but insulated therefrom, and the whole is taped up solid and assembled on a thick porcelain tube. This porcelain tube forms a moisture-proof insulation between primary and secondary and is submitted to searching mechanical and electrical tests before being put into service.

The "CR" transformer illustrated herewith is suitable for primary currents up to 300 amperes, where the voltage between any phase and earth does not exceed 1,000 volts. The core and windings are exactly similar to those for the "CS" transformer, but they are assembled inside a cast iron case. This case terminates at each end in a porcelain cone, through which the primary terminals are brought out. After the transformer has been finally assembled, the case and porcelains are filled with insulating compound. The secondary leads are brought through bushed holes to terminals fitted in the lower portion of the casting.

The "CN$_{11}$" transformer is suitable for e.h.t. circuits up to 300 amperes primary current, where the voltage between any phase and earth does not exceed 7,000 volts.

The primary coil is insulated from the secondary and frame by means of two thick porcelain tubes through which it is threaded. The secondary coil is wound on, but insulated from, a ring core built up of laminations. The secondary coil and core are taped up together, and the whole slipped over one of the porcelain tubes before the primary coil is wound. The porcelain tubes form a perfect moisture-proof insulation between primary and secondary. All porcelains are carefully inspected for cracks and flaws, and are also subjected to a searching electrical test. The finished transformer is assembled and clamped in a cast-iron bracket, furnished with slotted feet for fixing. The primary terminals are rigidly fixed on the insulated winding, one at each end of the transformer, and are drilled for a bolted connection.

An important feature of this transformer is the copper lining fitted to the porcelain tube and electrically connected to the primary coil. This renders impossible any corona effect or silent discharge between primary winding and porcelain tube, thereby avoiding liability of acid action and the consequent deterioration of the insulation.

"THE ELASTA MAN."

There is no need to introduce this "springy" individual to our readers. His adventures and capabilities are now set out in a new booklet entitled "My Life," which we have received from Pope's Electric Lamp Co. (Ltd.). In this booklet Mr. Elasta is depicted in all sorts of situations, each pointing a moral as to the virtues of "Pope's Elasta British-made Wire Lamps." We understand from Messrs. Popes that the use of this mascot has drawn considerable attention to the merits of their manufactures, and we feel sure that the booklet cannot fail to interest not only electrical men, but also the general public. Messrs. Popes offer to supply contractors with printed copies of this booklet upon request, and we would recommend our readers to get into touch with them at once before the first edition is exhausted.

SWITCHING EXAMINATIONS.

Messrs. A. P. Lundberg & Sons have just got out a new edition of their 6 pp. exam. folder, affording particulars of their free examinations in electric light switching. The fresh selection of unsolicited expressions of opinions from examinees given therein make interesting reading, and a reference is made to the good opinions of central station chief engineers and professors and teachers, which appear in other of the firm's publications. All these, together with the opinions of the electrical press, go to show that the subject of electric light switching has fully justified its claim to be an important branch of electrical installation work. Any doubt on that score should be dispelled by the reprint of the record results of the last competition, on the back page of the folder.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
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PHOSPHOR COPPER.
TRADE MARK. SEA CLIFF
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, November 3, 1916.

THE ROUND TABLE.

By "KVA."

Can the suggestion to use steel conductors be an indication that the public is tired of the honesty of the copper 'bus conductors, not to mention that of the conductorettes.

* * * *

Many well-known London commercial electrical men are, I understand, now residing in breezy Brighton. I am told that at present emerald green is a favourite colour in certain quarters, but for the moment I am not allowed to say more, except, perhaps, "provincial papers, please copy."

* * * *

THERE Y'ARE BILL, THAT'S WOT COMES O' USIN' A MOTOR CAR FOR PLEASURE.

[From *Glover's Almanac.*

* * * *

A correspondent informs me that the manager of a northern theatre syndicate, in forwarding an order for half-watt lamps, concluded his letter as follows: "I have got the 25-volt, 60-watt ½ watt lamps working O.K. The colour effects are absolutely IT, and if only the *life* is anything like *decent* well, I'll *click.* 'Shure.'"

What will this dear man do if the lives of the lamps are not strictly proper ?

* * * *

"Le Rire" makes a good joke on German submarines' showing a member of the crew complaining to the commander that the compass refused to work properly. "That comes of giving you all Iron Crosses," was the sarcastic reply. The story is, of course, a "variant." There are two others in the same series. One is that of the air pilot, who said his compass was so snesitive that if he took an iron tonic it was upset. The other is of the switchboard attendant who couldn't get a rise, and said that the paralleling voltmeter read 10 volts low because the "iron had entered into his soul!"

Apropos of the foregoing, a correspondent sends me the following humorous cutting from a lay paper :—

"A Continental surgeon, Prof. H. du Bois, has devised what is described as an entirely new method of massage. It is calculated to have a deeper reaching effect on the digestive organs than the usual superficial treatment, but primarily it is intended for the diagnosis of some forms of disease.

"The patient swallows a quantity of magnetic iron in the form of a very fine powder. Then an electromagnet with a current of about 3 kw. is played over the abdomen. The internal iron naturally responds to this, and active movements of the intestinal fibres are the result. These pulsations are also excited and increased by interrupting the electrical current, so that extreme liveliness of the patient's organs is produced.

"The magnet consists of an iron core 20 in. long by 5 in. thick, with a concave pole at an enlarged end, and an opposite flanged pole at the other end. This is wound with enamelled wire. It is provided with an iron frame, a universal joint, and a handle which render it easy to manipulate. As the iron inside the stomach and intestines is opaque to X-rays, the whole process of intestinal action can be watched during the massaging operation."

I believe that the Igranic Co. will be interested in this form of "lifting" magnet!

* * * *

Birmingham citizens ought to feel compensated for tramcar stoppages judging by the following from the "Birmingham Gazette": "Even a 10 minutes' service would be preferable to the queer excitement of getting on a car without any idea of whether one was going to be marooned on the way, or made to change, or enjoy the delirious good fortune of reaching one's destination according to schedule." Yes; but what other tramway authority outside the L.C.C. can relieve the monotony of a car journey with thrills and anticipations such as are now enjoyed in Birmingham ?

* * * *

The Wrexham electricity department have, according to the local paper, "decided to 'illuminate' the disconnecting boxes in the street with luminous paint." I understand that in national interests Mr. F. W. Willcox will not complain of this bringing the source of illumination into the line of sight, although it does contravene all the laws of good lighting!

* * * *

The Batti-Wallahs will "form fours" once this season, on Friday evening next, November 17th. They will be commanded by 'Appy 'Amp-stead Wyld, who will call the roll at 6.30 p.m. sharp; usual "dug out." One of the features of the round up will be a "bob-a-nob" sweep for a genuine Zepp relic. The proceeds will go to the British Red Cross Society. Wind, weather and Zepps permitting, the Batti-Wallah orchestra will give selections (?) during Mess.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Nov. 8, 1879.]

TELEPHONIC EXCHANGES.—We are glad to hear that the system of telephonic exchange is about to be practically tried in Sheffield. A number of firms have given in their names as subscribers, and wires will be laid forthwith.

THE LATE ELECTRIC LIGHTING COMPANY.—The apparatus belonging to this company was sold by auction last week. The sale took place by order of the official liquidator.

PROF. JAMES CLERK MAXWELL.—We regret to have to announce the death of Prof. Clerk Maxwell, which took place on Wednesday, Nov. 5, at his residence in Scroope-terrace, Cambridge. We hope in our next issue to give details as to the work of the late professor; meanwhile we may say he graduated as Second Wrangler in 1854, Mr. Routh being Senior, while both were bracketed as equal in the contest for Smith's Prize. His loss will be severely felt in all scientific circles, both at home and on the Continent.

ALWAYS INSTAL IGRANIC HEAVY DUTY
MOTOR STARTING RHEOSTATS
when the conditions of service are severe. They are most reliable.
No. 10a. Has carbon sparking contacts, main copper contacts and laminated brush bridging to massive hub plate.
No. 10c. Has interlocked, easy-to-operate, toggle joint levers, massive laminated brush contacts and bus bar.
IGRANIC ELECTRIC Cº. LTD 147, Queen Victoria Street, London.

SIEMENS

STANDARD

ELECTRIC MOTORS

For Direct Current. For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

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Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
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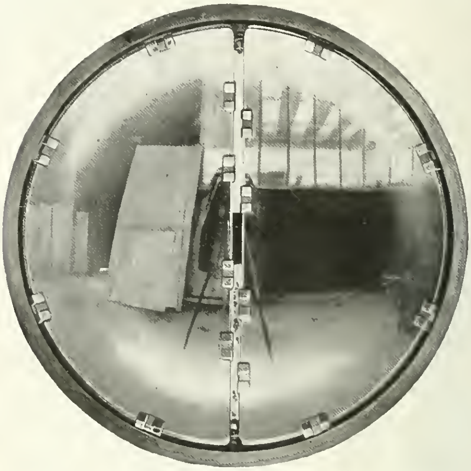
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood [Bldgs
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street
Branches in Principal Towns Abroad.

SEARCHLIGHTS.

For many years the searchlight projector has been an important item in naval and military equipments, and it is now recognised to be essential both for purposes of aggression and defence in night operations. It is extensively employed on all passenger and important cargo ships, as well as ferry, patrol boats and trawlers. In addition, it is applied to many industrial operations, including surface mining, excavation and dock work, also for advertising and theatrical purposes, and in connection with fire brigade and other rescue work. Messrs. Crompton & Co. have specialised in the manufacture of this class of apparatus for over 35 years, and have supplied many thousands of projectors to the British, Colonial and Foreign Governments, also to the leading steamship and commercial companies at home and abroad.

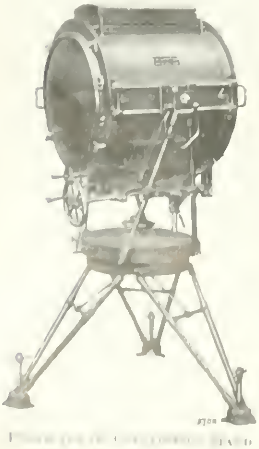
In the smaller sizes of Crompton searchlight projectors, the training and elevating motions are directly controlled by hand, either with or without the use of gearing, but in the larger sizes from 24 in. and upwards they can be supplied with hand control through gearing; and electrically, mechanically, or hydraulically controlled from a distance.



FRONT VIEW PARSONS SPLIT MIRROR.

Crompton standard projectors are built in many types and sizes, some of the principal of which are given in the following table, together with particulars of the currents for which the lamp can be designed:—

With pedestal base.		With cone base.	
Dia. of mirror.	Lamp current.	Dia. of mirror.	Lamp current.
12 inches	25 to 30 amperes	20 inches	60 to 70 amperes
14 ,,	30 to 40 ,,	24 ,,	70 to 80 ,,
16 ,,	40 to 50 ,,	30 ,,	90 to 100 ,,
18 ,,	50 to 60 ,,	36 ,,	100 to 120 ,,
20 ,,	60 to 70 ,,	42 ,,	150 to 180 ,,
		48 ,,	180 to 200 ,,
		60 ,,	200 to 220 ,,



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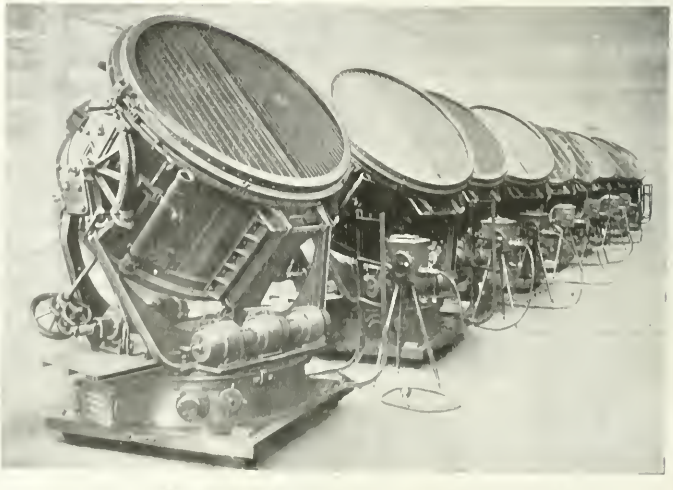


60 IN. MOTOR CONTROLLED PROJECTORS WITH FLASHING SHUTTERS.

The Lamp with a living in it.

The merits of Pope "Elasta" British Made Wire Lamps are being told to the general public in the "dailies" and "weeklies." A demand is being created in all parts of the country.

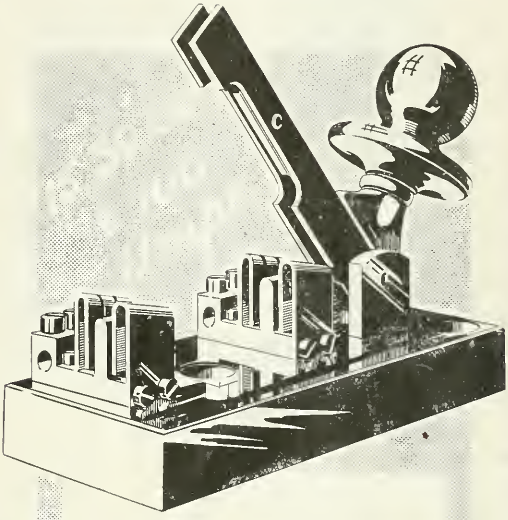
POPE
ELASTA
WIRE LAMPS

have built up a reputation on sheer merit. They withstand vibration. Filament never becomes brittle. Brilliance retained to the last. "Elasta" is the lamp of all-round merit.

Write for Terms and Booklet No. 11.

Pope's Electric Lamp Co., Ltd.
HYTHE ROAD, WILLESDEN,
LONDON, N.W.

Simplex Switches



Quick Break.

Blades dead when Switch is open.

Maximum Contact Surfaces.

Liberal Current Carrying Parts.

Sizes:
15, 30, 60 and 100 amperes.

SIMPLEX CONDUITS LTD.,
Garrison Lane, Birmingham.

LONDON—
113-117, Charing Cross Rd. W.C.
MANCHESTER—
16, Corporation Street.
GLASGOW—
72a, Waterloo Street.
BRISTOL—
10 & 11, Denmark Street.
NEWCASTLE—
61-65, High Bridge.
LEEDS—
6, White Horse Street.
LIVERPOOL—
96, Whitechapel.
SWANSEA—
14, Heathfield Street.
CARDIFF—
4, Westgate Street.
ABERDEEN—
1, Crimon Place.

BELLING

& CO.

We can quote you for and are regularly supplying:—

- Electric Heaters for Shell Drying Ovens.
- Gas and Fire-proof Heaters for Loading Rooms.
- Immersion Heaters for Wax Melting.
- Air Warmers for Fabric Drying Rooms.
- Low Temperature Radiators for Work Rooms.
- Electric Fires (Radiant type) for Offices, &c.
- Electrically-heated Water Tanks to deal with any quantities.
- Thermostatically controlled apparatus to keep either water or air at any desired temperature.
- Electric Toasters, Water Boilers and Grillers for Mess Rooms.

We have had large experience in adapting electricity to many novel manufacturing processes, and are prepared to submit quotations and drawings to meet any given conditions.

BELLING & CO., Electric Heating Specialists, Derby Road, EDMONTON, LONDON, N.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

Drawn Shell Work

IN BRASS, COPPER, and STEEL.

Any size
up to 8″ diam. × 4″ deep.

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REGULATING RESISTANCES

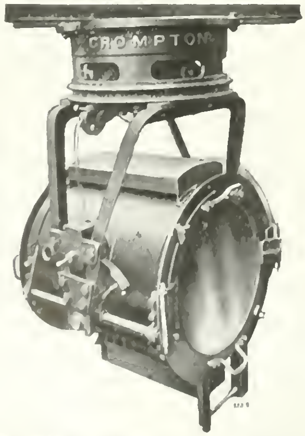
ISENTHAL & CO.
(Department 4)
Denzil Works,
Willesden, London, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

NEW LIST ON REQUEST.

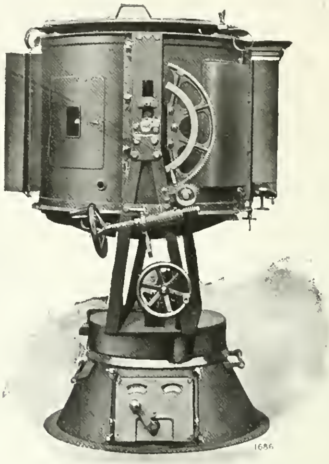
NATURE says:
"The list is one of the most complete we have seen."

The projectors are provided with accurately ground parabolic glass mirrors, but when desired other types can be supplied to suit customers' requirements. The lamps employed throughout are of the company's horizontal carbon type, arranged for hand and automatic working. They are designed to burn with 15 to 70 volts across the terminals, the actual value depending upon the current for which they are wound and the kind of carbons to be used. When lamps are supplied from constant voltage circuits, it is necessary to reduce the excess to the working voltage of the lamps; for pressures up to, say, 110 volts, a steadying resistance is employed. For pressures above 110 volts motor generators or converters are generally supplied, these machines being often designed to suit the working characteristics of the lamps without the use of steadying resistances. By this means the overall efficiency of the plant is considerably increased.



24 in. Inverted Projector for Rope Control.

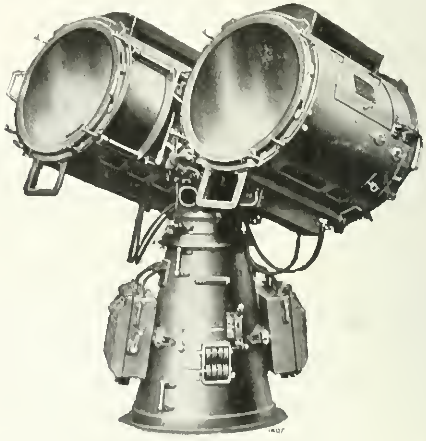
In addition to the ordinary hand-controlled searchlight projectors, with or without gearing for elevating and training motions, many hundreds arranged to be operated electrically from a distance have been supplied. In this case the motors for actuating the elevating and training gear are housed within the cone base. The company



Anti-Aircraft Projector.

has also supplied numerous searchlight projectors with various forms of distant mechanical control, in which the respective motions are actuated by means of rods or wire ropes from the bridge or chart house, together with others of specially constructed light-weight pattern designed for easy dismantling and storage.

The absence of any recognised standard as a basis of comparison for the effective range of any given size of searchlight projector renders the question of guarantees an exceedingly difficult one. It is impossible to compare the relative merits of searchlight projectors on the basis of candle power. Candle-power values are devoid of meaning, and therefore the company do not put forward any such values in the form of guarantees. The range of a searchlight projector, and the intensity of illumination at a distant point, are dependent upon a number of factors. These include the power absorbed, type, size and quality of electrodes, mirror and lens, the atmospheric conditions, nature and size of object to be illuminated, and the visual acuity and position of the observer relative to the beam. It is true that responsibility for many of these points rests



24 in. Twin Projector.

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Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
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Knife Switches.

PRESCOT FROGS & CROSSINGS.

The arcing and flashing which takes place at the termini of many tramway systems, when the trolley is reversed, can be obviated by the use of

PRESCOT TROLLEY CHANGERS.

Moreover, the car is not plunged into gloom while the conductor is fishing for the other conductor somewhere up aloft in the Cimmerian darkness.

Write for particulars.

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Cablemakers and Electrical Engineers,

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MOTORS.
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with the manufacturer, but the one having the most far-reaching influence on the beam, namely, atmospheric conditions, is quite beyond the control of the manufacturer. The distance which the beam from a searchlight projector will carry is not entirely a question of clearness of atmosphere (itself an immeasurable quantity), but it is also largely a question of humidity. The distance which the eye can see does not altogether depend upon the distance which the beam carries, but is governed to a large extent by the screening effect of the haze of light which is formed round the beam. The amount of this depends upon the distribution of light which takes place in the beam, which again is dependent on the humidity of the atmosphere at the time of test.

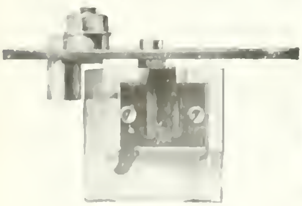
Messrs. Crompton & Co. have obtained experience in effective range of searchlight projectors of all sizes in many parts of the world. This important information has been carefully studied, and mean values obtained for atmospheric transparency over a long period of successive observations for a given locality. They can advise on the most efficient size of projector to employ for a given duty, on receipt of information relating to the locality and altitude, the range, size, colour and surroundings of the objects to be illuminated, and the type and size of electrical plant available. There may be a considerable difference in the size of a searchlight projector for a given duty, depending upon the locality. It is, therefore, essential for full information to be given with the inquiry so that the power consumption of the projector shall be a minimum, thereby reducing the initial cost, dimensions and weight of the generating plant, and possibly avoiding the necessity of enlarging an existing plant.

The company has designed and constructed a large number of portable projector equipments complete with generating plant, for field, fortress and anti aircraft service, mining, salvage and repair work. This class of plant for military field work is often required to withstand the worst possible service conditions, and careful attention is therefore given to the design to ensure light weight with rigidity and simplicity of construction, interchangeability and ease of replacing any of the working parts.

The foregoing details are abstracted from a new catalogue (List P.1) which Messrs. Crompton & Co. are just about to issue to the industry.

THE "KANTARK" FUSE.

Numerous and successful attempts have been made to produce a porcelain handled replaceable fuse which can be trusted to stand up to the conditions of industrial power circuits, and heating and cooking circuits. As a rule these fuses tend rather to complexity in the shape of the porcelain handle, and the fuse wire is so shielded that the ventilation is poor, and after repeated heating and cooling the wire will not carry its full rated current. There has not hitherto been designed a fuse in which any appreciable length of the fuse-wire is in free air. In the "Kantark" fuse, of which particulars are now being distributed to the trade, the makers have succeeded in devising a form of carrier which exposes a considerable length of the wire to the air and a contact block with a chamber so shaped that there is free circulation of air around the wire; the shape of the carrier immediately behind the fuse-wire and the shape of the chamber in the contact block assist in the expulsion of the arc when the fuse blows. The illustrations reproduced herewith clearly bring out these points.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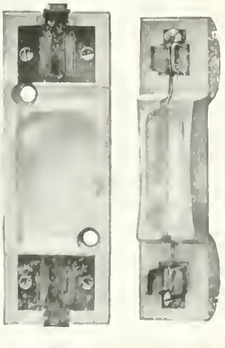
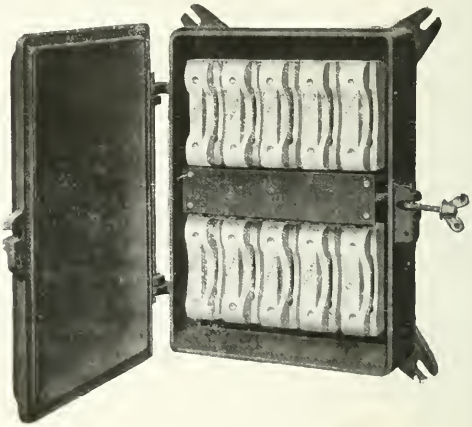
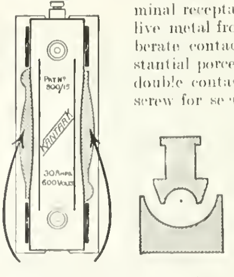

"Kantark" Fuse Block and Fuse Carrier.


"Kantark" Distribution Board.

Turning first to the contact block, it will be noticed that this is of substantial construction and that the terminals are embedded in rectangular receptacles at the top and bottom of the block. Detachable protective shields are fitted over the terminal receptacles, and these effectually guard the live metal from incidental or to some extent deliberate contact. The fuse carrier is also a substantial porcelain block and is fitted each end with double contact prongs and large sized pinching screw for securing the ends of the fuse-wire in position. The double contact blades are an advantage for carrying heavy currents.



Views of "Kantark" Fuse, showing position of Fuse in Carrier and Free Air Spaces.

This interesting fuse is being made and put on the market by the Midland Electric Mfg. Co., Birmingham, and is offered both in the separate block form and made up in iron cases as a distribution board. The descriptive list giving particulars of this fuse, contains a table of prices of double and triple pole fuse-boards for from 2 to 10 ways and in three sizes, 10–15, 20–30, and 50 amperes. The fuses are suitable for pressures up to 600 volts. The Company state that they will be pleased to send a sample board free of charge, on sale or return, for customers to test and inspect. The fuse is so interesting that we feel sure many of our readers will take advantage of this offer.

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Hall's Patents
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
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and the consequent lowering of production costs is of vital moment in these days of keen competition. If you use clutches or brakes, you are not securing the maximum efficiency if they are not lined with Ferodo fabrics. Leather is always unsatisfactory because its coefficient of friction drops very rapidly with a rise in temperature and it is liable to char. The efficiency of Ferodo fabrics rises with the temperature, and they are absolutely non-inflammable. Metal to metal surfaces often cause considerable trouble owing to the metal dust created by friction. This is obviated by using Ferodo fabrics.

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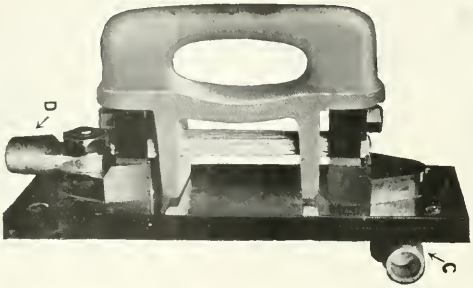

D. & S.
"HANDLE" FUSES.
50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.

DORMAN & SMITH Ltd.,
Ordsal Electrical Works,
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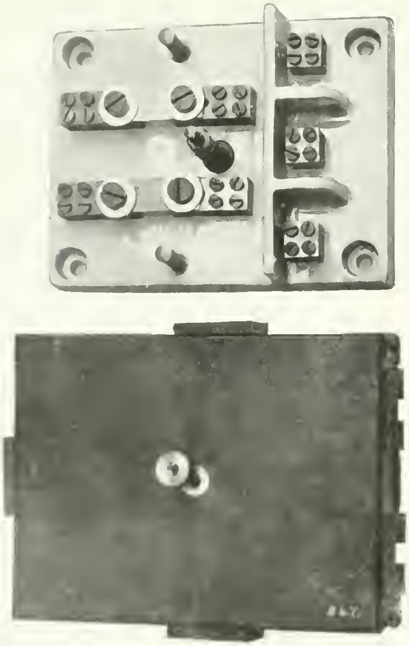
MANCHESTER.

WATTMETER TESTING TERMINALS.

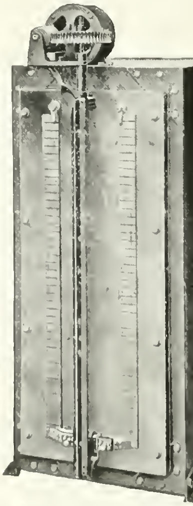
The terminal device illustrated is made for the purpose of conveniently inserting a testing instrument or check meter in series with the working instrument circuit without having to interrupt the supply of current to instruments which are required to be checked against a standard. The terminal base is fitted with two disconnecting links for the current leads. These are arranged so that the check meter can be joined to the terminal and put into the circuit with the instrument under test by the removal of the links. There are also three potential terminals each with two sets of cable receptacle holes, one set being free for the testing connections. Terminals as mounted on a porcelain base, with sheet metal cover, are shown in the illustration. The apparatus is made by Reyrolle & Co., Hebburn-on-Tyne, and is priced and described in Pamphlet No. 315.



[illegible] View of Wattmeter Terminal Block

MAIN REGULATORS.

From time to time we have illustrated various patterns of main regulators manufactured by the General Electric Co., Ltd., of 67, Queen Victoria-street, London, E.C., and Witton, Birmingham. All those previously described were of the hand-operated type, but the example illustrated, forming part of an important contract for a large municipality, is driven by a small "Witton" motor. This motor is mounted on top of the regulator and is controlled from the main switchboard by means of a pair of small push switches forming one unit and so arranged that they cannot be left in the "on" position. There is one switch for each direction of operation, and an interlock prevents both switches being operated at the same time. To preclude damage to the motor when the main regulator control has come to the end of its travel either at the top or the bottom, a resistance is inserted in series with the motor, and, in addition, a flexible coupling is provided between the motor and the worm driving the gear wheel. This construction avoids limit switches and is very simple and effective. The regulator itself is of the Witton rectangular pattern with grid resistance, one of a wide range of types which are manufactured by the G.E.C.



Front View of Motor Operated Main Regulator.

"THOR" High Grade Specialities
CASING and CAPPING
CONDUIT
CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
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Write for List :—
JENSON & NICHOLSON Ltd. INSULATING VARNISH DEPT. GOSWELL WORKS, STRATFORD, E.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, November 10, 1916.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Arrest of a glow worm for having its blinds up during restricted lighting hours.

* * * *

"Paris by candlelight" says a newspaper headline, but this time *not* the Jablochkoff candle!

* * * *

Mr. H. E. Blain's paradox for Londoners: "Above everything else, travel underground."

* * * *

Bon mot of the week: "It was an awful thought that we could not get rid of ourselves."—Sir Oliver Lodge, in an address on "Life or Death," at Dudley.

* * * *

The leading article in a recent issue of "Engineering" is entitled "The Gas Engineer of the Last Century." Round Table readers will, I feel sure, fervently pray with me that he will not be with us anything like as long as that!

* * * *

BUCK UP, EVLIN, THIS AINT A SKIPPING ROPE!

[From *Glover's Almanac.*

* * * *

In the "Daily Chronicle" of Nov. 14 appears a little poem, which Mary Farrah dedicated to our dear old friend Red Tape. Here are a couple of verses:

Yours was the ancient day of pre-war leisure,
When bland officials toiled from ten to four,
And pigeon-holed until the morrow's pleasure
All documents that might have proved a bore.
Although you blushed to witness such proceedings,
You still were made accessory, it's plain;
They took no notice of your voiceless pleadings,
But tied you into tighter knots again.

I should very much like to see our own electrical poets, "E. L. H.," "Nahlike Va," "B. C. H. J.," and other celebrities produce an ode to our dear old friend "Sticky Tape," who is always with us, who never changes his colour, no matter how often he is forced to change his role and do duty for Mr. Para Tape—hush! when no one is looking!

"Winter's Pie," is again out of the oven, and very good fare it is. If the electrical advertisements continue to increase, as they show signs of doing, next year the "Pie" should be electrically cooked, and, therefore, very full of "extractives." A particularly apposite joke in the currant (?) issue is that by E. Huskinson, who shows a top-hatted, fur collar and cuffs "gent." about to shake hands with a friend:—

The Rich One: "Pluck, dear boy, pluck! That is the reason of *my* great success and fortune."

The Poor One: "Yes, that's all right, but who—and how?"

* * * *

Round Table readers who buy "Winter's Pie" this year will, it is hoped by Mrs. W. Hugh Spottiswoode, the editor, send their copies to hospitals, convalescent homes, camps or to their friends with both Services at the Front.

* * * *

The hydro-electric plant at Bettws-y-coed was on Friday last pulled up by an eel, which blocked the main turbine valve. It measured 4 ft. 9 in. long and weighed 10 lb. It was evidently trying to get into the tail race!

* * * *

The "Newcastle Chronicle," in reporting the opening of the Inst.E.E. Local Section meeting, has added to electrical nomenclature a new switch—"the oil *drag* switch." Mr. H. W. Clothier, the new chairman of the local section, is stated to be interested in this unique invention, and my readers will be relieved to hear that it is "all British."

* * * *

Lieut.-Col. P. W. D'Alton, in his published report on the Dublin electricity undertaking, gives a nasty jar to our old friend the gas engine. He says: "There are many gas engines in use in the city, but no such engines should have room for existence." That is just the trouble, they have no existence apart from their room!

* * * *

"Underground Electric Position," says a "Pall Mall Gazette" headline. Let us hope it is not going to be moved, unless, of course, the platforms can by any chance be brought nearer the lifts!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Nov. 15, 1879.]

THE ELECTRIC LIGHT IN "THE TIMES" OFFICE.—Within the last few days the electric light has been introduced into the "making-up room," a large apartment on the ground floor of the east side of the quadrangle in Printing House-square. The illuminating power is most effective, "artificial daylight" being shed over the whole interior. The electric light has for some time past been in operation in the machine department of the establishment.

THE ELECTRIC LIGHT AT CHESTER.—The Hydraulic Engineering Company (Limited), of Charles-street (Brook-street), have just adopted the electric light for their new erecting shop. This shop is 120 ft. in length, by some 40 ft. in width, and 40 ft. or 50 ft. in height. It is fitted with a steam travelling crane capable of lifting great weights. At the time of inspection the men were working upon some hydraulic machinery under the electric arc, which gave a light resembling in its colour and its shadow the light of the moon, but of great clearness and intensity. The light was placed against the wall of the near end, and at the further end of the shop small print and pencil writing were distinctly visible and easily readable. The lamp adopted is the Serrin lamp, and the electric machine employed is the Gramme. Messrs. Crompton & Fawkes, of London, have laid down the apparatus, and Mr. Subworth, electrician, has superintended its fitting. The light was very steady, and the men were able to work uninterruptedly. In the adjoining workshop gas jets were profusely employed at the various machines, as well as two central dome lights of 18 burners each, but the effect was twilight compared with the almost "broad day" of the erecting shop.

L. P. S.
CLIPS, TIPS & TERMINALS
of all descriptions.
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Illustration shows our Standard Cast-iron Mining Pillar suitable for pressures up to 3,300 volts.

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Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
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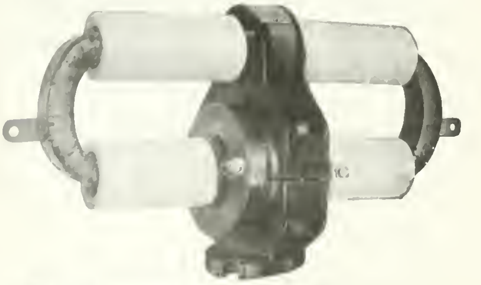
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

PORCELAIN INSULATED CURRENT TRANSFORMERS.

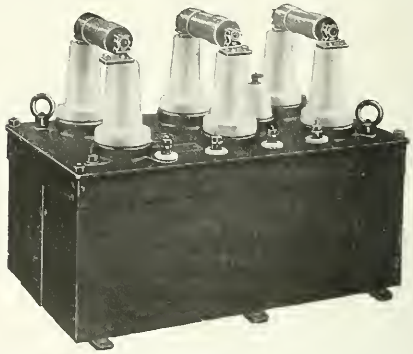
In a recent issue we referred to a line of instrument transformers made by the B.T. H. Co. (Rugby). We mentioned the Type C form N_2 porcelain insulated transformer and we now give an illustration of this herewith. This transformer is suitable for extra-high-tension circuits up to 300 amperes primary current, where the voltage between any phase and earth does not exceed 7,000 volts. The primary coil is insulated from the secondary and frame by two thick porcelain tubes through which it is threaded. The secondary coil is wound on but insulated from a ring core built up of iron stampings. The secondary coil and core are taped up together and the [illegible] into one of the porcelain tubes before the primary coil is wound. The porcelain tubes form a moisture proof insulation between primary and secondary. All porcelains are carefully in[illegible] and are all subjected to a [illegible] test. The finished transformer is assembled and clamped [illegible] fitted with slotted feet for fixing. The primary terminals are rigidly fixed on the insulated winding, one at each end of the transformer, and are drilled for a bolted connection.



B.T.-H. Porcelain Insulated Current Transformer.

An important feature of the transformer is the copper lining fitted to the porcelain tube and electrically connected to the primary coil. This renders impossible any corona effect or silent discharge between primary winding and porcelain tube, thereby avoiding liability of acid action and the consequent deterioration of the insulation. The "CP_2" transformer is another porcelain insulated transformer suitable for extra-high-tension circuits of 100 to 1,000 amperes primary current, where the voltage between any phase and earth does not exceed 7,000 volts. The secondary coil is wound round a laminated core but insulated from it, and the whole is taped up solid and assembled on a thick porcelain tube. This tube forms a moisture-proof insulation between primary and secondary, and is mechanically and electrically tested before being put into service. Brackets can be supplied if the arrangement of connections does not render the transformer self-supporting. These brackets bring the centre of the transformer 5 in. from the surface on which it is mounted.

Potential transformers are also listed in the same catalogue as the current transformers and are for use with voltmeters, wattmeters, and other switchboard instruments on alternating-current circuits, when it is necessary or desirable to insulate them from the line. These transformers are of substantial design and construction, and the two standard types are air and oil insulated. The air insulated transformers are supplied for all pressures up to 6,600 volts. They are fitted with sheet metal casings and cast-iron covers, upon which terminals, fuses and an earthing screw are mounted. The oil insulated transformers are supplied for pressures of 5,500 volts and upwards. These are placed in cast-iron cases filled with oil, the core and windings being suspended in the oil from the cover. The terminals are mounted on porcelain insulators fixed to the cover in such a manner as to be easily replaceable in case of breakage.



B.T.-H. Air Insulated Three-Phase Potential Transformer.

A combination of instruments can be operated with accuracy provided that the total volt-ampere load does not exceed the rated capacity of the transformer. For lighting purposes and the operation of low voltage relays where the same ratio accuracy as with instrument transformers is not necessary, all B.T.-H. transformers will, we understand, carry overloads of 100 per cent. in the case of air insulated and 200 per cent. in the case of oil insulated transformers, with a temperature rise not exceeding 50 C. (90 F.). All the transformers listed can be used on voltages within 10 per cent. of the rated voltage without loss of ratio accuracy.

In the case of three phase transformers the neutral points of both the high and low tension windings are connected to insulated terminals. All transformers are supplied complete with cartridge fuses. Transformers for 5,500 volts and above are fitted with adjustable clips, so that expulsion type fuses can be substituted for the cartridge type if desired. Transformers without fuses can be supplied if required so that the terminals can be connected to customers' fuses.

The high tension coils are separately impregnated under vacuum with insulating compound, thus eliminating moisture and securely

FURNACES for MELTING WHITE METALS, Etc.
(Hall's Patents)
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
PATENT MIXER PRODUCES HOMOGENEOUS ALLOY.
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The simplest, most efficient, and cheapest prepayment meters obtainable.

These meters are of the electrolytic type and have no fine working parts to go wrong.

They are accurate on the smallest loads because the amount of copper strip consumed is exactly proportional to the ampère hours.

Owing to the dimming of the lights a few minutes before the strip in the solution is exhausted, the customer is warned that further prepayment is necessary.

These meters are ideal for small house property where a more expensive meter would be out of the question.

Full particulars of these and our other meters will be found in our Pamphlet P. 134.

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Cablemakers and Electrical Engineers,

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SWITCHGEAR, TRANSFORMERS, METERS,
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supporting each individual turn. The low tension coils are wound with specially treated wire, insulated from the core, and from the high tension coils by a stout tube of varnished cambric. Before leaving the factory these potential transformers are thoroughly tested both for insulation and accuracy of ratio. The insulation between the high-tension windings and all other parts is submitted to a test of not less than three times the working voltage. The insulation between layers and coils is subjected to a test of not less than twice the working voltage applied across the terminals. Barriers for mounting between the fuses of oil insulated transformers can be supplied when required.

Interested readers should apply to the company for Price List No. 4591.

"CREDA" ELECTRIC FIRES.

We have received from Credenda Conduits, Ltd., Chester-street, Aston, Birmingham, copy of their leaflet No. 22, which describes and prices their new season's fires. Several patterns of these fires are illustrated herewith, and it will be noticed that a new pattern of element has now been fitted. The coiled nichrome wire is held in a vertical post on six grooved ceramic blocks, these being built up to form a core bar, the loading of which is 600 watts. The fire illustrated in Fig. 1 is offered in two loadings, 1,200 watt with two bars and 1,800 watt with three bars, there being two control switches in the case of the latter. The frame of the fire measures 17 in. high by 11½ in. wide by 4½ in. deep, and the weight is 18 lb. The cheapest pattern is plain and is priced at 27s. 6d.

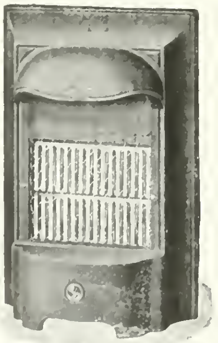

Fig. 1.—"Creda" Fire. Two-bar 1,200 watt Pattern.

Fig. 2 shows a much more ornate design of fire embodying a similar pattern of unit bar, but somewhat wider than that illustrated in Fig. 1. This is a 3 kw. fire and measures 21½ in. high, 20 in wide, 11½ in. deep, and weighs 36 lb. It is supplied in four different finishes, the plain pattern being listed at 80s.

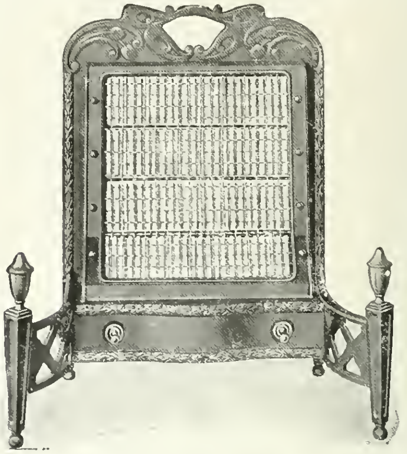

Fig. 2.—Ornamental "Creda" Fire. Four-bar 3 kw. Pattern.

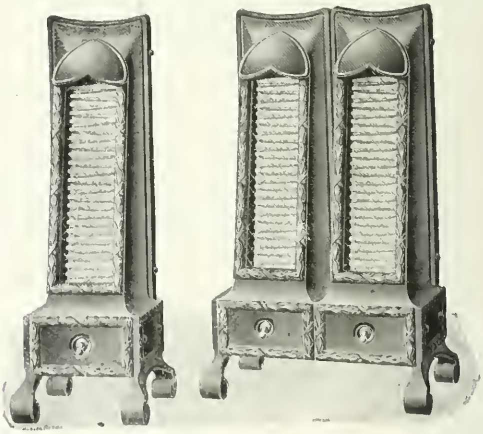

Fig. 3.—Pillar Pattern "Creda" Fires, for Halls and Corridors.

Fig. 3 shows quite a distinctive design of fire which is being put forward for use in halls and corridors. It is supplied as a unit pillar, and any desired number of units can be coupled together. The single unit is 21½ in. high by 7 in. wide by 7½ in. deep, and the weight is 19½ lb. Like the other fires, this is supplied in plain or ornamental

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
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Phone: Victoria 4026. Grams: Vicminster, Sowest, London.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

C.A.V. DYNAMO LIGHTING

Petrol Rail Car equipped with C.A.V. Dynamo Lighting Head and Rear Lamps (32 c.p. each), and ten Interior Lamps of 10 c.p. each.

The C.A.V. Lighting System, so simple and efficient for Automobiles, renders equally satisfactory service for Railway and Tramway Work.

As proof of this we have received large repeat orders from India, Spain, Canada, and other countries where the C.A.V. System is in use.

Electricians and Railway Engineers are invited to write for handsome 64 pp. Catalogue.

C.A. Vandervell & Co., Ltd.
Electrical Engineers, ACTON, LONDON, W.

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Should be in every office, shop, power-house.

The Premier PORTABLE ELECTRIC SUCTION CLEANER

Why be content to work in dusty and dirty surroundings when the evil can be overcome? By using a Premier *Portable* Cleaner your office can be kept in a clean, healthy and hygienic condition.

Your stationery and stock can be kept from getting soiled. No other machine has the same advantages as the New Premier Portable. It is a revelation in efficiency.

Comprises high-speed motor and fan in aluminium case. Can be clipped to belt and strapped round the waist, or carried in the hand. Weight only 7½ lbs.

Write to-day for Illustrated Booklet No. 14.

ELECTRIC SUCTION CLEANER COMPY.,
56, Victoria Street,
LONDON, S.W.

Worth your consideration.

These advertisements are appearing in the "dailies" and "weeklies." Pope "Elasta" Lamps are being asked for in all parts of the country. There is profitable business to be done by those who keep "Elasta" to the front.

POPE ELASTA WIRE LAMPS

have built up a reputation on sheer merit. They withstand vibration. Filament never becomes brittle. Brilliance retained to the last. "Elasta" is the lamp of acknowledged merit.

Write to-day for Terms & Booklet No. 8.

Pope's Electric Lamp Co., Ltd.
HYTHE ROAD, WILLESDEN,
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IRONCASED SOCKETS & PLUGS
FOR HARD SERVICE.
Sizes up to 200 amps.
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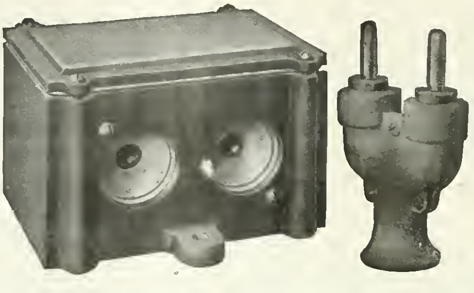
Also Combined Switch and Plug Boxes.



DORMAN & SMITH, Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

finish, and the cheapest pattern is listed at 30s. There are several other interesting fire patterns, in particular we may mention a two-bar fire which would doubtless be very acceptable for the heating of small offices. This is rated at 1,500 watts, and measures 16 in. high by 15½ in. wide by 4½ in. deep, and weighs 20 lb. In the cheapest pattern it is offered at 35s.

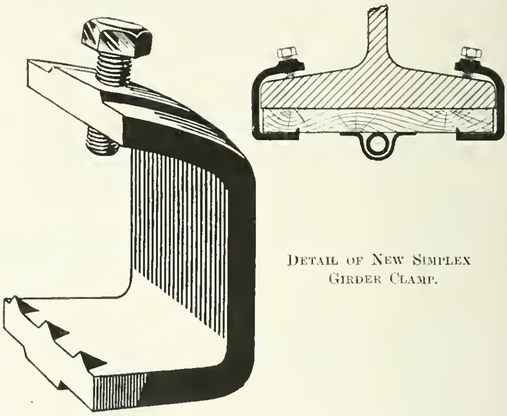
The list also contains particulars of a new design of electric hot-plate which embodies the new pattern Credenda heating element. This is made up of cast-iron, black enamel'ed finish, in two sizes, catalogue No. 400, 6 in. diameter rated at 750 watts, one heat, and catalogue No. 402, 11 in. diameter, rated at 1,500 watts, three heats. The 6 in. plate weighs 5½ lb., and the 11 in. plate, 16 lb. The Company also send us a copy of their catalogue of heating and cooking apparatus, which contains particulars and prices of kettles, irons, milk warmers, warming plates, frying pans, saucepans, grills, coffee percolators, toasters and water urns. In the heating section are details of lamp radiators and convectors. Copies of these catalogues are obtainable from the company on application.

SIMPLEX UNIVERSAL GIRDER CLAMPS.

One of the chief difficulties in present day wiring installation work is the trouble experienced in negotiating steel girders, and as most new buildings are largely using these, a well designed girder clip is a more important item than it used to be. The large number of sections of girders render it more difficult to conveniently clamp conduits and other fixtures, so that a universal girder clamp is very necessary.

The Engineering Standards Committee have done excellent work by choosing certain girders for general use, but the number still remains great. There are section rolled girders, riveted girders, also channels, angles and Tee sections in great variety. A large number of girder clips are on the market and nearly all of them are made for a particular section of girder, and even when a certain amount of adjustment is embodied in their design, it is only within small limits it can be used.

When setting out on the design of a universal girder fixing it is at once evident that to securely clamp a small wooden batten to the metal provides the best arrangement. It is this special feature that the Simplex girder clip embodies, as it consists of a pair of clamps which fasten on to the edges of the girder and hold a wood piece, on to which a saddle for the conduit, junction box or other accessory can be fixed by an ordinary wood screw. The clamps are made of tough malleable iron in two sizes at present and are provided with a set screw for drawing the wood tight up to the under side of the girder. Two or three sharp points are arranged to ensure the wood being securely held. The wood batten is not sold with the clip as this can easily be obtained on the job. It is the wood which provides the packing for the clamp, and it can be easily arranged the correct thickness for the particular girder flange in question. For angles or odd sections the batten can be placed lengthwise and two girder clamps spaced along the free edges to securely hold it in position ready for the conduit erector.



Detail of New Simplex Girder Clamp.

Prices are given in pamphlet No. 644 just issued by Simplex Conduits Ltd.

SWITCHING EXAMS.

The results of the first of a new series of "Batch Exams.," held by Messrs. A. P. Lundberg & Sons, 477-489, Liverpool-road, London, N., are as follows, the names being given in order of merit :—

Advanced Certificates.—H. Hanks (Birmingham), T. C. Hodges (London), S. Frankland (E. Morton, Yorks), L. Thomas (Rugby), T. Doyle (London), H. Cunnick (Swansea), J. W. Hiron (London).

Intermediate Certificates.—H. Grimshaw (Golborne, Lancs), W. A. McCall (Blackburn), W. E. Fairchild (Newark), C. R. Gunn (Liverpool), R. Maynard (Cleethorpes), J. J. Rogers (Dundalk), H. G. Ferguson (London), A. Holroyd (Port Clarence).

Preliminary Certificates.—A. Doyle (Bexhill), J. Moran (Storling, near Bury), "Winnie" (London), C. G. Ovens (Manchester), P. Carroll (Drumcondra), J. C. Gale (Eastbourne), C. H. Bull (Blaina, Mon). *Extra.*—A. V. Harris (Waltair, India).

These interim exams. have been instituted to give those interested in the subject an immediate chance of trying for a certificate.

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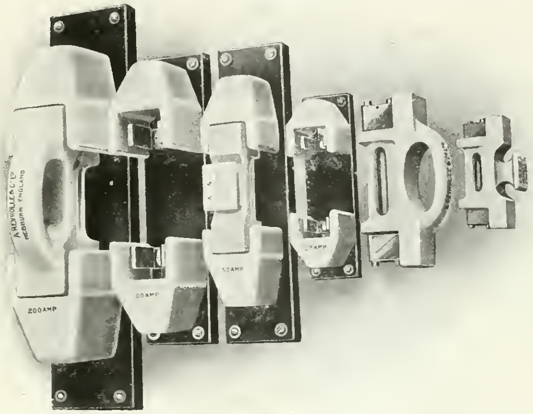

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To Latest Home Office Regulations.

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Drum Type with Free Handle Circuit Breaker (INTER-LOCKED) ALSO Lever Type.

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for 3,000 and 6,000 Volts.

TRIPLEPOLE AUTOMATIC OIL-SWITCH.
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OVERLOAD & UNDERLOAD RELEASE.
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INVERSE TIME LIMIT ATTACHMENT.
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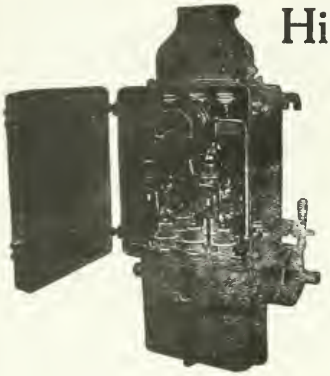
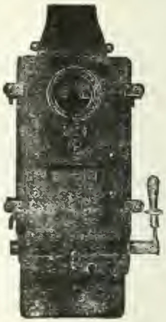


OPEN.



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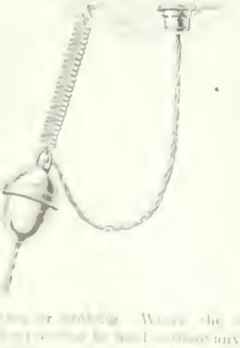
Other Types for all purposes.

ELECTRICAL APPARATUS up to 80,000 Volts.

Telephone: 5223 HOP.
Telegrams: "GABIONAGE FRIARS LONDON."

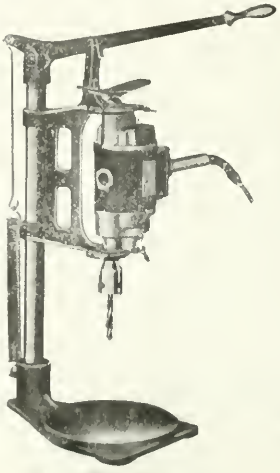
THE NEVA-KNOT ADAPTER.

In our issue of October 20th we published a description of a neat device which is being put on the market by Engineering & Arc Lamps, Ltd., St. Albans, to use in connection with flexibles for electrical utensils, irons, &c. We referred to the apparatus as a cord absorber, but we regret to find that in this we were incorrect. The following letter from the company explains the action of the adapter, of which we again give an illustration: "With reference to your recent notice of the Neva-Knot adapter, we are afraid that the illustration and lack of detailed description in the leaflet mislead you. The adapter itself is not in the nature of a cord absorber at all, but is a frictionless contact device or coupling, whilst the spring, which is a secondary part of the apparatus, does act as a cord absorber over limited range, which is sufficient for most purposes. The object of this spring is, as you say, to keep the flexible taut and, the function of the frictionless adapter or coupling is to allow this flexible, attached to a laundry iron or electrical tool, to rotate perfectly freely, however much it is twisted about, thus preventing any knotting or kinking. Where the movement necessary is small, the [illegible] without any spring or cord absorber at all, and where considerable motion is essential a real cord absorber can between the spring and the upper flexible."



DUNTLEY ELECTRIC DRILLING STAND.

This stand is strong and substantially made throughout, and is intended for accurate drilling. The weight of the drill and drill arm is counterbalanced by means of a spring, and a key or feather in the movable bracket keeps the drill in vertical alignment and ensures the drilling of straight holes. The larger sizes are provided with tee slots in the base plate so that the work may be bolted down if desired.



View of Drill Stand complete with Electric Drill.

It is built in five sizes to take the standard Duntley side spindle drills of either the universal or direct current types (see drill bulletins), ranging in drilling capacity of from $\frac{3}{16}$ in. to $\frac{1}{2}$ in. in metal. The drill itself is held in place by two clamping straps, shown in the illustration, secured by screws and thumb nuts, allowing it to be removed in a few seconds and used as a portable drill.

This drill stand is made by the Chicago Pneumatic Tool Co.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, November 17, 1916.

THE ROUND TABLE.

By "KVA."

Congratulations to Capt. K. A. R. Smith, of Edison Accumulators, upon his prowess in winning the Military Cross. Capt. Smith was nothing if not appropriate. He was a soldier before the war and during peace he acted up to his initials, K. A. R. S., by selling Edison battery vehicles!

* * * *

Mr. C. G. Nobbs, of the Falkirk Iron Co., has answered the Carron catch line, "A touch of the switch does it," by "Instant heat at a 'twitch of the switch,'" or as the gas wag would doubtless have it, "Twitchy, Switchy Koo!"

* * * *

"After being soaked for 4 hours in oil of vitriol, they were then placed in flue gases, chiefly composed of carbon dioxide and a little sulphur dioxide with a varying temperature ranging from 82°F. to 180°F. and averaging 130°F. for 96 hours."

No, this is not a newspaper report of our treatment of captured German submarine and Zepp crews; would that it were. It is just an announcement of an "ordinary" test of Helsby cab tyre sheathed cables.

* * * *

The faith of electrical men in one another must be on the increase. A few years ago I would not have deemed it possible, but now that I have had news of an "Ediswasram" shooting match *by proxy* I will renew my optimistic vows in men and things electrical. Ediswan and G.E.C. are respectively jealous of their prowess as marksmen, but the rival teams could not play "away" and "at home" matches, so the shoot was brought off in two places—to wit, Witton (ahem!) and Ponder's End. Mr. W. H. Fletcher, of Ediswan's Birmingham branch, acted at Witton, and Lieut. Ward, of the G.E.C., at Ponder's End. The targets on comparison put an end to the ponders of the "Witton" team, their average, out of 8 marksmen, being 5·5 points below the Ediswan cracks (80·0—74·43).

* * * *

Of course, if the principle of co-operation were strictly observed, all these shooting matches between metal lamp makers would be "drawn." But, really, Ediswan deserve their victory, because they shot on their outdoor range and had a keen wind and rain to make the affair more trench like. It is rumoured that the G.E.C. inadvertently warmed their indoor range with "Magnet" fires, and the "Witton Wag" thinks the "pull" of these was sufficiently great to cause premature release of the hair triggers of several marksmen; which, if it is true, proves that even an electric fire can have its drawbacks as well as its attractions!

* * * *

There are other metal lamp activities to take note of. The Wotanettes—*i.e.*, the ladies of the Wotan Lamp Works, Dalston—have been saving their pennies to give tea and entertainment to wounded soldiers. As is recorded elsewhere in this issue, the first of these parties was held on Saturday last. I hear that throughout the afternoon "each wounded Tommy had the attentions of a lady." This phrase rather suggests that these charming and generous Wotanettes, while they do not dislike making electric lamps, would very much rather make "matches."

The Batti-Wallah Reunion held on Friday last was well attended and, under the chairmanship of "Amp"-stead Wyld, was a high-tension gathering. The Zepp relic, for which there was a "bob" sweep, was appropriately won by the heaviest man in the room, "Baby" Beevor, who was then toasted as a good all-round man and the prototype of the Tanks. The Red Cross Funds benefited by £6. 6s. as a result of the "sweep." The B.-W. orchestra had got up wind enough for its performance, but the "lions" insisted on closing the "den" early so the performers had to save their wind to blow their porridge the next morning!

* * * *

I hear that several prominent electrical contractors in London who remember the stone age of the industry, still base their ideas of electric cooking upon a certain dinner at the Crystal Palace, given by a firm of pioneer electrical manufacturers. The viands were generally voted "par-boiled," and the effects have evidently lasted all these years! The stomachs, like the pockets of electrical contractors, appear to be their most sensitive parts. But think how electric cooking has suffered in the meantime.

* * * *

No. 220 to— OUR HOT PLATES

Mr. H. H. Holmes upon his release by the Marylebone Borough Council Electricity Department to join the Colours. May he give the enemy a "real red hot time!"

THATS GOT IT SAM I GET YER! BUT I CANNA SEE AS WELL AS I DID 30 YEAR BACK!

THE OLD STAGERS RESUME DUTY IN PLACE OF THE "ELIGIBLE."
[*From Glover's Almanac.*

THIRTY-SEVEN YEARS AGO.

(From THE ELECTRICIAN (Second Series), November 22, 1879.)

EDISON.—There is no truth in the facetious report that Mr. Edison has become a gas engineer.

WHERE IGNORANCE IS BLISS.—The young lady, who, on observing the wavy signals arriving on the siphon recorder per the Atlantic cable, inquired if they got sea sick coming over, was not a profound electrician.

CORNWALL.—Edison's telephone has been tried at the Wheal Uny mine between the office on the pit head and the adit level 26 fathoms below the surface. Orders were freely given and heard in spite of a good deal of noise from stamping and splashing of water. The verdict was that while the Edison instrument gave louder sounds than the Bell telephone, it did not reproduce the clang-tint of the voice so perfectly. There is undoubtedly a slightly Punchinellian one in the utterances of the Edison telephone, but from our own experience we should say that a very little practice would enable anyone to recognise the voice of the distant speaker at once.

'IGRANIC'
SPEED REGULATORS
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No. 38.—Combined Starter and Interlocked Shunt Field Regulator to increase motor speed from normal. Protective features prevent incorrect operation.
No. 44. Combined Starter with Shunt and Series Regulation. Permits wide speed range above and below normal motor speed.
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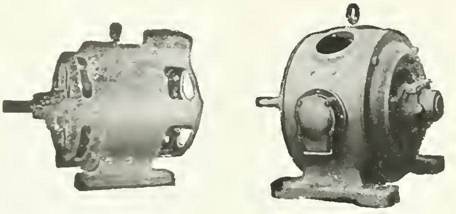

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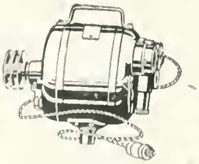
Branches in Principal Towns Abroad.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

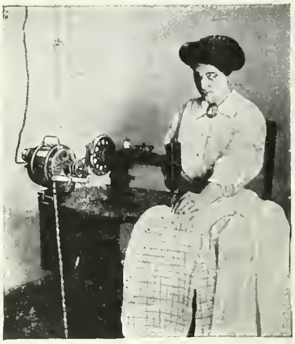
DOMESTIC UTILITY MOTORS.

In its Supply List No. 150/9 issued by Long Millgate Showrooms, Manchester, the British Westinghouse Electric & Mfg. Co. illustrates and describes a utility motor or domestic help which is offered as a solution of the problem of the domestic servant. Numerous attempts have been made to market a device of this kind, but hitherto with little or no success. High price is one of the chief drawbacks. The Westinghouse motor, however, appears to be designed upon lines of durability, and although the price is on the high side, the design has a good deal to commend it over previous patterns. The motor is rated at 1/20th H.P., and can therefore be run from an ordinary lighting circuit. It will work on either direct or alternating current, and is available for voltages of 115 and 230. The motor itself is provided with a carrying handle on the top and a large diameter pin underneath for attaching it to a heavy pedestal base. In addition to the motor there are other attachments by means of which a sewing machine can be driven, silver, metal ware and pans can be cleaned with a buffing wheel or rotary brush, knives can be cleaned and sharpened, and a 4½ in. Sirocco blower can be driven. The various attachments for carrying out these operations are catalogued and priced separately from the motor. The adjoining illustrations show one or two of the applications of the machine. The sewing machine attachment is very neat and provides for the operation of the machine by a round belt. This passes over a jockey pulley, which is carried at one end on an equal lever arm. At the opposite end of the lever is a pull cord which is taken down to the ordinary treadle of the machine. Pressure upon this releases the brake and tightens the belt up, pressing the jockey pulley against it. With a little practice the pressure required to drive the machine at various speeds can be learned. The motor can be turned off from a small rotary switch, which forms part of the casing.

Domestic Motor [illegible] on Pedestal.



Domestic Motor Detached from Pedestal.



Domestic Motor Driving Sewing Machine.

Probably these little outfits are not yet made in sufficiently large quantities to merit their being put on the market at a price which would ensure a very large demand, but the experience of the next few months of selling should show whether such an outfit will find favour in domestic service. The present is an excellent time for putting forward this class of apparatus, and if it can be got into service among those who can afford to pay the present prices it will help to break the ice a little for the class of customer to be found in the wider fields of electricity supply.

From the same source we have received a copy of Supply List 181/2, which includes illustrations, particulars and prices of the "Premier" suction cleaner and the "Little Briton" vacuum cleaner. These well-known machines are being handled by the Westinghouse Supply Dept. in Manchester, and can be seen demonstrated there at any time. Mr. Gibson, or his assistant Mr. Ellam, are always pleased to see both new and old customers and to help in explaining any points upon which there may be doubt or difficulty.

Copies of the lists referred to are available on application.

LEAD MELTING FURNACES
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For Cable and Pipe Presses, Accumulator Grids, etc.,
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
ENORMOUS SAVING IN RESIDUE.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
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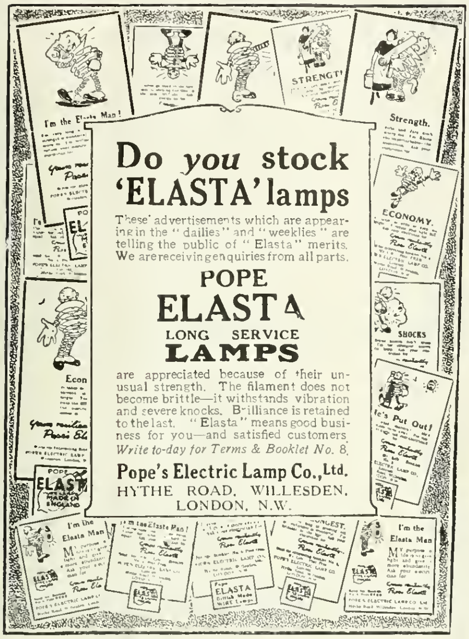
Phone: Victoria 4026. Grams: Vicminster, Sowest, London.



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These advertisements which are appearing in the "dailies" and "weeklies" are telling the public of "Elasta" merits. We are receiving enquiries from all parts.

POPE
ELASTA
LONG SERVICE
LAMPS

are appreciated because of their unusual strength. The filament does not become brittle—it withstands vibration and severe knocks. Brilliance is retained to the last. "Elasta" means good business for you—and satisfied customers.

Write to-day for Terms & Booklet No. 8.

Pope's Electric Lamp Co., Ltd.
HYTHE ROAD, WILLESDEN,
LONDON, N.W.

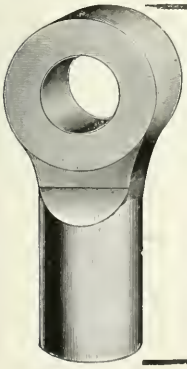
BELLING
& CO.

We can quote you for and are regularly supplying :—

Electric Heaters for Shell Drying Ovens.
Gas and Fire-proof Heaters for Loading Rooms.
Immersion Heaters for Wax Melting.
Air Warmers for Fabric Drying Rooms.
Low Temperature Radiators for Work Rooms.
Electric Fires (Radiant type) for Offices, &c.
Electrically-heated Water Tanks to deal with any quantities.
Thermostatically controlled apparatus to keep either water or air at any desired temperature.
Electric Toasters, Water Boilers and Grillers for Mess Rooms.

We have had large experience in adapting electricity to many novel manufacturing processes, and are prepared to submit quotations and drawings to meet any given conditions.

BELLING & CO., Electric Heating Specialists, Derby Road, EDMONTON, LONDON, N.



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STIRCHLEY, BIRMINGHAM.

Cast Cable Sockets.

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Type A.—Straight.
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SIMPLEX CONDUITS

Make a perfect and permanent protection for all electric light and power installations.

The Simplex Conduit Wiring System provides a thoroughly sound engineering job, complying throughout with all mechanical & electrical requirements.

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72a, Waterloo Street.
Bristol—
10 & 11, Denmark Street.
Newcastle—
61-65, High Bridge

Leeds—
6, White Horse Street.
Liverpool—
96, Whitechapel.
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4, Westgate Street.
Aberdeen—
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AN OPPORTUNITY.

We have a quantity of new

ELECTRICAL HEATING UTENSILS

of the "Elektra" make, which we desire to clear, and should be glad to hear from firms willing to entertain the purchase of these, either in bulk or part, at particularly low prices (much under actual cost). Enquiries invited.

ISENTHAL & CO., (Dept. 4.) Denzil Works, Willesden, London, N.W.

THE SKIAFIX.

The most important consideration in connection with successful radioscopy is that there shall be absence of all movement of the patient when placed in the desired position. Even instantaneous exposures do not overcome this difficulty, because they would have to be made in from 1/150th to 1/200th of a second, if sharp prints were required eliminating all movement; and most of the exposures are of unusual positions which the patient could not maintain at all without support. There is a demand, not only in hospitals, but also in smaller institutions, which do not possess the means for expensive accessories, for a simple and handy universal apparatus to hold any parts of the body securely in any position. Complicated and expensive supporting apparatus, various compressor devices, the bandage process, &c., do not satisfy the radiographer fully who may wish to fix the patient in as many ways as possible with a single simple device. Hence, the general method adopted in daily practice and in the majority of cases for exposures of the extremities and of the head, is the old fashioned use of sand bags. This method is sometimes inadequate, and is useless where a part has to be held firmly in a difficult and unusual position or in the case of irresponsibles who are not able to control all their movements. Hence, generally, every institution devises special apparatus of its own, such as various kinds of pillows; bandages attached to the table; the hands of an attendant (which is a dangerous practice); the combined employment of sand bags, girdles, and compressor diaphragms, &c. But the result is, frequently, that the picture is not sharp, and, owing to the great importance to diagnosis which is to-day ascribed to the plate showing structural alterations in the bones, it is necessary to eliminate the error of appearance of foggy structure due to the even slightest movement of the patient.

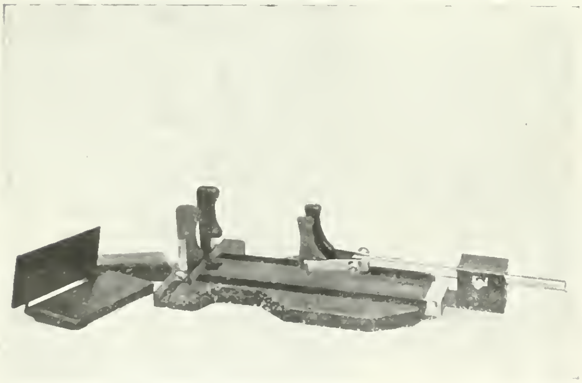

FIG. 1. THE SKIAFIX.

An additional disadvantage, in connection with radioscopy as generally practised now, is that patients with fractures of the extremities, or having injuries to the skull or neck, are brought into the X-ray chamber on a stretcher or bed, then moved on to the X-ray table, and subsequently replaced on the bed. This is not only disadvantageous to the patient and his complaint, but may actually do considerable harm, and is rightly dreaded by the patients as the torture of radiography, because it is impossible for it to be carried out without pain, especially in the case of those who lack, or have small power of, self-help. Quite apart from the fact that this procedure necessitates time and attendance, the radiographer, as well as the patient, are equally interested in the desirability of avoiding these changes of position by the introduction of a simple and useful device. Not less painful for the patient, and troublesome for the physician, is the operation of moving the patient on to his side, for taking side-way exposures of the lower limbs. A simple apparatus is required,

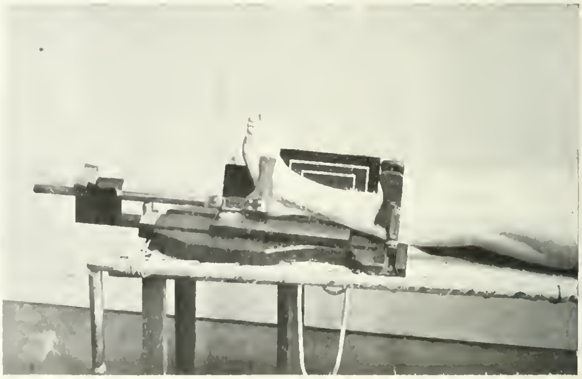

FIG. 2. ADJUSTMENT FOR SIDEWAYS AND VENTRO-DORSAL EXPOSURE.

One, Two & Three Phase MOTORS.

LANGDON-DAVIES MOTOR CO.

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"THOR" High Grade Specialities

CASING and CAPPING
CONDUIT
CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
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Cables for Lighting, Power,
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HELSBY
CAB-TYRE SHEATHED CABLES.

(Patent No. 3996 11.)

Just the thing for Breweries, Chemical Works, Collieries, &c., where the conditions are necessarily somewhat trying and cables are subject to ravage, scathe, impairment, injury, outrage, corrosion, degradation, oxidation, and hob-nailed boots.

Exempli Gratia.

The Engineer of an important Gas Works tells us that our cab-tyre sheathed cables emerged from the following test with flying colours:—

> "After being soaked for 4 hours in oil of vitriol, they were then placed in flue gases chiefly composed of carbon dioxide and a little sulphur dioxide with a varying temperature ranging from 82°F. to 180°F., and averaging 130°F., for 96 hours."

BRITISH INSULATED & HELSBY CABLES.
LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
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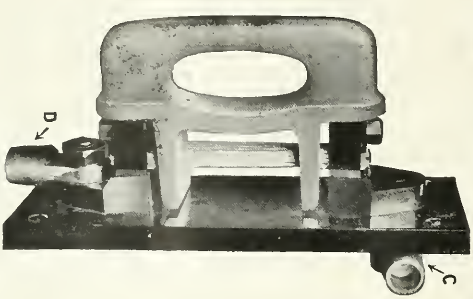
AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

D. & S.
"HANDLE" FUSES,
50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.



DORMAN & SMITH Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

with which the patient need not alter his reclining position on the stretcher, trolley, or bed, the stretcher being placed on two stools or chairs, so that it is not necessary to work on the floor.

The Skiafix is a simple fixing apparatus, illustrated herewith, which is made almost entirely of wood, and serves for the purposes described. It consists of a base board 20 in. long × 12 in. wide, with two adjustable rests and clamping jaws capable of being rotated and adjusted lengthways, and drawn out of a slide to a length of 4 ft., the two cheeks of which each remain rigid in any position. The board is recessed on each side to admit the shoulders when taking side exposures of the head. Two grooves are provided in the longitudinal direction, which serve to carry the dark slide or plate holder for side exposures. Two supports may be inserted under the apparatus, which raise it about 6 in. for fixing the patient comfortably for side exposures of the head. The apparatus is suited for use with any kind of protective device, and can take, in all cases, even with the plate-holder, a dark slide as well as a plate with paper wrapping.

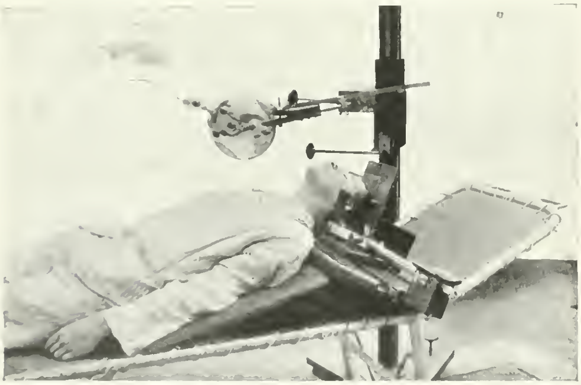


Fig. 3. Base and Top of Skull Fixing.

The length of the apparatus is 21 ins. and the weight 11 lbs., so that it can be handled by anyone quite easily, and may be used as an accessory to all portable X-ray outfits as well as Army field X-ray equipment. In addition, the weight of sand bags is saved.

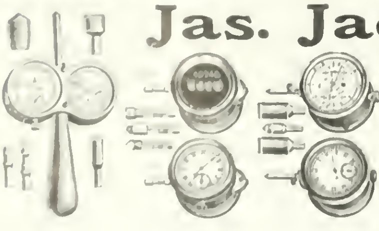
The employment of the apparatus, which although at first sight is quite obvious, is carried out in detail as follows: When using the plate-holder for two exposures it is advisable to make the side exposure first, so that the limb is brought into the correct position relative to the plate-holder, at the commencement. On removing this holder, the second dark slide or plate for the ventro-dorsal exposure, is pushed immediately under the wood support below the limb, so that the part to be exposed is once and for all properly fixed for both exposures. It is advisable to employ a tubular diaphragm when using the plate-holder, so that only the limb comes on to the plate, and not the shadow of the wooden support.

In order to take the base and top of the skull, a wedge-shaped bolster is placed below the shoulders, and the apparatus with the plate-holder is inclined at an angle so that the head falls as far backwards as possible. The neck then lies firmly in the shoulder recess, whilst the head is supported on one side by the rests, and on the other by the wide open clamping jaws. This form of exposure, which can easily be made with the Skiafix, has, we understand, been little known up to the present, and should be of considerable interest for examination of the base of the skull, and of the conveniently projected temporal bone (middle ear process).

Successful fixing, which has been so difficult to attain up to the present, is of the greatest importance for head and neck exposures. It has been established that quite apart from sharp projections of the basis bones, further details can be brought to light than have been so far obtained. These may all be obtained quite easily with the Skiafix. It is claimed that the apparatus fulfils the following purposes: enables all parts of the human body to be fixed suitably in any position; enables foreign bodies, &c., to be localised in the skull by simple exposures in three planes; renders the removal of the patient to a special X-ray table superfluous for all exposures; renders it unnecessary to move the patient on to his side in the case of side exposures of the lower limbs, so that the patient is not obliged to leave the bed in which he has been brought in or even to alter his position; saves expensive special devices, trouble, time and attendance, and, in the case of the patient, pain and danger.

The advantages of such an apparatus are also of the greatest importance for X-ray technique in war, where it would undoubtedly play a valuable part owing to the large variety of wounds encountered.

The foregoing details and illustrations are taken from Supplement No. 9 to catalogue No. 506 just issued by Siemens Bros. & Co., from whom copies can be obtained.



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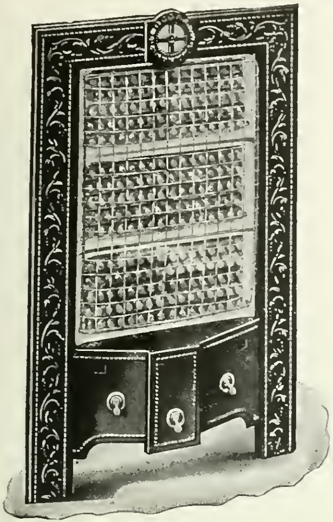
Combined Revolution Counters, with Chronograph.
Very Accurate Timekeepers.
CHRONOGRAPH AND STOP WATCHES.
Lists on Application.



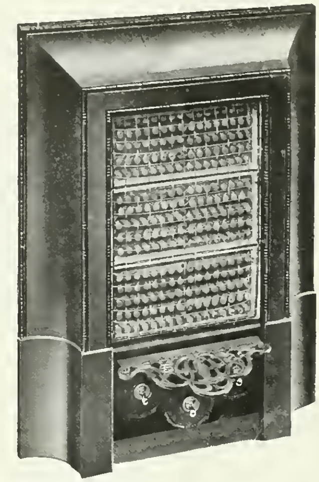
No. 209.—Electric Fire Interior. (Registered Design.)

Order your Electric Fires from Carron——Carron stands for design, quality and service.

Your clients will naturally ask for Carron Fires, but should they omit to specify, give them Carron—for *their* satisfaction and *your* credit.

Fires illustrated require no building in and can therefore stand quite flush against a tiled background—loadings 3000 watts — attractively finished in art black, armour bright or electro brass or bronze.

¶ **Write for New Season's List (No. 22 M) and learn more fully the merits of these popular fires.**



No. 203.—Electric Fire Interior. (Reg. Design.)

By Appointment.

CARRON COMPANY

INCORPORATED BY ROYAL CHARTER 1773

Works
CARRON, STIRLINGSHIRE.

Showrooms: LONDON—(City) 15, Upper Thames Street, E.C.; (West End) 50, Berners Street, W.; LIVERPOOL—22-30, Redcross Street; BRISTOL—6, Victoria Street; BIRMINGHAM—218, 220, 222, Corporation Street; NEWCASTLE-ON-TYNE—13, Prudhoe Street; EDINBURGH—114, George Street; GLASGOW—125, Buchanan Street.

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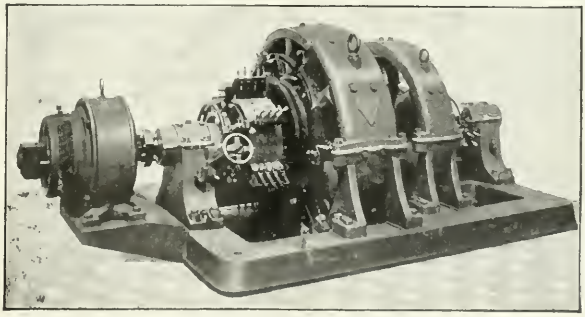
Motors and Generators of all types.

Rotary Converters.

Complete equipment for the electrical lighting and driving of Machine Shops, Factories, Mills, etc



250 K.V.A. Rotary Converter. 6 phase, 50 periods, 480/560 Volts.
1,000 r.p.m. Inverted type.

Patent Automatic Reversing Drive for Machine Tools.

River Don Works, SHEFFIELD.

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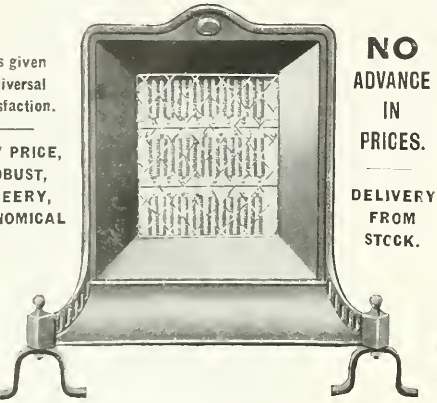
ARORA
ELECTRIC
FIRE



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LOW PRICE, ROBUST, CHEERY, ECONOMICAL

NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

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to Sole Manufacturers—
THE ARORA CO., LOUGHBOROUGH.

Canadian and Indian
MICA
CUT, SLAB & SPLITTINGS.
MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.
Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
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Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,
Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).
Hopwood St. Mills, PRESTON.
Established 1868.
Codes: 5th Edition A B C & Western Union

WEATHERPROOF LANTERNS FOR INDUSTRIAL LIGHTING.

Although at the present time outdoor lighting is conspicuously subdued, this is, of course, not due to the absence of suitable lamps or fittings. When the removal of the temporary lighting restrictions becomes advisable, the opportunity will come to bring up to date existing systems of outdoor illumination. The introduction of a wide range of sizes of half-watt lamps has been accompanied by the evolution of an equally extensive series of lanterns and reflectors for use with them. These fittings have been designed specially to suit the characteristics of high efficiency lamps, with the result that outdoor illumination may be carried out, not only on correct scientific lines, but may be of an agreeable character. In anticipation of the coming demand for improved outdoor lighting schemes, the British Thomson Houston Co. (Ltd.), Mazda House, 77, Upper Thames-street E.C., has published a 44 pp. catalogue devoted exclusively to the subject of weatherproof lanterns, street lighting fittings and accessories, ironclad ship and mill fittings, for use with standard and half-watt type lamps. It is one of the most comprehensive lists of its kind we have yet seen, and it illustrates and gives details of a number of fittings that are quite new in design.

Large numbers of arc lamps and clusters of glow lamps that no longer represent the highest degree of economy, are being replaced by half-watt type lamps in conjunction with special reflectors and lanterns, and the process of changing over—checked to some extent by war conditions—will be accelerated when street lighting authorities and industrial users are able freely to take advantage of recent developments. Half-watt type lamps are now available in sizes from 15 to 1,500 watts, and for voltages between 25 and 255. They can be used on alternating-current circuits of any frequency down to 25 cycles, and may be run satisfactorily singly on high or low voltage direct or alternating-current supplies, or in series to replace groups of arc lamps. Their efficiency compares favourably with any type of arc lamp, while the absence of moving parts, their steady, uniform and intensely white light, their long life and low maintenance costs, are advantages that no user can afford to neglect. Owing to the high temperature at which the half-watt type lamp operates, it is essential that, when used out of doors, it should be thoroughly protected from the weather, particularly from driving rain, and that adequate provision be made for ventilation, while providing for scientific distribution of the light. These points have received careful attention from the makers, whose lanterns reach the highest standard both as regards the form of light distribution and the efficiency of the reflecting surfaces employed.

Among the new weatherproof models listed are the "Strela" cast-iron lantern, with vitreous enamelled reflector; the "Globa," the "Alabas," the "Ilstra" street lighting unit, and the "Radial Wave," all of which are suitable for Mazda half-watts. These provide in every case for adjustment of the total length, so that lamps of different size may be employed in the correct position relative to the reflector. The B.T.-H. series incandescent street lighting system provides for the replacement of arc lamps on series circuits without altering the existing circuits, substitutional resistances with automatic cut-out for each lamp, constant current transformers for each circuit, with an automatic film cut-out for each lamp, or an automatic film cut-out for each lamp only.

Copies of this catalogue, which gives full information as to construction, dimensions, applications and prices, may be obtained by readers interested in street and industrial lighting.

THE ESSEX Accumulator and Dry Battery.
HAND LAMPS, INSPECTION SETS, TORCHES,
POCKET LAMPS, ACCUMULATORS, ETC.
List on Application.
THE ESSEX ACCUMULATOR CO.,
197 GROVE GREEN ROAD, LEYTONSTONE, LONDON, N.E.
[illegible]

FOR EFFECTIVE IMPREGNATION
USE
"LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON LTD Insulating Varnish Dept
GOSWELL WORKS, STRATFORD, E.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, November 24, 1916.

THE ROUND TABLE.

By "KVA."

It is, I understand, incorrect, to assume from the new Osram posters that Mr. Fletcher is suffering from an attack of elephantiasis.

* * * *

My sympathies are with the Trent Navigation Company, who have just opened at Keadby a lifting bridge over the Trent, which is built on the Scherzer* principle. Surely such a bridge must always be in the wash!

* * * *

I understand from the B.T.-H. Co., Rugby, that the catch-line "A Twitch of the Switch," which I attributed last week to Mr. Nobbs, of the Falkirk Company, is by no means new. The G.E.C., of Schenectady, can claim parentage in a booklet which they issued in 1911, urging the domestic importance of switch twitching. Not that it matters very much so long as this habit can become popular. Why not commission Wilkie Bard or George Robey to work up some really knobby song on the idea?

* * * *

The Western Electric Co. are justly proud of the fact that to one of their employees has fallen the honour of winning the first V.C. awarded in the electrical industry. Private F. J. Edwards, Middlesex Rifles, was before the war engaged in the drum-making department at the company's Woolwich works. He is a member of a fighting family, his father and two elder brothers being with the Forces. He received the coveted award for conspicuous bravery and resource. His part of the line was held up by machine gun fire and all officers had become casualties. There was confusion and indication of retirement, but Private Edwards on his own initiative dashed out alone towards the gun and knocked it out with bombs. This gallant act made our further advance immediately possible. The Western Electric Co. will now be able to claim that they do not merely turn out good telephones and cables but also "first-class" soldiers.

Private Edwards, 1st Electrical V.C.

---

* Pronounced Shirts-er.

OUR FIRST SHUT-DOWN.

The hour of lunch was drawing nigh,
The plant was running sweet as pie;
But who'd have thought that by and by
We'd get a cruel blow?
The record that has stood so long,
Proclaimed in verse, extolled in song
Through Britain and the Continong
At last has had to go.

The Resident sat in his chair,
His thoughts were back again to where
In days gone by he'd breathed the air
Of Cymru's purple hills.
He dreamed of crags he used to scale,
Of cliffs attacked in snow and hail,
Of stunts that made the sheep turn pale
And white about the gills.

The Second chewed a stumpy pen.
Sub-consciously he murmured: "When
Those costs are coming down again
I really cannot see.
Since every week the Chief expects
The lot of us to break our necks
To drop the curve at least *dx*
There is no peace for me."

The Engineer-in-charge was full
Of competitions in "John Bull,
By which a chap of normal skull
Could make a quid a day.
The Switchman's thoughts were with the girls,
Buying for one with wavy curls
A string of imitation pearls
With half his next week's pay.

The Driver cogitated what
Were best to do, to risk the lot
On tips from "Our Man-on-the-Spot"
Or "Hawkeye's" nap selections.
The Leading Fireman pondered how
Last night when at the "Spotted Cow"
His wife came in and caused a row
By most ill-timed objections.

But suddenly there comes a shout:
"The volts are off the scale, Look out!"
Th' exciter's gone, without a doubt.
Now comes the busy time.
At once the seemingly inert
Men spring to life, put on a spurt,
And quickly all stray throughts divert
Along the proper line.

Commands are uttered, prompt and terse
With now and then an added curse
To help them on (pray think no worse
Of us for doing that).
Another set is soon away,
Supply's restored and quite OK
Before the public's time to say
"I wonder what they're at."

"A smart performance," says the Chief;
But even that brings no relief
To sorrowing hearts bowed down with grief.
Our pride is in the dust.
Gone is the swank of yesterday,
Vain glorious boasts were washed away
When on that thrice accursed day
Th' exciter went and bust.

* * * *

THIRTY-SEVEN YEARS AGO.

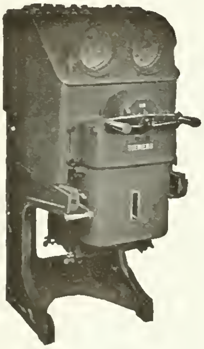
(From The Electrician (Second Series), November 29, 1879.)

Electrical Apparatus for America. We are so accustomed to hear brother Jonathan crow over his exports to benighted Britain, his potted porridge for Scotland, his canned Christmas pudding for England, and his tinned potatoes for Ireland, that we shall, perhaps, hardly be credited when we affirm that a well-known London firm of telegraph engineers this week shipped a large consignment of telegraph plant to Chicago.

L. P. S.
CLIPS, TIPS & TERMINALS
of all descriptions.
Write for Booklet, with Illustrations, of 75 types to:—
THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

SIEMENS



IRONCLAD
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Distribution Boards
Main Switchboards

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Head Office: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: Gerrard 860. Telegrams: "Siembralos, Vic, London."
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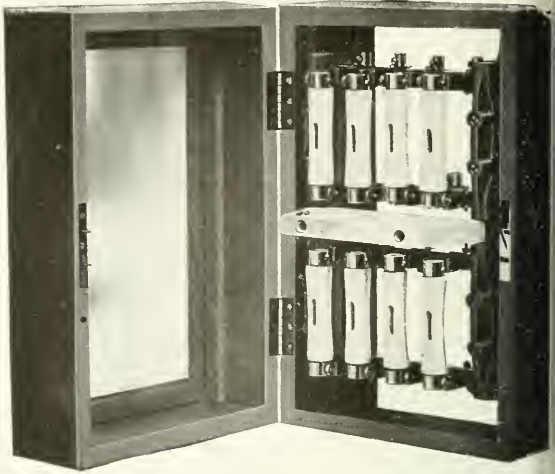
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

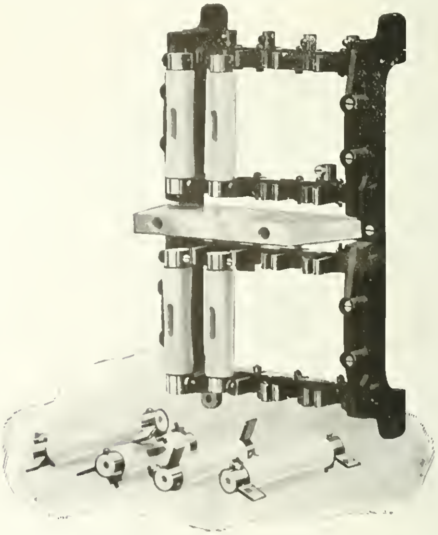
A NEW "DIS." BOARD.

A distinct departure from the ordinary in the way of distribution fuse boards is made in the design which Messrs. Wm. Sanders & Co., Wednesbury, are manufacturing and putting on the market. The type of fuse carrier employed follows standard practice, it being of the procelain tubular pattern with slots in the centre through which the condition of the fuse can be ascertained. It is the construction of the fixed fuse contacts that shows interesting modification from existing methods. The china base with its frail structure and large creepage area and the slate base with its friable edges, hidden metallic veins and capacity for moisture have been dispensed with. Rigidity of construction has been aimed at and achieved in the use of vertical metal bridges which are fixed by four screws to the wood wall-battens or the bottom of the teak or iron glazed containing case. The illustrations show how these bridges are provided with stout metal clamps, each held by two screws and securing in place the bus bar and insulated bar for each pole of the circuit. To these two bars are attached the terminals and spring clip contacts for the fuses. A special and patented form of clip is used which makes electrical and mechanical contact with [illegible] of the sectional area of each bar. The fuse contacts for the distribution circuits are mounted on a bar insulated with moulded mica; the common bus bars are also insulated from the bridge supports or frame by moulded mica. The main feeder terminals are also of the patent clip form and can be clamped on to the bar at any desired point between the fuse contacts. This is a great convenience when wiring up with large sized conductors. Between the two halves of the board a heavy insulating barrier is placed and is held in position by two long screws.

The construction leaves ample room behind the fuses for wiring and the absence of china or slate bases gives a clear view to trace out the connections to all fuses, a fact which is also conducive to neat laying up. One of the defects of the contact base system of fuse board is thus obviated by the new board illustrated herewith. We understand that the mica insulation is subjected to a flash test of 2,000 volts and that all current carrying parts are generously proportioned. Needless to say this form of fuse board is what we may call climate proof and is little liable to breakage in transit.



Sanders' Fuse Board complete in Teak Glazed Case.



Sanders' Fuse Board shown Removed from Case.

The boards are offered in four sizes, up to any number of ways, 5-15, 30, 60 and 120 amperes, and can be supplied with teak or iron glazed cases.

A price list is available and may be obtained from the makers at Falcon Electrical Works, Wednesbury.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
'Phone: Victoria 4026. Grams: Victminster, Sowest, London.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
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Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
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Static Condensers.
Pole Line Steelwork.
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Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
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Overhead Equipment.
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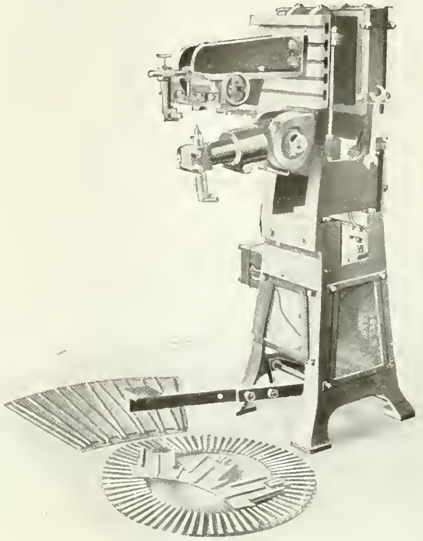
Knife Switches.

PRESCOT ELECTRIC WELDERS.



No. 47 WELDER.

This machine was specially designed for attaching the distance pieces to dynamo and motor ventilating plates. The strips may be plain, rectangular, or other sections.

We make many other types of Spot, Seam and Butt Welders.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

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AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

BASTIAN METERS FOR DIRECT CURRENT ONLY.
Made in ENGLAND with
BRITISH CAPITAL and BRITISH LABOUR.
THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

WESTINGHOUSE RESISTANCE UNITS.

The resistance units listed in Control Catalogue 76 1B are intended for use in various instruments and apparatus, and as will be seen from Fig. 1, the units are made in five different types, according to length and diameter. Each type, however, has a number of different windings giving a considerable range of both resistance and current-carrying capacity, as is shown in the following table:—

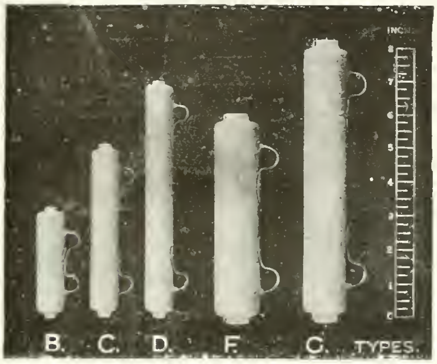

Fig. 1.—Relative Sizes of the Different Types of Units made.

Type.	Length of unit.	External diameter of unit.	Resistance in ohms.	Continuous capacities in amperes.
	Inches.	Inches.		
B	3¼	7/8	0·033 to 55·0	30·0 – 0·23
C	5¼	7/8	0·066 to 1,100	25·5 – 0·198
D	7	[illegible]	0·10 to 1,650	23·5 0·15
F	6¼	1 3/8	0·13 to 2,200	26·0 0·13
G	8 [illegible]	1 [illegible]	0·20 to 3,200	24·5 0·08

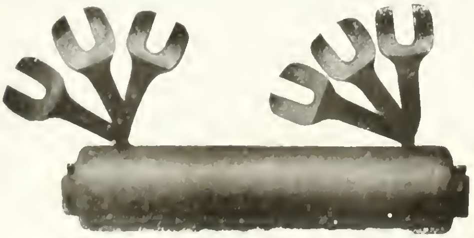

Fig. 2.—Detail View of Resistance Unit.

Each winding is given a different catalogue number, and this number is stamped on the brass terminal strips. When ordering it is sufficient to give this catalogue number. A split steel or porcelain tube is covered with an insulating cement on which the resistance wire is wound. The ends of the wire are attached to flexible terminal strips which provide an easy means for connecting up the units. The resistance wire is finally covered with a second coating of cement which protects it against corrosion and mechanical damage. The finished appearance is shown by Fig. 2. The resistance of every unit is guaranteed by the makers to be within 5 per cent. of the value stated in the catalogue, and all units are subjected to an insulation test of 1,000 volts between the steel core, where used, and the winding.

Particulars of five different ratings for each style of unit are given in the catalogue. These will, it is thought, be sufficient for most requirements, but the company will be pleased to send lists of special ratings on receipt of inquiries, stating particulars of the service.

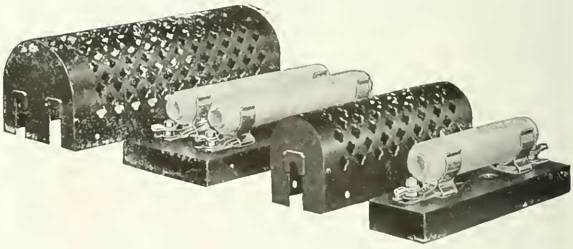

Fig. 3.

It is sometimes required to mount the units singly or in pairs on an insulating base, and Fig. 3 shows a group of units mounted thus. The units are recommended for use in motor starters and all types of controllers, for instruments with telephone and telegraph apparatus, in the laboratory, for arc lamps or series burning half watts, in lightning arresters (without iron core).

The units have large heat absorbing capacity with maximum radiating surface, and the resistance material is completely protected against both corrosion and mechanical damage; the resistance coefficient is nil. The units obviate all complicated and troublesome connections in the resistance box and they facilitate the replacement of burnt out resistances.

We understand that these units have been specially tested and approved by the British Admiralty and will be accepted in lieu of the resistance units specified by them.

The British Westinghouse Electric & Mfg. Co. will supply fuller details and prices.

THE ESSEX Accumulator and Dry Battery.
HAND LAMPS, INSPECTION SETS, TORCHES,
POCKET LAMPS, ACCUMULATORS, ETC.
List on Application.
THE ESSEX ACCUMULATOR CO.,
497, GROVE GREEN ROAD, LEYTONSTONE, LONDON, N.E.
[illegible]

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
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TRADE MARK. SEA CLIFF
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

A few pages from "MY LIFE"

Published to interest the public in Pope "Elasta" British Made Wire Lamps. A quantity of these booklets will be sent to any Electrician who will co-operate with us to broaden "Elasta" sales.

POPE
ELASTA
WIRE LAMPS

are of unusual strength. They withstand vibration. The filament never becomes brittle. They retain their brilliance to the last.

"Elasta" Lamps are being advertised in the "dailies" and "weeklies"—a demand is being created—there is good business to be done. Our terms will interest you—and profit you.

Write for particulars to-day and copy of "My Life" Booklet, No. 8.

Pope's Electric Lamp Co., Ltd.
Hythe Road, Willesden, London, N.W.

H. Weidmann, Ltd., Rapperswil, Switzerland.

WE ARE SPECIALISTS IN THE MANUFACTURE OF—

PRESSPAN (3)

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Best Quality.——Proved by repeated tests.

Sheets in thickness from 0·1 upwards.
Endless Rolls and Strips from 0·1 to 1 mm. thickness.
Presspan Coils and Tubes for Transformers.
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VARNISHED PRESSPAN. BLACK PRESSPAN.
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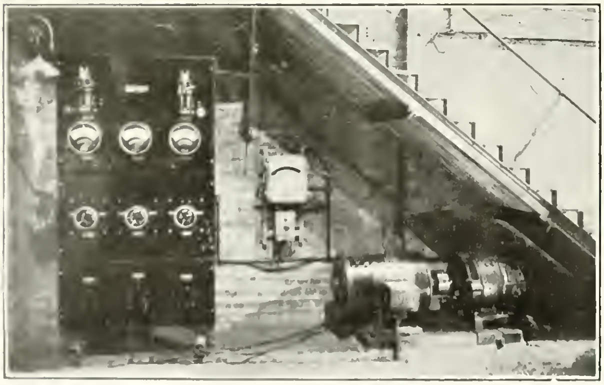
Grand Prix: Marseilles 1908. Gold Medal: Berne 1914. Silver Medal: Paris 1900.

VEHICLE BATTERY CHARGING OUTFITS.

The standard charging outfit for battery vehicles used by the Birmingham Corporation consists of a D.C. motor generator set, with a control panel for two battery charging circuits, one or more of these standard charging outfits being installed at each station as found necessary. Each motor generator set consists of a D.C. shunt-wound motor direct-coupled to a shunt dynamo having an output of 15 kw., both machines being mounted on a common bedplate. These sets are assembled by the Corporation's own workmen, the motor being taken from the "hire purchase" stock carried by the department, whilst the dynamo is specially purchased for the purpose, both machines being mounted on a common bedplate made locally. The charging panel for two circuits has mounted upon it the instrument and apparatus recommended by the Electric Vehicle Committee, and includes a resistance in series with each charging circuit of such an amount that the charging current into the two batteries in parallel can be varied to suit their condition.



Typical Motor Generator and Battery Charging Equipment, Birmingham Corporation.

The number of electric vehicles now being charged at the stations of the Birmingham electric supply department is steadily growing, and at the present rate of progress it will not be long before the available accommodation will be severely taxed. It is probable that after the war a scheme for the hire or hire purchase of charging outfits to vehicle owners may be inaugurated by the Corporation, which will help to relieve the threatened congestion, and at the same time make it possible for the very valuable mid-day boost to be given to the battery at the premises of the owner. At present, owing to the loss of time in bringing the vehicle to the charging station, the mid-day boost is rarely taken advantage of. The electric vehicle garage so common in the United States has not yet made its appearance in Birmingham, although such a garage with a moderate inclusive monthly tariff to cover battery charging, vehicle cleaning, [illegible] and storage would meet a real want, and should be a [illegible].

An interesting equipment for battery vehicle charging is in use by Messrs. Davis & Mawson in connection with their Baker electric vehicles.

This plant has been designed to charge a vehicle battery of 42 I.M.V. 5 Ironclad Exide cells without requiring attendance. It is foolproof both on the motor and the accumulator side. The plant consists of a single armature motor generator, to bring the 440-volt current of the supply down to 110 volts 40 amperes. The field coils are wound for 440 volts.

The switchboard consists of one high-tension or motor panel, having the following instruments: One 50-ampere double-pole main switch, one 50-ampere double-pole main fuse, one 50-ampere automatic cut-out, the solenoid of which is controlled by the battery current at 84-110 volts. This battery current is taken from the lorry by a thin flex from a small plug. The leads of the plug are connected, one to the lever blades of the Sangamo auto-cut-out on the vehicle, and the other to the opposite pole of battery, no matter where. The automatic cut-out on the switchboard is fitted with an overload cut-out, which interrupts the circuit of the solenoid and thus releasing the automatic switch should the supply current become dangerously high (viz., through insulation of the machine giving out or short-circuit in battery or any other part of the plant). On the switchboard is also one D.C. motor starter with no-voltage release.

The second panel of the board is fitted with one ammeter reading to 100 amperes, one voltmeter reading to 120 volts, one Record automatic cut-in-cut-out, one 50-ampere double-pole main switch, one 50-ampere double-pole main fuse. Two terminals to connect to the charging plug. A permanent resistance of 0·3 ohm is inserted between one of these terminals and one of the leads of the charging plug. This resistance prevents the voltage of the charging current rising beyond 2·3 volts per cell, when it gets above 1 2 standard rate, but allows the voltage to rise slowly as the C.E.M.F. of the battery comes up, the charging current tapering off until the voltage rises to 110 volts. The battery will then be fully charged and the Sangamo automatic switch will break the circuit and in turn will knock off the automatic switch on the switchboard and cut off the supply current. The Record cut-in-cut-out will disconnect the battery circuit and the no-voltage release of the starter will release the starting lever, so that everything comes to a position of rest ready to start again. The following are the instructions to start the plant:—

1. Put the charging plug in receptacle.
2. Put the small plug in its receptacle.
3. Push the Sangamo auto-switch in.
4. See that all the main switches are in.
5. Push the main auto-switch in.
6. Start the motor and the Record auto cut-in-cut-out will establish the battery circuit at the proper voltage.

Needless to say, Messrs. Davis & Mawson find this semi-automatic charging plant an immense convenience, because the unskilled labour can be relied upon to put the battery on charge at the end of the day.

LEADING-IN BUSHES.

Leading in bushes are employed for a variety of purposes in electrical work. In some instances a bush of fairly large diameter, it may either be plain or screwed, is frequently called for, while in

ENGLISH EDISWAN EVERYTHING ELECTRICAL

The house of Ediswan is the best equipped to deal with all enquiries for

Everything Electrical.

ENTIRELY BRITISH.

The Edison Swan Electric Co., Ltd.
PONDERS END, MIDDLESEX.
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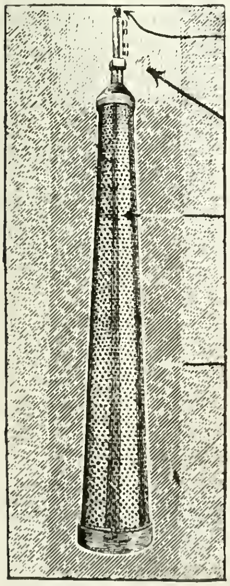
The Paragon Earth Cone



Where it may be used with advantage.

Electric Tramways and Railway Systems, Telegraph, Telephone, Electric Light, Power, Steel Chimneys, and any form of Lightning Conductor.

In Electric Railway and Power Systems, the Paragon Cone provides the extremely low resistance ground required for proper protection of relays, transformers, &c.

In Telegraph and Telephone Installation the Paragon Cone provides the efficient ground such services require.

The Paragon method is the safest and surest method. Supersedes the Earth Plate.

Write for Illustrated List which explains it in detail.

SCHOLEY & CO., Ltd.,
56, VICTORIA STREET, LONDON, S.W.

MAZDA

Half-Watt Type LAMPS give arc light effect without arc light troubles

They need no adjusting because they have nothing that *can* be adjusted.

They need no trimming because they have nothing that *can* be trimmed.

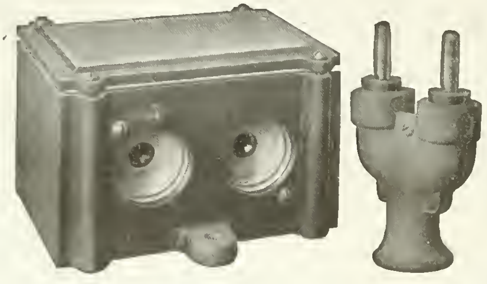
They need no attention because they have nothing that *can* require attending to.

MAZDA HALF-WATT TYPE LAMPS do not flicker—they ensure a steady, constant flood of brilliant light as long as the switch is on.

The British Thomson-Houston Co., Ltd.,
Mazda House, 77, Upper Thames Street, London, E.C.

Branches:—
Manchester, Birmingham,
Leeds, Sheffield, Newcastle,
Middlesbrough,
Glasgow, Swansea,
Cardiff & Dublin.

BRITISH MADE IN RUGBY, ENGLAND.



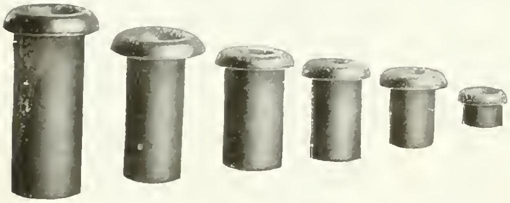
IRONCASED SOCKETS & PLUGS
FOR HARD SERVICE.
Sizes up to 200 amps.
D.P. and T.P. 500 volts;
with "earthing" connection.

Also Combined Switch and Plug Boxes.

DORMAN & SMITH, Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

connection with motors and dynamos a rather different type is demanded being of small diameter, but of much greater length in order to carry the cables clear of the machine shell.

These bushes have in the past been made of rubber, micanite and wood, while moulded insulation has little been resorted to despite its obvious claims. Users of these classes of bushes will probably find an extensive range of plain and screwed bushes, manufactured by the General Electric Co. (Ltd.), 67, Queen Victoria-street, London, in their insulation department, Witton, Birmingham, of utility to them in these directions. Capable of manufacture in large quantities with great rapidity and cheapness they can be used to replace bushes made of other materials. Their accuracy of moulding and neat appearance give them fuller claims to consideration.



Samples of one pattern of leading-in tube are shown in the illustration, and are but typical of the hundreds of patterns manufactured at Witton. The General Electric Co. (Ltd.) will be glad to quote for their standard bushes or special patterns in any grade of insulation, including Bakelite, to suit the user's requirements. These bushes are also made both plain and screwed with external and internal threads in great variety.

MAZDA LAMP HANDBOOKS.

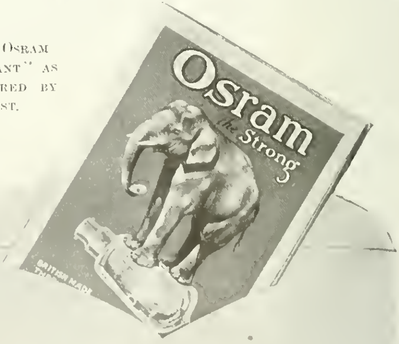
We have received from the B.T. H. Co., Ltd., of Mazda House, 77, Upper Thames-street, E.C., a copy of their handbook No. 1, the first of a series of incandescent lamp handbooks they are issuing. It gives much useful information and data regarding Mazda lamps of both vacuum and half watt types, suitable for general illumination, train lighting, projector work, &c. A glossary of technical terms used in connection with glow lamps is also a feature of this first handbook, which gives in addition rules and terms for the sale of Mazda lamps to private consumers, trade users and re-sellers.

All the forms of standard lighting lamps falling under the heading of group 1, are illustrated to scale, accompanied by full details as to size, type of cap, efficiency, wattage, voltage range, illuminating output in lumens, standard packing quantities, &c. Diagrams are also included showing full-size illustrations of the various styles of caps fitted to lamps in Group 1.

This Handbook is one of the most complete yet published in connection with incandescent electric lamps, and readers who have not received a copy can obtain one by writing to the address given above. The data contained should be studied by all who have to do with the sale and installation of metal filament lamps, and this handbook with its 52 pages forms a notable contribution to the trade literature on the subject.

OSRAM LAMP TRADE LITERATURE.

The G.E.C. have completed their publicity arrangements for the ensuing lamp season and are, we understand, now in a position to supply posters, show-cards, window-signs, and similar suitable material for the use of the trade during the dark days which are now upon us. A novel design has been adopted for the show-card and other literature, and this is shown in the adjoining illustration. It is certainly an effective method of conveying to the public mind the claim that above everything else the Osram lamp is strong. The pamphlets and printed material generally are now available for the use of the trade, and in certain instances the name and address of the contractor, merchant or trader can be overprinted without extra charge. It is probably not necessary to state that the use of this literature is very helpful to the carrying on of lamp sales and previous experience has shown that there is a considerable demand for it on the part of lamp sellers.



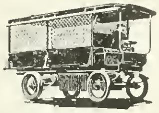
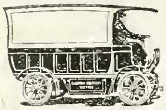
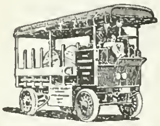
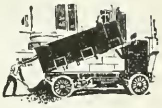
The "Osram Elephant" as delivered by post.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

BURNER & HEAT CONTROL
Equipment for Lead Presses
(HALL'S PATENTS).
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

Printed and [illegible] by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 1, 1916.

ELECTRIC VEHICLE PROGRESS

COMMERCIAL BATTERY VEHICLES IN BIRMINGHAM.

One of the moving spirits in the recent revival of the storage battery road vehicle in this country is Mr. R. A. Chattock, City Electrical Engineer and Manager for Birmingham Corporation. Mr. Chattock presides over one of the largest municipal electricity undertakings in the United Kingdom, and he probably holds the record for cheap industrial electric power supply. During the past 10 years the generating plant has undergone a process of centralisation which has enabled the Birmingham Corporation to offer energy for industrial and kindred purposes within the extended boundaries of the city at rates which place all other power agents at a distinct disadvantage.

The growth of the undertaking has naturally resulted in the laying of both high and low-tension mains in districts which, under former conditions of local generation, would have been commercially impossible.

This availability of the electric service within the borders of a vastly important industrial district naturally prompted Mr. Chattock to urge both publicly and privately the claims of the storage battery road vehicle as an economical means of local transport. We have no record of the tonnage of raw material, semi-finished articles and completed goods which is hauled daily within the Birmingham area. Were it available such figures would, we think, give rise to considerable astonishment. In any event, Mr. Chattock was not "scared to death" at the idea of suggesting that a high percentage of this tonnage should be hauled electrically by means of storage battery vehicles.

Facilities have been arranged whereby purchasers of battery vehicles in Birmingham can obtain energy for charging at any time. A uniform low rate for energy has been fixed, and for vehicles which obtain a charge at the Corporation sub-stations the rates for charging have been fixed on a favourable basis. Similarly, those vehicle users who are finding it more convenient to charge the batteries on their own premises have been given useful advice as to the best form of apparatus and the correct method of its employment.

It is with considerable pleasure that we are able to confirm in this issue the interesting fact that Birmingham holds the record for the largest number of storage battery road vehicles in service in the provinces. The illustrations and particulars which we publish clearly prove that in a hilly district like Birmingham the commercial battery vehicle can make good in competition with all other forms of road traction. At one time power vehicle users were content to think that a battery vehicle was out of the question for a hilly area. It did not seem to occur to anyone to try it out, because on the face of things the idea appeared absurd and there the matter has been allowed to rest all these years. One day an enterprising individual comes along with a car and the critics are dumbfounded because it has done what they, in their wisdom, had declared to be impossible.

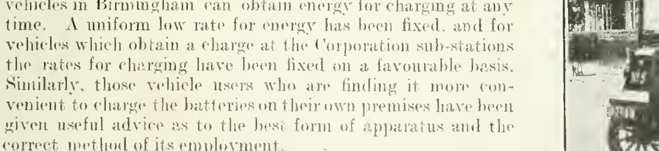
Anyway, there seems little doubt that the battery vehicle has conquered Birmingham, and for that achievement the pioneers of the movement have laid the industry at large under a considerable obligation for "what Birmingham thinks in power road vehicles to-day the rest of the country will think to-morrow."

EDISON ELECTRICS IN BIRMINGHAM.

The revival of battery road traction in Birmingham is attributable to two things: First, the fixing of low rates for electrical energy and convenient charging facilities; and, second, the initial demon-

NOTED FOR BEST BISCUIT BREAD
BRIDE CAKES TO ORDER
GEORGE BAINES
THE LARGEST CASH BAKER IN THE MIDLANDS

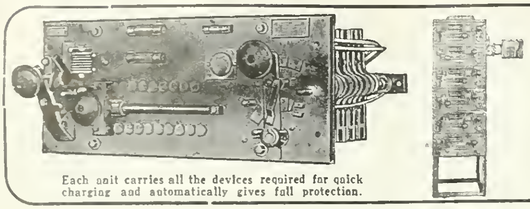
½-ton Edison Electric in Service of George Baines, Ltd.



For Motor Car Lighting.

Made at the Osram-Robertson Lamp Works, Hammersmith, London.

Osram
G·E·C
DRAWN WIRE
Lamps



Each unit carries all the devices required for quick charging and automatically gives full protection.

Begin with one or two units and build up your panel as the number of your electrics increases.

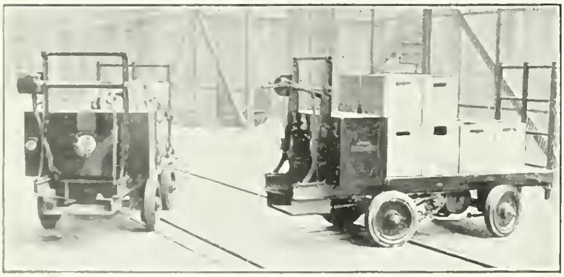
IGRANIC

Unit Type Battery Charging Equipment

is almost as simple to extend as a sectional bookcase. Separate and complete units may be added at any time as more charging circuits are required. Pamphlet No. 627 describes this equipment. Ask us for a copy.

IGRANIC ELECTRIC Co. LTD 147, QUEEN VICTORIA STREET, LONDON.

stration in the city with an actual battery vehicle of its capacity to meet local transport conditions. The credit for the establishment of the first of these is due, as we have said, to Mr. Chattock, the city electrical engineer and manager. The pioneer work which has led up to the second important matter has been done almost entirely by Mr. J. P. Kemp, who in August, 1915, purchased an Edison ½-ton G.M. type lorry, drove it by road under its own battery power to Birmingham, and sold it after a long demonstration period to Mr. Frank Starkey, who has been an enthusiastic user of it ever since. Mr. Kemp is, of course, an enthusiast himself on Edison battery electrics, because, as an electrical engineer, he is convinced of the soundness of the principles on which they are designed and constructed. It is the experience of over 20 years of mechanical and electrical engineering that Mr. Kemp is able to bring to bear on his work of introducing battery electrics. In great measure this fact serves to explain the success which has followed immediately upon his first experiment with an electric vehicle in Birmingham, one of the greatest centres of the petrol motor industry, and showing on the streets and hills of the city that his machine would do all that he claimed for it. We do not propose to go into all the details of Mr. Kemp's ultimate triumph over the many local difficulties with which it was only natural he would be confronted during the course of his campaign. He has broken down a number of the prejudices which have for many years past operated against the electric and prevented its real merits being seen in their proper perspective. Difficulties are not, of course, new to him. He was for several years resident engineer at the Stuart-street power house of the Manchester Corporation, for three years he represented Sir A. B. Kennedy on the electrification of the Mersey Tunnel Railway, and for nearly 7 years was resident engineer at the Summer-lane power station, Birmingham Corporation; also he was for three years chief electrical engineer to the Para Electric Railways Co., Brazil. In these responsible positions he was able to confirm his belief in the immediate future of electricity and its utilisation for the driving of factories and workshops, for commercial and domestic illumination, for cooking and heating, and, above all, for the propulsion of road vehicles for the transport of goods within industrial areas. In this latter regard Mr. Kemp has succeeded in carrying conviction to a number of Birmingham vehicle users who have found themselves in difficulties owing to scarcity and high cost of transport facilities, and have been compelled to seek some alternative to horses and petrol. The large number of vehicles which Mr. Kemp has sold have not, however, been purchased merely because of the famine in vehicles and the famine prices of fodder and fuel, but because practically each machine has been a profitable investment to the purchaser. Mr. Kemp argues from his experience that the purchase of an electric is an investment which will return 30 per cent. and more per annum on the capital outlay, not to mention the incalculable benefits which the purchasers derive from being freed from many worries in matters of maintenance.



Two Edison Automatic Factory Trucks supplied by Mr. Kemp to a Birmingham Munition Works.

Mr. Kemp has explained to us that he has little or no trouble in convincing the prospective power vehicle user of the merits and simplicity of Edison electric vehicles. He is usually able to appreciate these good points at a glance. What he has wanted, and will always want, is to know the *all-in weekly* running cost of the electric for the class of transport service with which he is himself concerned. Mr. Kemp has accepted this cue from the vehicle user and based his arguments upon it. From an extensive experience of a number of vehicles of different classes employed in Birmingham on different kinds of work he can now give this information to a degree of accuracy which is, at any rate, convincing to the prospective buyer.

Reference has been made to the fact that Mr. Kemp took his first Edison electric vehicle down to Birmingham by road. He has since actually driven vehicles from Chelsea (London) to Birmingham in one day with two charges of the battery, one at Luton and one at Rugby. One of the most interesting trips which Mr. Kemp made was with a 2-ton Edison G.M. chassis, with which he covered 132 miles in one day and drove the machine at an average speed of 15¾ miles an hour. He had taken a fresh charge at Luton, and between that town and Rugby drove some 7 miles out of his way to put down at a concentration camp some carpenters whom he had given a lift. At Rugby his mileometer showed that the vehicle had run 64 miles on one charge and was still fresh on his arrival. This vehicle was sold to Messrs. Henry Hope & Sons, manufacturers of builders' fittings, &c.

All the electrics which Mr. Kemp has so far handled have necessarily been of American manufacture, and he is sometimes reminded that there is no home benefit in paying Americans for electrics; but the answer is just simple arithmetic, and Mr. Kemp, without the aid of his ever-ready slide rule, is always able to give it. He states it in perfectly comprehensible terms thus:—

One 3-ton electric, say	£1,000	One American 3-ton petrol lorry	£750
All electrical energy for which is purchased in this country. Therefore in 20 years the U.S.A. receives for one Edison 3-ton electric, say	£1,000	Cost of petrol per annum to U.S.A.	£150
		In 20 years U.S.A. receives for one 3-ton petrol lorry	£3,750

In the centre pages of this issue will be found a number of illustrations of Birmingham battery vehicles and automatic trucks, and among these are several of the grand total of 41 which Mr. Kemp has disposed of during the comparatively short period of 16 months' working. His first customer was Mr. F. Starkey, an enterprising Birmingham baker, who decided to purchase the ½-ton van which Mr. Kemp had used for demonstration purposes, after he had given it a convincing trial on one of his bread rounds.

Another enterprising Birmingham baker is Mr. George Baines, who has a large bakery on the north side of Birmingham. Mr. Baines now has a fleet of five vehicles, three ½-ton and two 1-ton, and these are used daily, except on Sundays, for the delivery of bread over a round of about 5 miles. Four to five journeys per vehicle

"CONSULT KEMP re ELECTRICS."

ROAD VEHICLES, AUTOMATIC TRUCKS, MINERS' LAMPS.
ALL WITH EDISON ACCUMULATORS

The Simplest and Most Economical Forms of Industrial Transport. Can be driven by UNSKILLED Men and Women at less than ONE-THIRD the cost of Petrol.

Each Factory Truck costs less than 6s. per week for Electric Power, and saves the labour of over 7 men.

J. P. KEMP, Grand Hotel, BIRMINGHAM. 'Phone: CENTRAL 7301.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:

Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON. S.W.

AGENTS:—

Birmingham:—
J. P. KEMP,
Grand Hotel, Birmingham.

Lancashire and Cheshire:—
DRAKE & GORHAM, Ltd.,
47, Spring Gardens, Manchester.

Glasgow:—
J. HALLY CRAIG,
45, Hope Street, Glasgow.

BE UP-TO-DATE

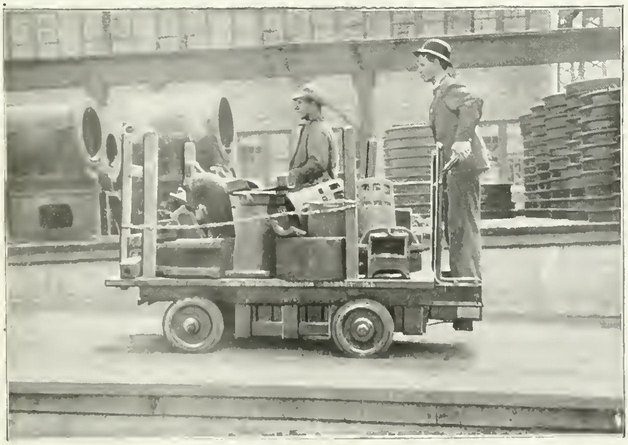
and install BUDA Electric Battery Trucks in your works

TIMKEN-DAVID BROWN WORM DRIVE.

FULL FLOATING REAR AXLE.

FOOL PROOF CONTROL.

ALL PARTS ACCESSIBLE.



BUDA TYPE A TRUCK.

COSTS ABOUT 8d. PER HOUR TO RUN.

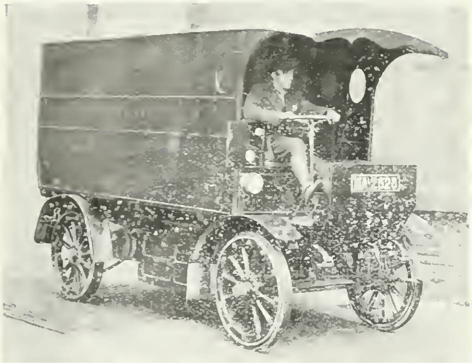
WILL SAVE ITS COST IN A FEW MONTHS.

WRITE FOR DETAILED SPECIFICATION TO

The ELECTROMOBILE (Leeds), Ltd., Neville Street, Leeds.

Telegrams: "ELECTROMOB, LEEDS."

COMMERCIAL BATTERY



A 1-ton Baker Electric carrying Munitions for Messrs. Davis & Mawson.

Two General Vehicle Lorries in Service of Midland Railway Co.

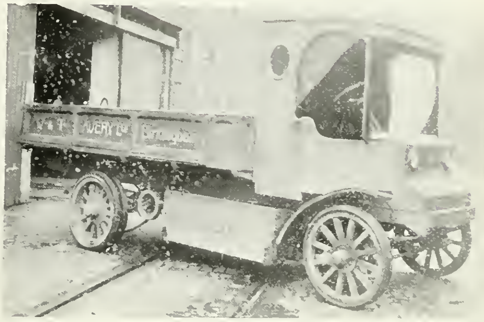
A General Vehicle Truck Doing Hard Duty for A. Kenrick & Sons, West Bromwich.

A Further View of Messrs. Davis & Mawson's Baker Electric

Fleet of Four Edison Electrics in Service of Mr. Geo. Baines.

VEHICLES IN BIRMINGHAM.

½-ton Edison Electric in Service of George Ellison.



The 2-ton Edison Electric used by Messrs. W. & T. Avery (Ltd.)

An Edison 1½-ton Lorry as used by Messrs. W. D. Richards.

One of A. Kendrick & Son's Walker-Edison Lorries.

Two of Mr. G. Baines' Fleet of Edison Electrics.

½-ton Edison Van Sold to Starkey's Bakeries.

The Victoria Tube Co.'s 2-ton Anderson-Edison Electric.

2-ton Edison Electric used by Messrs. Hope's.

Part of Fleet of 41 Vehicles sold by Mr. J. P. Kemp.

TUDOR
Accumulators
FOR ELECTRIC VEHICLES
AT BRIGHTON AND HOVE

About 16 Electric Omnibuses have been in regular service for the past six years, and TUDOR Accumulators have been employed exclusively.

THE TUDOR ACCUMULATOR CO., LTD.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

re made per day. The van bodies have been specially designed by Mr. Baines for carrying bread in trays, to facilitate handling both at the bakery and the shops. There are 25 shops in all to which the deliveries of bread are made, and one vehicle delivers to five shops. At the outbreak of war Mr. Baines had all his horses commandeered, and he purchased several Ford vans, some of which are still in service; but after a short experience with a ½-ton Edison van he decided to extend entirely with electrics. His vehicles are charged at the Handsworth and Alma-street stations of the Birmingham Corporation, and we append particulars of typical bills, which show the weekly cost of electrical energy for battery charging:—

Week ended.	Number of vehicles in daily operation.	Rated capacity of vehicles.	Average cost for electric power per vehicle per week.
August 26, 1916........	3	1—1 ton 2—½ „	8s. 0d.
September 2, 1916......	3	1—1 „ 2—½ „	8 3
September 9, 1916.. ...	4	2—1 „ 2—½ „	7 1
September 16, 1916 . .	3	2—1 „ 1—½ „	7 11

NOTE.—The above figures relate to vehicles actually running, the others being with coach builders for completion of body work.

All the vehicles handled by Mr. Kemp are fitted with Edison accumulators, and the early vehicles were of the G.M. type, with battery mounted under the driver's seat. More recently he has taken up the Walker, Lansden & Anderson vehicles. Messrs. A. Kenrick & Sons, of West Bromwich, have purchased a 3-ton Walker lorry, which is fitted with 60 A8 Edison cells, having a capacity of 375 ampere-hours. Mr. Geo. Ellison, Warstone-lane, is another of Mr. Kemp's customers. Mr. Ellison is well known as a manufacturer of alternating current motor-control gear and circuit-breakers, and he has several works within the Birmingham area, in the conduct of which he finds the electric extremely convenient both for handling raw material and finished goods.

The Edison vehicles which Mr. Kemp has sold are ½ ton, seven; 1 ton, four; 1½ ton, two; 2 ton, three; and 3 ton, two; small Edison factory trucks of 1 ton and 30 cwt. capacity have been sold to the number of 22. Mr. Kemp's customers include Geo. Baines, Ltd., F. Starkey, Thos. Baines, and E. Harding, bakers, W. D. Richards, grocer, W. & T. Avery, Ltd., Victoria Tube Works, Cadbury's Ltd., Mirror Laundries, Birmingham Mint, Stewarts & Lloyds, Tubes, Ltd., Chance Bros., Birmingham Battery & Metal Co., &c.

Regarding the general performance of electrics in Birmingham, there is after 16 months' campaigning on the part of Mr. Kemp no longer need to prove that a vehicle will carry a heavy load under its own battery power to its destination and return without mishap. Mr. Kemp showed initially that the steepest streets could be climbed without difficulty, and that the battery vehicle was a "get there" machine. One of his chief selling points is based on the simplicity of the control, which enables an electric to be driven by unskilled labour, not excluding women labour. Mr. Kemp finds that the best type of driver for the electric is an elderly carter who knows the rule of the road. Given such a man, he undertakes to leave him with confidence in complete charge of the vehicle after less than an hour's tuition. This claim is not difficult of acceptance, because there are about the electric no carburetters, sparking plugs, clutches or gears for the man to be worried with. This class of driver also finds that the greatly superior speed of the electric compared with horses is quite to his liking.

In conclusion, we may say that in Mr. Kemp's experience the scarcity and high cost of motor fuel have focussed attention upon electrics, and now it is found from good hard practical service that electrics will do the same ton mileage as any other type of power vehicle at *one-third* of the cost, it would appear that they are about to receive in this country that consideration which their economical working merits.

Our thanks are due to Mr. Kemp for the facilities which he has given us to obtain the information in the foregoing article, and also for the supply of photographs of a number of his clients' vehicles.

[illegible] Birmingham Corporation [illegible]

CORPORATION FACILITIES FOR CHARGING ELECTRIC VEHICLES IN BIRMINGHAM.

The Birmingham Corporation electric supply department have installed vehicle battery charging outfits at five of their sub-stations in various parts of the city. They are also prepared to further extend these charging facilities to their other generating stations and sub-stations to meet the convenience of battery vehicle owners. Fortunately, at nearly all the stations and sub-stations of the department, it is possible for vehicles which require charging to be run into the premises, where they can be left under cover by the drivers until the charge is completed. As most of the vehicle battery charging is done during the night, the fact that the vehicles can be left all night in safety under the Corporation supervision until they are called for in the morning by the drivers, is one of the greatest importance to those vehicle owners who have not yet installed charging arrangements on their own premises. No payment is required for garaging the vehicles, but as the accommodation available is limited, no guarantee of garage space is, of course, possible.

"Ironclad Exide"
(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.

The number of repeat orders received is the best testimony of the results obtained. Continuous hard work with a minimum of attention day in and day out aggregating 10,000 miles per annum is the record of many sets over the past two years. Some of them have completed

25,000 MILES

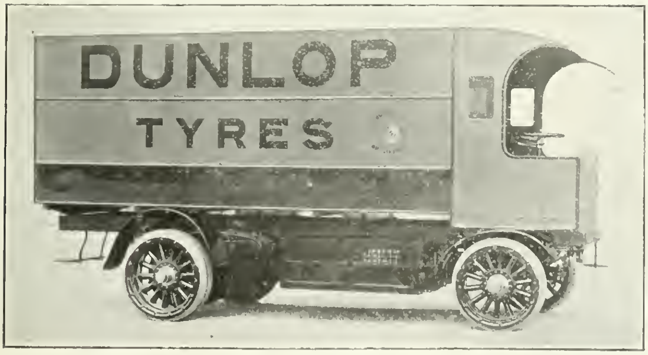
on the road without a single cell having to be removed from the vehicles for any electrical defects whatever.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION,
MANCHESTER.

LONDON OFFICE:
39, VICTORIA STREET.

Current for charging electric vehicles is supplied at power rates, and for vehicles charged at the department's stations a minimum figure of 2s. per charge is made. Regular customers are permitted to send their vehicles six times a week for a minimum weekly charge of 6s, and all extra attendances are paid for at the rate of 1s. a visit. The charge for current is merged in the charge per visit. A charge on a time and material basis is made for any extra work upon the cells beyond the necessary connecting-up and disconnecting. This is considered reasonable by vehicle users who also find it a great convenience.



Baker Electric Van in the Service of the Dunlop Tyre Co.

¶ Pure distilled water for topping-up purposes is supplied by the department to vehicle owners at 4d. per gallon, the water being furnished in 10-gallon carboys. This price includes delivery to any of the stations or sub-stations of the department. The supply of distilled water by the department is much appreciated by the electric vehicle owners, and incidentally should help to prolong the life of the batteries, as there is now very little or no inducement for a careless driver to "top up" the cells with ordinary tap water.

BAKER ELECTRICS IN BIRMINGHAM.

A proof of the interest in the electric vehicle created among petrol motor manufacturers is furnished by the placing on the market some time ago of the Baker battery vehicles by Wolseley Motors (Ltd.). A number of these trucks have been sold to Birmingham manufacturers and merchants who speak well of the manner in which they behave under local transport conditions. The Baker machine is an American product of a factory in which only commercial vehicles are manufactured. It enjoys a good reputation in the United States, and, judging by the experience of Birmingham users, these claims for its efficiency and durability are not exaggerated.

The Baker battery vehicle is fitted with a single motor drive through double reduction, silent enclosed chain and roller side chain gearing. The reduction ratio between the motor shaft of the road wheels of the 1-ton vehicle is 10 to 1, which gives the maximum speed on the level with full load of 10½ miles per hour. A vehicle of this size will carry its rated load over 40 miles of good level road on one charge of the battery. The latter is underslung in the frame between front and rear wheels and is made up of 42 Ironclad Exide, 11 plate cells arranged in six trays of seven cells each. It has a total weight of 13 cwt. and a capacity of 161 ampere-hours. The controller lever is placed under the steering wheel and in the same plane with it; movement to the right gives five speeds forward and to the left three speeds reverse, there being a central off position. The position of the controller handle is conducive to easy driving, and, as is the case with all battery vehicles, by unskilled persons. There are two main brakes of the band type acting respectively on the countershaft and the rear wheels; the former is actuated by pedal and the latter by side lever.

We may mention that the sale of the Baker electrics for the United Kingdom has recently been taken over from Wolseley Motors (Ltd.) by the General Vehicle Co., Imperial House, Kingsway, London.

Users of
G. V.
ELECTRIC VEHICLES

—and they are many—are unanimous in their praise of the G.V., its efficiency and capacity for hard work, its simplicity and remarkable economy.

To you, who fully realise the future possibilities of electric transport the clean design of the G.V. and the sound engineering skill exhibited in its every detail will readily appeal.

The G.V. was a pioneer in electrical transport development and, with fifteen years' experience behind it, it is still in every way the best.

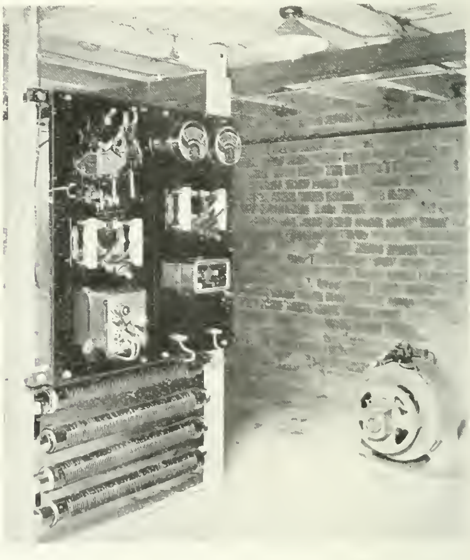
Ask for our Edison Battery Proposition.

[illegible] supplied for Baker Electrics.

General Vehicle Company Ltd.
IMPERIAL HOUSE,
KINGSWAY, LONDON, W.C.

Among the users of Baker and G.V. electrics in Birmingham we may mention the Dunlop Rubber Co., Messrs. Davis & Mawson, F. W. Harris, Henry Sayer, A. Kenrick & Sons, Midland Railway Co., etc.

The Dunlop Rubber Co., whose large works and warehouse are at Aston Cross, Birmingham, have had a 3-ton Baker vehicle in daily service since July, 1915. It is fitted with Ironclad Exide batteries underslung in the crate which will be noticed between the front and rear wheels. This vehicle, as the illustration shows, is equipped with an enclosed body, and it is used for transporting Dunlop tyres of various descriptions from factories to depots in the Birmingham area. In discussing the merits of an electric vehicle, the company states: "One must necessarily compare it with a petrol vehicle of the same carrying capacity, and so far as we are able to judge, the comparison works out somewhat as follows: The electric vehicle has the advantage that it accommodates a larger body, and for comparatively light, bulky loads, such as pneumatic tyres, it offers distinct advantages. The comparatively restricted distance it will travel on its batteries precludes it being used on long-distance service. The somewhat slow speed at which it runs is no serious disadvantage if a large proportion of its time is occupied in loading and unloading. It is free from the mechanical breakdowns and accidents associated with high speed, and depreciation and maintenance charges are on a lower scale, with the exception of the battery renewal costs, which we have not so far encountered. Carrying 2 to 3 tons on outward journeys and returning light, the charging current per mile averaged over some months is approximately 1·1 to 1·2 B.O.T. units, costing, say, ¾d. This shows a considerable reduction on the cost for petrol for a vehicle of the same capacity at present-day prices. The cost for lubricating oil added to the cost for battery acid approximates to the cost of lubricating oil for a petrol vehicle of similar capacity."



SEMI-AUTOMATIC CHARGING EQUIPMENT USED BY MESSRS. DAVIS & MAWSON.

The Baker vehicle run by Messrs. Davis & Mawson is a 1-ton machine, with box van body. It is used for the transport of munitions within the city area and has a daily round of about 30 miles. The weight handled per day is about 10 tons, and we are informed that the total running costs approximate 5d. per mile. The mileage mentioned is well within the battery capacity of the vehicle, and if a boosting charge were given for about an hour at mid-day a distance of 60 miles per day could be covered.

Mr. H. J. Sayer, metal merchant, informs us that his 2-ton Baker Vehicle is giving him every satisfaction. The average daily mileage which it runs is now about 16 miles, the longest daily round being about 28 miles. The class of load carried is tin plates and metals, and the vehicle is always up to its capacity, namely, 2 tons. The average number of journeys per day are 5 to 8, depending on the distance, but 10 short journeys have been done in one day. The cells are overlooked about every two or three months by the makers. The battery is charged at the Birmingham Corporation electric supply station at a cost of about 6s. to 7s per week, as Mr. Sayer has not yet any facilities of his own.

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1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, DECEMBER 1, 1916.

THE ROUND TABLE.

By "KVA."

" A.S.E. and Dilution," says a " Times " headline. Something radically wrong here. My experience is that they always prefer it neat !

* * * *

" Tramways on the Carpet," says a headline in the " Islington Gazette." Even they are preferable to bombs in the bedroom.

* * * *

The tramway stoppages have, it is stated by the " Birmingham Gazette," now reached the stage " that the public are beginning to disagree that walking is good exercise." Quite so, but why not run ?

* * * *

The London " Evening News " advises its readers thus : " Use your switches." Of course, there is nothing new in this suggestion, as those of us who went to a dame school have reason to remember !

* * * *

It comes as a welcome change from the now hackneyed " fusing of electric wires " report in the lay papers to hear that the fire at St. Helens Parish Church is attributed by the " Liverpool Post " to " the fusing of the *main electric switch.*"

* * * *

" Is copper manipulated ? " asks the " Financial Times." The answer, of course, is " Not 'Arf," in the rolling mills and forges. In another issue the same paper announces, " Copper quiet," and with this mains engineers, who have been burying it for years, will agree.

* * * *

The members of the Electro-Harmonic Society will be interested to know that in Russian liquid measure 10 tcharkas = 1 schtoff = 2·16444 pints. This will be handy to know when peace is declared and the Society has an inter-Allies Concert. Those who have their slide rules with them will then be able to measure the liqueurs in tcharkas and, of course, the beer in schtoffs. But I am afraid the strain will become excessive towards closing time ! All of which reminds me that the next men's concert is to-day week and that there is no moon !

* * * *

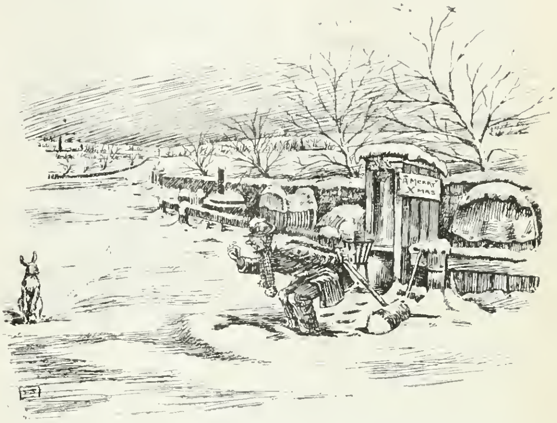
According to a correspondent in Engineering :—

" Let the line OX represent time in fractions of a second ; and let RW, the radius of a sphere, be equal to the wave-length known as 3646·1, corresponding to the convergence frequency of the hydrogen series. Let the duplicate transverse chords α, β, γ, &c., be equal to the respective wave-lengths of the transverse vibrations of the Balmer series, and the diameter $xQ = 7292{\cdot}2$ a constant for all series. Let the line Oy represent the amount of energy or momentum E entering at W in the direction of WD. The hyperbola MN is the locus of a series of rectangles as Ox, Qy, representing the constant h and its equation is $xy = h$. Now $h = 6{\cdot}6 \cdot 10^{-27}$ ergs × by seconds, and n = number of vibrations ÷ by seconds in the equation $E = hn$, so that — — "

As the Irishman would have said, " The answer's a lemon ! "

The question which is likely to agitate the lighting section of the industry in the near future is, Will the Osram lion lie down with the gas lamb ? Judging by his appearance in the poster, it will take all the pressure of the Osram elephant to make him lie down at all !

* * * *



[From *Glover's Almanac.*

NOTHING LIKE GETTING IN EARLY RATIONS FOR XMAS WITH MEAT AT PRESENT PRICES.

* * * *

THIRTY-SEVEN YEARS AGO.

(From THE ELECTRICIAN (Second Series), December 6, 1879.)

The late Prof. Clerk Maxwell was in the habit of recreating his mind from its severer tasks by penning amusing physio-comic parodies of well-known poems. One of the best of these was his electric valentine, which runs as follows :—

ELECTRIC VALENTINE.

Telegraph Clerk A to Telegraph Clerk B.

" The tendrils of my soul are twined
 With thine, though many a mile apart ;
And thine in close-coiled circuits wind
 Around the magnet of my heart.

" Constant as Daniell, strong as Grove ;
 Seething through all its depths, like Smee ;
My heart pours forth its tide of love,
 And all its circuits close in thee.

" O tell me, when along the line
 From my full heart the message flows,
What currents are induced in thine ?
 One click from thee will end my woes."

Through many an Ohm the Weber flew
 And clicked this answer back to me—
" I am thy Farad, staunch and true,
 Charged to a Volt with love for thee."

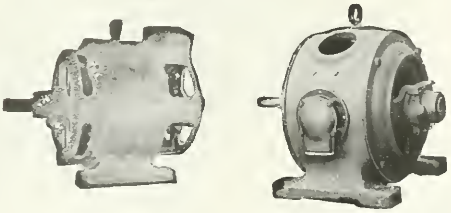
$\frac{dp}{dt}$.

The inscrutable signature $\frac{dp}{d}$ is explained by a correspondent in last week's " Engineering," to be adopted from the fundamental equation of thermodynamics $\frac{dp}{dt}$ = J.C.M. (James Clerk Maxwell). This explanation reminds us that the famous colleague physicists, Thomson and Tait, are familiarly known to their students as T. and T., nicknames also drawn from the jargon of thermodynamics.

IGRANIC SELF-STARTERS
For Reliability.
No. 29-1. "Z" Type for small motors and centrifugal pump service.
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, LONDON.
No. 30-1.—With Circuit Breaker. For compressor duty and larger motors.

SIEMENS

STANDARD
ELECTRIC MOTORS


For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CBNT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

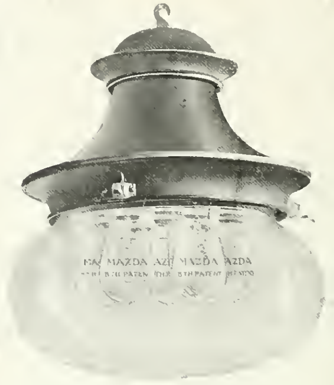
TINNING FURNACE
(Hall's Patents)
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

HALF-WATT LAMP LIGHTING ACCESSORIES.

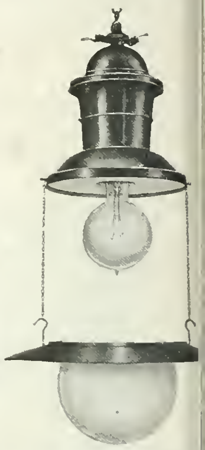
We commented in a recent issue upon the publication by the British Thomson Houston Co., Mazda House, Upper Thames-street, London, E.C., of their price list, No. 10,484, which deals with weatherproof lanterns, street-lighting fittings and accessories, ironclad ship and mill fittings, &c., for ½-watt type and standard lamps. We now illustrate a few fittings included in this list.

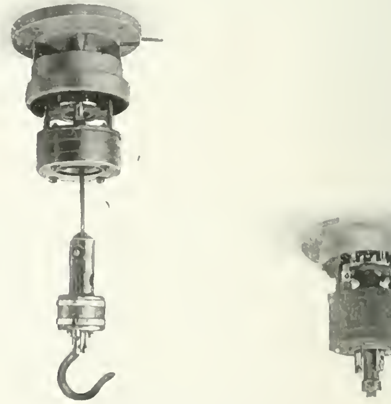
The "Endura" lanterns, which are of original design, may be employed for outside illumination of all classes. The lantern itself is of mild steel and is finished with a high quality vitreous enamel. It affords thorough protection for the lamp and the internal wiring from the weather, and at the same time furnishes adequate ventilation. The standard designs are supplied with an inner reflector, but outer reflectors are recommended and can be fitted if desired. The opalescent glass globe is supported by a ring which is secured by spring clips having safety chains attached to them. These admit of the lowering of the globe to a position which leaves the lamp and the inner reflector freely exposed for cleaning or replacement. The hood of the lantern is fitted with a porcelain insulated suspender, below which is a drip proof cover which protects the incoming leads. A suitable porcelain holder is provided according to the size of the lantern and type of lamp to be used. Each lantern is sent out ready wired, the standard finish is black vitreous enamel. These Endura lanterns are offered in a variety of sizes for ½-watt lamps from 100 to 1,000 watts. The 100 watts lanterns are fitted with a bayonet cap porcelain holder. From 150 to 200 watts an Edison screw holder is employed, and for 300 watts and upwards a goliath Edison screw holder is supplied. An illustration of one of these lanterns with the globe lowered for cleaning purposes is shown herewith.

We also illustrate a "Rugga" weatherproof lantern which is designed for use with ordinary type lamp clusters. It is supplied in two main styles (1) with vitreous enamel reflector plate for clusters up to seven lamps, (2) for use with any type of reflector unit which employs a single lamp. The lantern body is of heavy copper spinnings of graceful contour, which are assembled on an internal mild steel spider, which also carries the lampholder. By the removal of a single nut the upper spinnings can be detached and access obtained to all the holders for wiring purposes. The spider acts as a gallery which holds the reflector in its correct position in relation to the lamp. The globe itself is secured to a copper ring by specially designed clips, which are fixed by screws, and the ring itself is attached to the lantern frame by three special spring catches; this



5-CLUSTER "RUGGA" LANTERN.


THE "ENDURA" LANT
SHOWING GLOBE LOWERED
CLEANING AND INSPECTION.

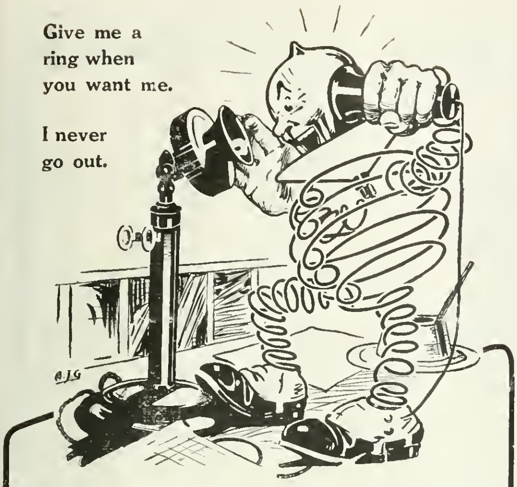

VIEWS OF CONTACT SUSPENSION GEAR.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicminster, Sowest London.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

Give me a
ring when
you want me.

I never
go out.



Willesden double one seven o; that's my number. If you want a better lamp, give me a ring.

POPE

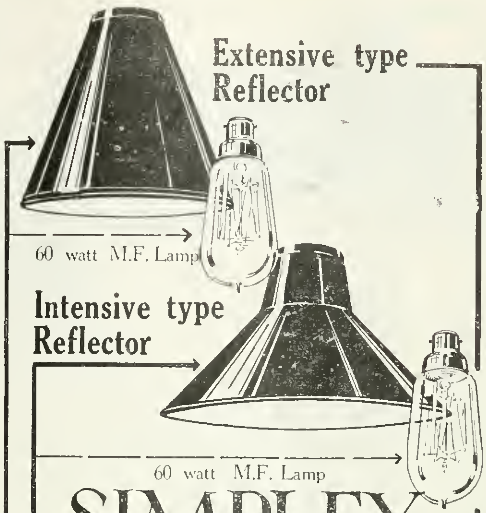
ELASTA

WIRE LAMPS

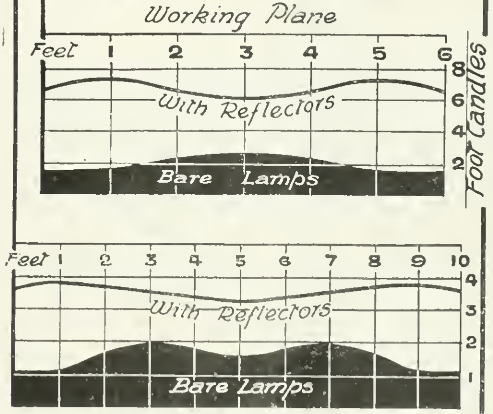
are in big demand. Their superiority and all-round merit plus our advertising in the "dailies" and "weeklies" has given a fillip to their sales. Keep "Elasta" to the front. It means good business—good profits—and satisfied customers.

Write for Terms and Booklet No. 8.

POPE'S ELECTRIC LAMP CO., Ltd.,
HYTHE ROAD, WILLESDEN, LONDON, N.W.
Telephones Willesden 1170 and 1224.



SIMPLEX SCIENTIFIC INDUSTRIAL LIGHTING REFLECTORS



SIMPLEX CONDUITS LTD.,
Garrison Lane, Birmingham.

LONDON—113-117, Charing Cross Rd., W.C.
MANCHESTER—16, Corporation Street.
GLASGOW—72a, Waterloo Street.
BRISTOL—11, Denmark Street.
NEWCASTLE—61-65, High Bridge.
LEEDS—6, White Horse Street.
LIVERPOOL—96, Whitechapel.
SWANSEA—14, Heathfield Street.
CARDIFF—4, Westgate Street.
ABERDEEN—1, Crimon Place.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

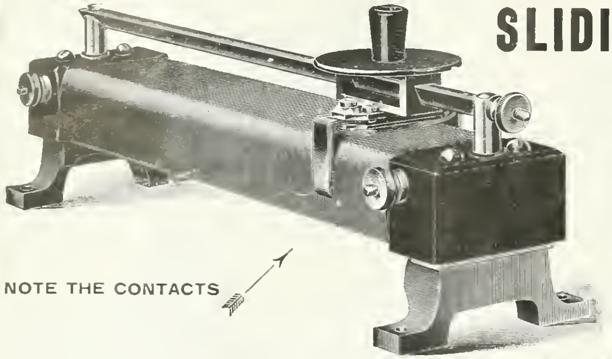
WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

Hopwood St. Mills,
PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union.



SLIDING RESISTANCES
FOR
LAMP TESTING
METER TESTING
LABORATORY WORK, Etc.
BRITISH-MADE THROUGHOUT.
List on request.
Nature says: "The list is one of the most complete we have seen."
ISENTHAL & CO.,
(DEPARTMENT 4)
DENZIL WORKS, WILLESDEN, LONDON, N.W.
Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

construction allows of the easy removal and insertion of the globe, and also ensures its secure fixing. The lantern can be used as a pendant or fixed to a rigid screwed tube; in the latter case the incoming leads are carried in beneath the detachable upper spinning, which does away with a weatherproof hood. Special attention is paid to the ventilation, though of course this is not as important as it is with a ½-watt type of lamp. It should be noted that pear-shape lamps must be employed in these lanterns. The size of the lantern is the same for 100-watt lamps numbering from 1 to 7, the overall dimensions being 22 in. high by 19 in. wide. The standard finish is black stove enamel, but other coloured enamels or polished copper finish can be had at a slight extra charge.

In the same list interesting details are given of a contact suspension gear which is illustrated herewith, and which is intended for supporting lanterns containing either clusters of ordinary types or ½-watt lamps. This accessory is a necessity in cases in which the lamps are used in lofty buildings, where it would be exceedingly costly to reach them by means of ladders or scaffolding. The gear combines a mechanical clutch and electrical contact, and when the suspension gear is in position the whole weight of the fitting is borne by the gear and not by the supporting cable. This is offered in two styles, with and without pulley in the gear housing; in each case 2-contact and 3-contact gear can be supplied.

DOMESTIC HELPS.

Under the above title the Westinghouse Supplies Department is issuing a catalogue which calls attention to the value of many well-known electrical appliances as presents for Christmas and New Year. We have repeatedly urged that enough has never been made during the festive season by the electrical selling organisations of irons, kettles, toasters and many other electrical "utilities." The public are always susceptible to something new in this way and in certain buying centres the question of price is immaterial. An electric iron or a toaster makes an acceptable present, and at this time when the domestic problem is so much to the fore, it would be doubly so.

We hope that the attempt of Westinghouse Supplies Department in Manchester will be successful, and we feel sure that if it is accompanied by a little enthusiasm on the part of the contractors it will result in many homes becoming acquainted with the "other uses" of electrical energy. The catalogue to which we have referred is marked Xmas List No. 7 189, and is provided with an attractive cover which shows two of Britain's daughters serving out something hot from an electric chafing dish, and an electric toaster and electric coffee percolator are on the table ready to do their bit towards the comfort of the guests, the latter would doubtless be wounded Tommies, though they are not shown in the picture. The drawing should certainly prompt anyone to look inside. The matter pages of the list illustrate, price and describe a variety of table utensils, hot plates, grills and ovens, irons, [illegible] stoneware utensils, the Westinghouse Utility Motor (described in our issue of Nov. 24), and a variety of electric fans.

The new I.Z. sewing machine motor is an attractive item in the series which will certainly appeal on demonstration, even if the illustration does not show its good points quite to advantage. We have had one of these little motors in use at home for some months and can speak from experience of its ease of attachment to any machine, hand or treadle, and the wide range of speed control provided by the pedal regulator. The motor itself is carried on a horseshoe frame, one end of which is clamped against the sewing machine head (behind the flywheel), and the other carries the motor, not directly but on a spring-controlled hinge. The drive to the flywheel is by direct contact with a tiny cork pulley on the motor shaft. The foot-regulator which also contains the resistance gives seven speeds, and the power of the motor is sufficient to sew through a number of thicknesses of heavy cloth. The motor itself is a Hamilton-Beach (U.S.A.) machine, is a splendid example of efficient construction, combined with pleasing finish. It is quite powerful enough to drive by belt a pair of polishing mops for cleaning the domestic silver.

INSULATING VARNISH.

A copy of their latest booklet on insulating compositions has been sent to us by Jenson & Nicholson (Ltd.), Goswell-road, Stratford, London, E., and this will be found to cover a wide range of electrical insulating varnishes. "Lacwatt," the trade name of an insulating preparation for armature and field coils, switch and control gear and railway and tramway motor equipment. It is intended for baking on and a temperature of 190°F to 200°F. should be applied from 8 to 12 hours, according to the depth of the windings. This varnish, it is claimed, will not corrode copper, is non-hygroscopic and acid and alkali free and will resist the action of grease and lubricating oil. It can be applied by brushing or dipping and in the ordinary way is sent out ready for use. If specially required it may be diluted to the desired consistency with benzine. The same composition is also supplied for air drying or baking; in this case it dries in air in from 12 to 15 hours and can be also baked at a low temperature. A quick air-drying "Lacwatt" is also listed for quick repair work or as a finishing for armature and field windings; it air-dries in about half-an-hour. It is recommended that the workshop in which the dipping is carried out be maintained at a uniform temperature of about 60° F. because the viscosity of the varnish is affected by temperature variations. The above remarks relate to the black varnish, but "Lacwatt" is also supplied in a golden variety both for baking and air drying.

"Coilac" is a finishing varnish supplied either golden or black, and is a quick air-drying material. It can be applied either by brush or spray. Another product listed is a core plate varnish, in clear or black and for either air-drying or baking. It is for coating armature or transformer laminae and provides a tough film which remains hard when heated. Acid-proof enamel in black, white, red and blue colours is also listed by the firm and is recommended for battery rooms, accumulator boxes, &c.; this material also has insulating properties.

A section of the list is devoted to mica finishing and sticking varnishes, the latter being in two qualities for producing a hard or a flexible result in the finished material.

Central station engineers and plant users will be interested in "Malinel," a range of machine finishing enamels intended to supersede the slower and more costly process of painting and varnishing. For use with this material an iron filler—air drying or baking—is first applied to the casting by painter's knife and after drying off is rubbed down with glass paper. The "Malinel" finishing enamel is then put on.

Our Manufactures include:

- Cables for Lighting, Power, Telegraphy and Telephony.
- H.C. Copper Wires and Strands.
- Aluminium Wires and Sheets.
- Phosphor Bronze Wires.
- Brass Rod.
- Brass Forgings.
- Enamelled Wires.
- Cotton Covered Wires.
- Aerial Cables.
- Joint Boxes and Pillars.
- Jointing Compounds.
- Primary Batteries.
- Exploders.
- Shot Firing Cables.
- Window Lead.
- Cable Racks.
- Static Condensers.
- Pole Line Steelwork.
- Paper Pinions.
- Fuses and Fuse Wire.
- Electric Welders.
- Telephone Cords.
- Annealing Furnaces.
- Tramway Insulation.
- Overhead Equipment.
- Electricity Meters.
- Knife Switches.

CORALINE SOLDERING PASTE.

This is an excellent flux for soldering Copper, Brass, Tin, Iron and Lead.

It is economical and efficient, as a mere trace is sufficient to make a sound joint, and it does not run after being applied.

For repetition work it is much safer than ordinary fluxes, as it gives off no injurious spray.

It will not corrode the most delicate material, and it can be used with safety in electrical work, as we know from 10 years' experience.

BRITISH INSULATED & HELSBY CABLES.

LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

OVERSEAS BRANCHES:

AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

Drawn Shell Work
IN BRASS, COPPER, and STEEL.
Any size
up to 8" diam.×4" deep.

Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, Staple Inn, London, W.C.
TELEPHONE: *Holborn* 6323.

BELLING
& CO.
We can quote you for and are regularly supplying:—
Electric Heaters for Shell Drying Ovens.
Gas and Fire-proof Heaters for Loading Rooms.
Immersion Heaters for Wax Melting.
Air Warmers for Fabric Drying Rooms.
Low Temperature Radiators for Work Rooms.
Electric Fires (Radiant type) for Offices, &c.
Electrically-heated Water Tanks to deal with any quantities.
Thermostatically controlled apparatus to keep either water or air at any desired temperature.
Electric Toasters, Water Boilers and Grillers for Mess Rooms.

We have had large experience in adapting electricity to many novel manufacturing processes, and are prepared to submit quotations and drawings to meet any given conditions.

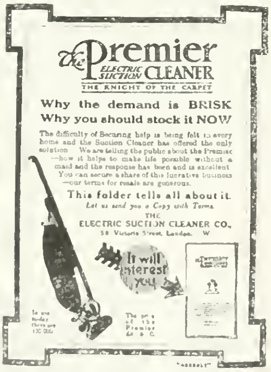
BELLING & CO., Electric Heating Specialists, Derby Road, EDMONTON, LONDON, N.

HELPS FOR ADVERTISERS.

The continuance of trade advertising is a noteworthy feature of the war. It displays a determination to carry on with industry and commerce despite the loss of staff and the difficulties in obtaining materials. The purchase of advertising space is one of the important duties of the publicity manager, but the preparation of the copy is equally important. It is gratifying to note that the advertiser who never changes his copy from one year's end to the other is gradually disappearing; that is, the custom is changing because this class of advertiser shows no tendency to discontinue in the ways of publicity. What is happening with regard to trade paper advertising is this: the advertiser is realising that his announcement is part and parcel of its selling organisation. In fact, a number of his salesmen rolled into one. It is true the use of advertising space in this way requires more attention on the part of the publicity department, and during normal times such attention is considered merely as part and parcel of the work of conducting sales. Now that the war has removed so many publicity and sales managers from the paths of industry to the paths which lead to glory, the work of advertising copy preparation has either to be discontinued or be entrusted to those who have made a study of it from a wide and varied point of view, but who are not in the employ of the advertiser himself.

It is of interest to advertisers who are suffering from staff shortage to know from a catalogue just issued by A. J. Greenly & Co., [illegible], London, W.C., that they can obtain copy writing [illegible] and can also be advised upon the [illegible] of trade literature generally.

A LIGHTING ADVT. DESIGN.


The Premier Electric Suction Cleaner
THE KNIGHT OF THE CARPET
Why the demand is BRISK
Why you should stock it NOW
The difficulty of securing help is being felt in every home and the Suction Cleaner has offered the only solution. We are telling the public about the Premier —how it helps to make life possible without a maid and the response has been and is excellent. You can secure a share of this lucrative business —our terms for resale are generous.
This folder tells all about it.
Let us send you a Copy with Terms.
THE ELECTRIC SUCTION CLEANER CO.
58 Victoria Street, London. W
It will interest you.

EXAMPLE OF TRADE ADVT. COPY.

Mr. A. J. Greenly, the head of the firm, is well known in the electrical industry, and has for some time past been commissioned by a number of manufacturers, traders and commercial houses upon publicity work in general. The catalogue to which we refer sets out clearly with prices and details what the company will do for the advertiser. It shows at a glance the cost of sketches for catalogue preparation, poster stamps, and trade mark designs. "House organs" are included and can be edited complete for a round sum. Booklets, folders and circulars, and showcards will be prepared, also drawings of buildings, and ideas for advertisements drawn up. Th circular letter, designs for advertisement borders, small card "ads." and letter headings and stationery are other matters with which the catalogue deals. Technical articles on works and installations are also a speciality and will be undertaken at fees which are specified in the catalogue.

THE COVER OF A "HOUSE ORGAN."

A BOOKLET COVER DESIGN.

In many respects the catalogue referred to is unique because it is the first we have yet seen in which the advertiser is made aware of the cost of "outside" advertising assistance. We reproduce herewith miniatures of some of the work which the company has done for the electrical trade, and in conclusion would recommend those of our readers who are interested to apply to the company for a copy of the catalogue at the address given above.

MEAT SHRINKAGE IN COOKING.

The controversy which raged some few years back on the subject of the shrinkage of meat cooked in electric and gas ovens respectively is of especial interest at the present time on account of the prevailing high cost of meat and food generally.

At a lecture recently given by Mr. C. G. Nobbs, of the Falkirk Iron

THE ESSEX Accumulator and Dry Battery.
HAND LAMPS, INSPECTION SETS, TORCHES,
POCKET LAMPS, ACCUMULATORS, ETC.
List on Application.
THE ESSEX ACCUMULATOR CO.,
[illegible] GROVE GREEN ROAD, LEYTONSTONE, LONDON, N.E.

One, Two & Three Phase MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS,
VULCANISERS,
CONDENSING PLANT.

Solvent Recovery and Derisinating Plant a Speciality.

Sole Representative :

JAMES LIVINGSTON, LTD.,

30, GT. ST. HELENS, LONDON, E.C.

Telegrams and Cables: "CINERARY, LONDON."
Telephone: LONDON WALL 3151.

The speeding up of machinery

and the consequent lowering of production costs is of vital moment in these days of keen competition If you use clutches or brakes, you are not securing the maximum efficiency if they are not lined with Ferodo fabrics. Leather is always unsatisfactory because its coefficient of friction drops very rapidly with a rise in temperature and it is liable to char. The efficiency of Ferodo fabrics rises with the temperature, and they are absolutely non-inflammable. Metal to metal surfaces often cause considerable trouble owing to the metal dust created by friction. This is obviated by using Ferodo fabrics.

Secure efficiency and economy by lining your clutches and brakes with

FERODO

CLUTCH AND BRAKE LININGS.

Contractors to the War Office and Admiralty, London General Omnibus Co. and Underground Electric Railways of London and Paris. List "X" from

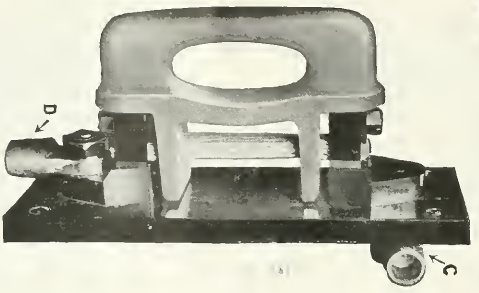
The Herbert Frood Company, Ltd.

Works: CHAPEL-EN-LE-FRITH.

'Phone: 19 and 20 Chapel. Wires: "Friction, Chapel"

We hold stocks at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester and Newcastle.

C3.



D. & S.
"HANDLE" FUSES.
50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.

DORMAN & SMITH Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

[illegible] in the clubroom of the staff of the company, the subject was again revived and emphasised. While the lecture proceeded, Miss Neilson, Falkirk, of the Glasgow and West of Scotland College of Domestic Science, demonstrated by cooking with an electric stove, in full view of the audience, a comprehensive menu, comprising: roast joint of beef, roast chicken, dish of filleted sole with sauce; dish of grilled cutlets and tomatoes, with peas and potatoes; apple tart, and about 100 small cakes and pastries of various kinds; also some delicious shortbread fingers. The preparation of the food was done during the morning. The cakes were distributed amongst the audience, and the roasts, &c., were purchased on the spot by eager friends whose palates had been stimulated by the appetising appearance of the food and the odours that permeated the hall.

An interesting experiment was demonstrated to prove the small shrinkage of meat when roasted in an electric oven as compared with gas or coal ovens. The electrically roasted joint lost only 11¾ per cent. in evaporation, as compared with 25 to 33⅓ per cent. with gas or coal-fired ovens, thereby showing a saving of 12½ per cent to 20 per cent., in other words a saving in the butcher's bill of 9d. to 1s. 2d. upon a 4½ lb. joint of beef costing 1s. 4d. per lb. The electricity consumed in cooking the joint, chicken, fish, apple tart and the 100 odd cakes and pastries was but 5 units, which, at 1d. per unit (the average cost for electrical power for cooking in Great Britain, many others sold current for this purpose at ½d. or ¾d. per unit), would be 5d. only. It would thus be seen that the saving on the roast beef more than paid for the electricity used for the whole menu. In addition to the economy in cooking, it was pointed out that electricity had other advantages. It was safer, cleaner and more convenient than "flame" cooking; it saved time, required less labour, and the quality of the food was much improved. All these meant greater comfort and better health.

Instructive lectures of this kind upon the sciences applied to every day work will do much to bring the workers' efficiency and knowledge to a high standard. The management of the Falkirk Iron Co. are to be congratulated upon the inauguration of such lectures in their works.

FLOODED ELECTRIC MOTORS RUN WITHOUT DRYING.

Three electric pumping motors supplying all the water used in the city of Rock Hill, S. C., were submerged during recent floods and [illegible] under water for more than a day and a half. Yet when [illegible] to the natural channel of the Catawba River the [illegible] promptly when the current was applied and [illegible] a few hours after the flood had left the [illegible]. The use of a hose to wash the mud out of the [illegible] and the removal of accumulations of sand and mud from [illegible] were the only precautions taken before starting up the motors. Deposits of mud completely stopped up the intake pipe of the pumps and it was necessary to lay a new pipe line to the river before the pumps were again started. "We have been pumping ever since, and no trouble whatsoever has developed. If they were human beings I would raise their pay," says the Rock Hill city manager in a letter to the Charlotte office of the General Electric Company, maker of the motors. The Rock Hill pumping station is located five miles from the city of Rock Hill. It is equipped with two motor pumping outfits of 100 H.P. each, and a third motor outfit of 7·5 H.P. The motors are all controlled by the action of a self-starter and two starting compensators. The pumps are operated without an engineer by simply closing an oil switch at the town end five miles away. The pumping station is inspected once a week. Power for the motors is supplied through a high-tension line carrying current from the hydro-electric plant of the Southern Power Company at 11,000 volts. At the pumping station it is reduced to 550 volts, three-phase, and fed to the motors.

In a short time after the flood occurred the Catawba River left its banks and entered the cement pumping station building, quickly covering the motors and touching the top of the building; 36 hours after the flood reached its height the water receded enough to allow linemen of the company to climb into the window of the pumping station, using the power wires as a means of crossing the flooded ground. They found the switches, instruments and connecting bars as well as the motors covered with river mud. The oiling system was filled with water and mud, and it was necessary to use a hose and brushes to clean off the equipment. As the water in the city standpipe was low, it was necessary to start pumping at once to prevent a water shortage, and so all three motors were started up without trouble five hours after workmen were able to enter the pump house. The performance of the motors is unusual because no time was given for drying out the coils and equipment, the only preparations for operation consisting in removing the actual accumulations of dirt. This noteworthy performance shows the ruggedness of electric motors and the reliability of electric power.—"Elec. Rev.," Chicago.

FERODO BRAKING MATERIAL.

An interesting case of Ferodo braking has recently come to hand. A large firm of printers had some trouble with their litho machines owing to the brakes not acting with certainty, this resulting in the work getting out of register. They had the brakes lined with Ferodo fabric with the result that the brakes acted perfectly. Further the leather lined brake required renewing at least every fortnight, whereas the Ferodo fabric is still good after running for several months. Ferodo fabrics are also proving their worth on the brakes of Priestman's grabs, bucket ladder engines, and on the cones of hopper door winches and, in fact, wherever a friction surface is used.

WE SPECIALIZE *in Electrical Varnishes, Compositions, Enamels etc.*
Write for List :—
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1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, DECEMBER 8, 1916.

THE ROUND TABLE.

By "KVA."

On the Telephone.—"Good morning, old chap; how are you?"

"Better than I thought, old chap: passed A1 yesterday!"

* * * *

According to the "Staffordshire Advertiser," "the No. 2 gasholder at Stafford had jammed through wind pressure and would be scrapped." "It's an ill wind," &c.

* * * *

The echoes of the war ring as far north as Fort William, where the local authority, owing to light restrictions, recently sought to obtain a rebate of 20 per cent. from the electricity company on the street lighting account. After a short discussion, the offer of 10 per cent. was agreed to "while it still remained open." This, from the land of bawbees, surely means that we are in for a long war.

* * * *

Liverpool is about to adopt the "Talking Tram," which will do gramophonically what the conductor is supposed to do in the ordinary "hoarse" of his business—*i.e.*, to announce the stages along the line of route. Already the citizens of Liverpool realise that the idea need not stop at that, but that the stage-shrieking gramophone may also play popular airs, particularly along the suburban routes. With all of this I am sure that everyone will agree, but I think the "Liverpool Courier" might have shown a little more regard for the civic amenities than by announcing that "this arrangement will call out the names of the stoppages automatically." This is putting it across Birmingham with a vengeance!

* * * *

Gems from the Local Section addresses:—

"The only way in which solar energy is taken up chemically in Nature is through the agency of plant life. *Failing other means, we must grow our fuel.*"—Prof. R. D. Robertson, at Bristol.

"Our friends the gas engineers have, of course, been very much more affected than we have by the working of the Summer Time Act."—Mr. A. E. Mackenzie, at Manchester.

"This subject of so-called Tariff Reform, or Trade Protection, should not be made a political football for the sake of catching votes, but should be as free, we hope, from political bias as the Army or the Navy."—Mr. J. K. Stothert, at Glasgow.

"If it is really necessary to impose the heavy restrictions on the use of electricity in mines that are now in force it would seem to be up to the electrical manufacturers to develop further improvements and to produce plant still better suited to the conditions."—Mr. H. A. Nevill, at Leeds.

* * * *

OUR HOT PLATES

No. 221 to—

Mr. C. W. Mallins, manager Liverpool Corporation Tramways, for the introduction of the "Tram-ophone."

No. **222** to—

Prof. H. E. Armstrong, for the following aphorism in a recent lecture delivered at Nottingham University College on "National Fuel and Power": "The policy of 'wait and see' was a self-condemnatory one, because those who had not foreseen never would foresee."

ELECTRO-HARMONIC SOCIETY.

2ND CONCERT, 31ST SEASON, 1916-17.

Holborn Restaurant, London. To-night, 8 p.m.

Unofficial Programme.

In the Chair, Mr. W. J. Tennant.

NIGHT DUTY CHORUS "Beautiful Land of Nod." ... *Greene*
SHIFT ENGINEERS FROM ANY STATION.

HOTPLATE INTERLUDE "Kukri" Grogan will do a Few Spiral Stunts on the Simmering Slide *After Bastian*

MARYLEBONE SOLO "I'm going away to be a soldier." *Pleasants*
MR. H. H. HOLMES.

SHUT-DOWN LAMENT "Where My 'Tram-avan' Has Rested" ... *Löhr*
MR. R. A. CHATTOCK.

DUBLIN MELANGE ... "Ireland, You're Callin' Me" *Kingston-Stewart*
COL. P. W. D'ALTON.

"STRAFE" CHORUS "It's Nice to get Up in the Morning" *Lauder*
VOLUNTEER MUNITION WORKERS.

REAL RED HEATETTE "They'll All Have to Toe the Thin Red Line" ... ... *Adapted*
THE "GREAT ORME" BASTIAN.

SHOCKPROOF SOLO "I Fear No Foe in Shining (or Draw-out) Armour" ... *Ray Rolled*
MR. H. W. CLOTHIER.

"OSRAM" CIRCUS "The Animals Went in One by One" *Atmos'd*
Ringmaster MR. J. Y. FLETCHER.

DAYLIGHT DIRGE "Good-bye, Summer" (and good riddance) ... ... *Tosti.*
ALL DISGRUNTLED CENTRAL STATION ENGINEERS.

TRANSPORT SOLO "I Dreamt I Dwelt in Clearing Halls" *Balfe*
MR. A. W. GATTIE.

VARNISH MEDLEY ..."I Know Some Funny Tales" ... *Leighton*
"STILL THE BEST" BARRALET.

GRAND FINALE "Another Little Drink Won't Do Us Any Harm" ... ... *Ayer*
(9.25 sharp)
MEMBERS OF THE ELECTRO-HARMONIC SOCIETY.

GOD SAVE THE KING.

* * * *

THIRTY-SEVEN YEARS AGO.

(From THE ELECTRICIAN (Second Series), December 13, 1879.)

TORPEDO BOATS AND THE ELECTRIC LIGHT.—From the recent torpedo experiments made on board the "Bloodhound" with the electric light it would appear that black painted boats are least distinguishable by the electric light, while white, red and green were the next in order to plainness.

MR. GLADSTONE AND THE TELEPHONE.—When the ex-Premier addressed the monster audience in the Corn Exchange, Edinburgh, a telephone was planted on the desk to convey his oration to a number of people collected in a neighbouring hall; but only a small part of the speech could be heard, for the modern Cicero, according to an established habit of his, placed his hat right in front of him, and screened off the sound of his voice from the diaphragm of the telephone.

MARAT AND ROBESPIERRE. We are indebted to Mr. A. J. Frost, the energetic compiler of the Ronalds library catalogue, for the following curious and interesting notes: "It is, perhaps, not generally known that Jean Paul Marat, one of the most prominent characters of the first French Revolution, and who was assassinated by Charlotte Corday, wrote several important works on electricity, most of which were translated in German. These works were written and published between 1779 and 1785." Robespierre also contributed a Paper to the Journal.

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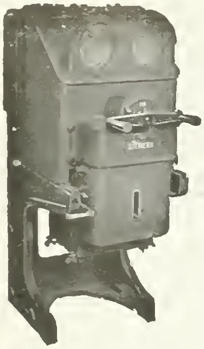
"Gosilplat, Ox., London." 4746 Gerrard.



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ELECTRICALLY HEATED OVENS.

One of the most important problems with which industrial plants have to cope, in a great variety of productive work, is that of securing the most efficient and economical application of heat.

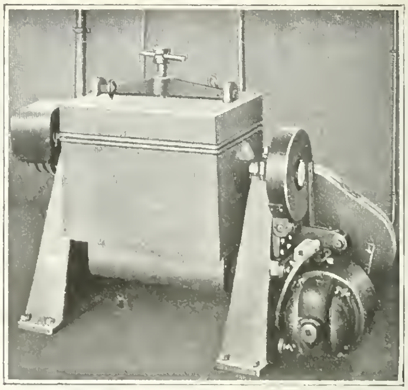
[illegible] Baking Oven.

The [illegible] electrically heated ovens which [illegible] uniform production [illegible]

In a bulletin issued by the General Electric Co. (U.S.A.) illustrations and descriptions are given of several interesting examples of electrically-heated ovens which are in constant commercial use, and which serve to indicate the progress and present day value of electrical methods of applying heat in industrial manufacturing.

Air heaters have been developed for heating core baking ovens, small bread baking ovens, such as the reel type, ovens for drying paints, varnish, ink, lumber, leather, for baking cereals, &c., and for other similar applications. These heaters are made up by mounting on a metal frame a number of units, each of which consists of a thin metal strip, having insulating blocks mounted on the edges. These blocks are made of a compound which will retain its insulating qualities at the temperatures to which they are subjected, and at the same time are strong and will not crack. Notches on the edges of the blocks make a winding form for the flat resistance ribbon, and the blocks serve to insulate the ribbon from its support. These units are assembled in an iron frame, and are insulated therefrom by blocks of the same compound. The frames are provided with feet for mounting in the oven, and are made in standard forms for mounting on either wall or floor. These heaters are available in capacities from 1·3 kw. to 12·3 kw., and are standard for voltages up to 480. The temperature range for which they are suitable extends as high as 900°F. in the oven.

One of the ovens shown herewith is used for baking foundry cores. This oven was formerly heated by gas, with which it was difficult to get a uniform temperature or to regulate the temperature. The oven has four shelves, each 30 in. wide and 30 in. deep with an opening of 5 in. The shelves are hinged at the right, so that they can be swung open. The illustration shows three shelves in the open position. When in this position a baffle at the back of the shelf closes the opening, so that while the cores are being changed or examined the heat losses are reduced to a minimum. Electric heaters totalling 16 kw. were installed in the bottom and sides of the oven. This installation is an old-type gas oven equipped with electric heaters to determine the advantages of baking core electrically. The experimental oven gave quicker baking with practically total elimination of imperfectly baked cores, and as a result is being replaced, for regular production, with a modern oven equipped with electric heaters.



ELECTRICALLY-HEATED SHERARDIZING OVEN.

The process of sherardising consists of baking, in zinc dust, metals which it is desired to make rust proof. This is best accomplished by baking the metal parts with zinc dust of the correct chemical analysis at a certain predetermined constant temperature for a period of time, depending upon the thickness of coating desired. The most satisfactory results with this process are obtained by use of electrically heated ovens, consisting of an electrically-heated revolving oven mounted on trunnions, which are supported in pillow blocks. The

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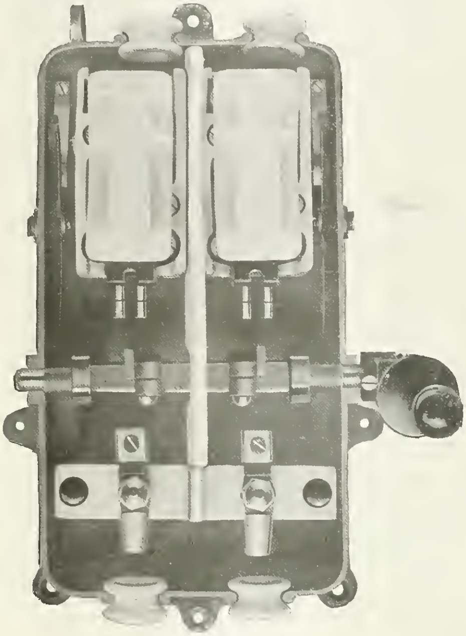

With cover completely removed.

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Fuse cover cannot be opened when switch is on, nor can switch be closed when fuse cover is open.

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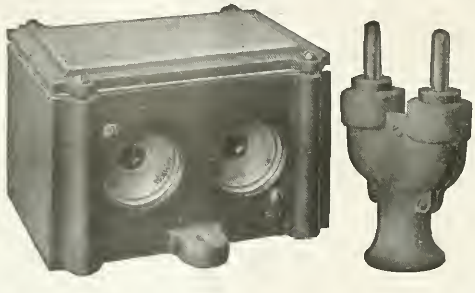

DORMAN & SMITH, Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

oven is rotated by an electric motor geared to the driving shaft. In the equipments referred to metallic resistance elements are placed on each of the sides of the oven, and current is supplied to them through collector rings. The ovens are made in several sizes; those shown in the bulletin each have an average capacity of 1,800 lb. and internal dimensions of 40 in. by 24 in. by 24 in. The maximum current input of 53·5 kw. will raise the charge to the maximum sherardising temperature (375°C.) in about three hours, where it can be maintained with an input of 13·5 kw. A smaller oven also shown in the list has an average capacity of 150 lb., and internal dimensions of 10 in. by 10 in. by 17 in. The maximum input is 15 kw., and it requires 5 kw. to maintain the oven at working temperature.

The best formulæ for sherardising can only be properly carried out in the electric oven. The product is uniform in thickness, density, metallic zinc content, and in its resistance to atmospheric corrosion. This has been proven by subjecting metals which have been treated in the electric oven, to the salt spray test. In this test a concentrated salt solution is sprayed into a box producing therein a salt atmosphere. Where a coating of requisite thickness has been applied to metal in the electric sherardising oven, the metal will withstand the salt spray test for at least a week, and when no rust develops in this length of time, experience has demonstrated that the coating will last indefinitely under atmospheric conditions.

Electrically heated Revolving Oven.

A mica mould heating oven is also shown, and is used for heating moulds in which various shapes of mica are formed under a hydraulic press. The dimensions of the oven are:—

Outside.	
Total height	75½ in.
Height of oven body	40½ in.
Width ,, ,,	47½ in.
Depth ,, ,,	47½ in.
Inside.	
Inside height of top compartment	14 in.
Width ,, ,,	41 in.
Depth ,, ,,	41 in.
Height of bottom compartment	10 in.
Width ,, ,,	41 in.
Depth ,, ,,	41 in.

With an input of 14·25 kw. this oven with no-load can be brought to a temperature of 500°F. in one hour and 45 minutes. To maintain this temperature requires an input of 9 kw. The oven has a maximum input of 28·5 kw.

Electric Wood Drying Oven.

An oven used for baking the mica insulation on brush holders is also described. The outside dimensions of this oven are: Height, 67 in.; depth, 40 in.; width, 58 in. There are three compart-

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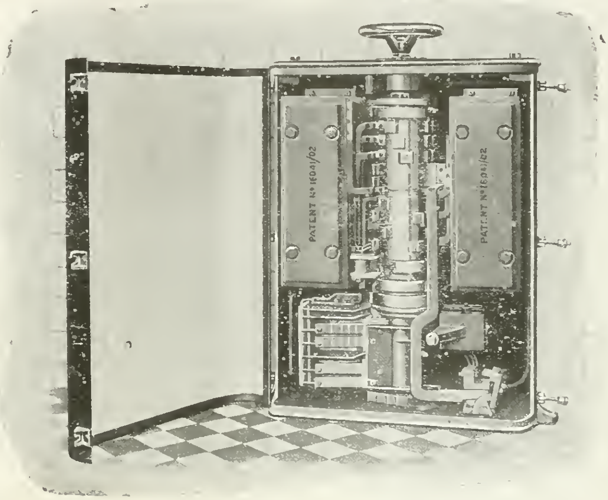

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ment, each 36 in. by 51 in. by 12 in. high. The heating units are six in number, two under each shelf with a total maximum input of 30 kw. Each set of two units is arranged for three heat operation through the switches mounted on the right of the oven. With an input of 30 kw. the temperature of the oven with no-load can be raised to 500 F. in about two hours. An input of 8·6 kw. is sufficient to maintain this temperature. This oven replaced a much larger steam-heated oven, and it not only does the same amount of work in less time, but the quality of the work after baking is superior to the best that could be obtained with steam heat when using the utmost care.

In many cases it is practical to remove gas burners from an oven and substitute electric heaters. A battery of ovens in which such a change has been made is illustrated in the bulletin. These ovens are of the following dimensions inside: Width, 61 in.; height, 51 in.; depth, 38 in. Each oven has a maximum current input of 22·5 kw. The heating units are located in the bottom of the oven, and so grouped that heats of 7·5 kw., 15·0 kw. and 22·5 kw. may be obtained. The temperatures used for baking the work put through these ovens averages 400 F. to 458 F.

An oven which is used for drying asbestos board and fibre and for materials that have been impregnated with pitch is another interesting specimen. A great variety of work is done in this oven at various temperatures, and the fact that with electric heat any one of the desired temperatures can be held constantly at the correct value, has proved to be a great advantage. Any desired temperature from about 130 F. to 650 F. can be obtained. This oven has inside dimensions of 6 ft. high by 9 ft. deep by 7 ft. wide The units are placed in a pit under the floor of the oven, the floor being made of perforated iron plates which allow the heat to rise into the oven. The maximum input to the oven is 37 kw.

An oven used for baking enamel, with which wooden switch handles and similar articles are coated, is described. The baking is done at a low temperature 180 F.—in order to prevent the possibility of carbonising the wood. The inside dimensions of this oven are 78 in. wide, 78 in. high, and 38 in. deep, and is equipped with six shelves with 8 in. spacing between shelves. The electric units are placed in a compartment in the bottom of the oven. The oven has a maximum input of 7·5 kw., and the heaters are grouped so that varying heats may be obtained to carry on the baking at any speed desired. When this oven was equipped with electric heaters, it was found that the temperature could be controlled closely, and a greatly improved finish on switch handles was obtained.

A japanning oven which is used for baking a great variety of metal parts ranging from small punchings to large castings is so arranged that one half of the oven can be charged with fresh material while the material in the other half is baking. This is accomplished by having the oven fitted with a revolving drum which is divided into two parts by an insulated partition through the centre. The drum is revolved by a suitable motor-driven mechanism. The dimensions of this oven are as follows: Height, 6 ft. 6 in.; diameter of drum, 8 ft. Each compartment is 5 ft. 3¼ in. wide, 2 ft. 9 in. deep and 6 ft. 6 in. high. The current input is 67 kw. maximum, which will raise the temperature of the oven to 500 F. in one hour and 35 minutes with a current consumption of 105 kw. hour. To maintain this temperature requires an input of 31·5 kw. The oven is provided with blower ventilating system for carrying off the gases.

The agents in this country for these electrically heated ovens are the British Thomson-Houston Co., Rugby, to whom inquiries regarding [illegible]

BASTIAN ABRIDGED CATALOGUE.

We have been sent a copy of a neat folder containing a number of leaflets which deal with the Bastian Electric Co.'s most popular lines in heaters and stoves. In issuing this abridged list the company state that they have built up a good stock for the winter trade of the apparatus shown in the list, and they ask for the support of central station engineers and factors in concentrating upon these popular lines. In the foreword to the booklet the company calls attention to the fact that in addition to their ordinary work in supplying heating apparatus for domestic and commercial purposes they have also supplied the needs of munition works, Government laboratories and a large number of subsidiary industries engaged upon war work. In this connection we understand that the company have gained a considerable reputation for their heating apparatus for chemical research work, and they have successfully obtained results which have not hitherto been achieved in this field.

THE "ROYAL" PATTERN OF BASTIAN QUARTZALITE HEATER.

Turning now to the list itself, this reminds the reader in the initial stages that Bastian heaters were introduced to the public for the first time just over seven years ago, and in the interim, we understand, that over 90,000 have been sold in all parts of the world. The company claims, and rightly, to be the pioneers of the real red-heat form of radiator or fire for use with electricity, the successful effect being obtained by the combination of quartz in tube form as the supporting medium, and a spiral wire which is made up of a special alloy. It is interesting to note that all Bastian heating elements are guaranteed by the makers under normal conditions for a period of four years.

The Bastian real red-heat glowers are now obtainable in three forms, each form is 10 in. long and is provided with the same pattern

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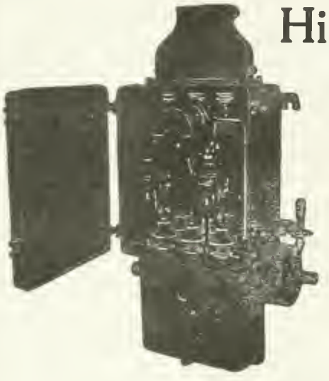

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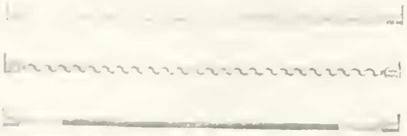
of terminal for attachment to the spring clip contacts which are carried on the frame of the fire itself. The No. 1 glower is of 125 watts capacity and comprises a quartz tube with *internal* spiral and terminals; the No. 2 glower is of 250 watts capacity and differs only from No. 1 in that the spiral element is placed outside the tube. The No. 3 glower, which is also of 250 watts capacity, is identical as to the tube and terminals with the Nos. 1 and 2, but in this case the resistance element is closely wound on the quartz tube and forms then an *external* wire sheath. When turned on, this element



The Three Types of Bastian Glowers.
No. 1, Top. No. 2, Centre. No. 3, Bottom.

[illegible] An allowance is made on all glowers returned, provided the quartz tube itself is intact. These glowers [illegible] from 33 to 66 in the case of No. 1 [illegible] in the case of Nos. 2 and 3 glowers. [illegible] within the fire frame varies in [illegible] with the type of heater. In the type A the elements are [illegible] frame, which is provided [illegible] carrying purposes. This is a 1-unit heater, and is made up in three finishes, iron, nickel and brass. In the type F heater the glowers are also placed horizontally on the fire frame which is of the panel pattern, and can be supplied in a variety of sizes. This heater can replace an ordinary gas fire taking 35 cubic ft. of gas per hour, and with electricity at 1d. per unit and gas at 3s. a thousand, the cost is about the same. There is, of course, no comparison between the two as to convenience.

The quartz can also be placed vertically, as in the lantern type of heater, which is of pedestal form, and the elements are placed equally round the centre column of the pedestal.

The Bastian "Pygmy" heater and pyro-ring are extremely popular lines. The first-named has been widely advertised by the company in the lay press, and is, we understand, an extremely popular electrical contrivance. It has a rating of 125 watts. The pyro-ring is rather larger than the Pygmy heater, and is rated at 400 watts, there being in this case three-heat regulation. The pyro-stove is a larger form of pyro-ring and has a loading of either 600, 900 or 1,500 watts, according to requirements, there being three-heat control. With this stove the heating element occupies a rectangular central well, which is surrounded by a perforated plate which is wide enough to accommodate a number of saucepans, kettles, &c. The weight of the pyro-stove is 15½ lbs. We anticipate that central station engineers and electrical engineers, who are interested in pushing electrical heating at the present time will be anxious to obtain copies of this list. It will be supplied on application to the company at 185, Wardour-street, London, W.

The list has been prepared with the idea of overprinting the names and addresses of electricity undertakings and contractors which arrange for its distribution.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 15, 1916.

THE ROUND TABLE.

By "KVA."

The Season's Greetings and all good wishes to Round Table readers at home and abroad, and may the New Year give us no illusory peace !

*   *   *   *

This Week's Chestnut.—Country Dame (to discharged R.E., who had started on " dairy work," and was busy milking): " Now, then, young man, why ain't you at the front ? "

Discharged R.E. : " I'm very sorry, mum, but I allus understood that the milk was at *this* end ! "

*   *   *   *

" The Misox Railway," says a headline. I hope it is an undertaking without " spots."

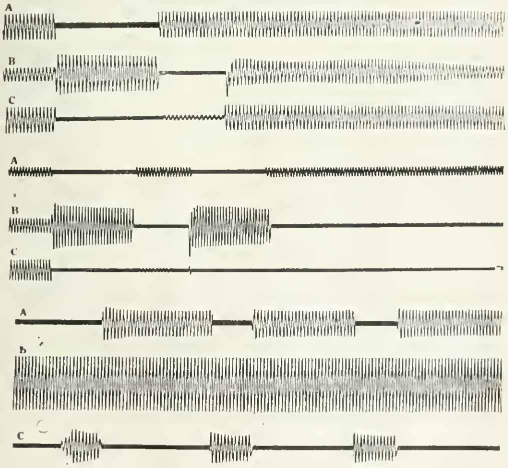
*   *   *   *

" Give me a ring when you want me," says Pope's Elasta man. I think this is a little contradictory, because, judging by recent events, Pope's did not want the Ring. Eh ?

*   *   *   *

The latest revolving thing is the Mazda pendant shade, a novelty which will, I am sure, supersede the standard pattern, brought out some time ago by the B.T.-H. Co. I imagine that at this season the revolving lamp shade may take its place with the " revolving carpet " famous in story as the last entry in his book of the man who was sent to take an inventory, and who discreetly started in the butler's pantry and finished in the drawing room.

*   *   *   *



⚑ The adjoining diagram, which for the present purpose I have lifted out of its context, may be considered to represent plan views of the tracks of three diners who decided on Christmas-eve to let the new food regulations " go hang," and have an old-fashioned but none the less " gradely do." The records for A, B and C should be read as continuous lines, but for convenience in reproduction they are cut into three. C seems to have made a brave attempt to follow the " straight line law," but the efforts of the other two, and especially B, appear to be productive of only wattle-ss cross-currents. I publish the records as a warning to holiday makers beforehand. Perhaps, when we get a Minister of Public Equilibrium we may have to produce our records (I hope mine may never be like B's) as a guarantee of good conduct. Who knows ?

*   *   *   *

The first of the 1917 desk pad calendars to reach me is that issued for the second year in succession by the Sun Electrical Co. Its modesty and subdued advertising tone will make it welcome, but I must especially compliment Mr. E. R. Morton, the company's publicity manager, upon the mottoes which he has dotted in between the Sun maxims on each daily slip. For instance, " Competition is the mother of invention ; " any meter manufacturer will, I think confirm this. " Anger is powerless when met with good humour ; " here I am tempted to say, " Try the Round Table," but I won't. " It is nonsense to believe you are handicapped by empty pockets," a perfectly obivous remark in these days of the " No Treating Order." " It is an easy matter to take a day off, but can you put it back." Ha ! Now that surely is a matter between you and the time clock Not a word, eh ? Just one more from the collection, " Of two evils why choose either ? " This subtle question must, I am sure, be addressed to the wireman who hesitates between American and German (stocked before the war, sir, I assure you) installation material ! So much for the calendar and its mottoes. If you want a copy you must " squeak pickly," as Harry Tate would say, as I understand that there will not be anything like enough to go round.

*   *   *   *

OUR HOT PLATES

No. 223 to—

The Sun Electrical Co., for the mottoes and maxims on their 1917 desk pad calendar.

*   *   *   *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Dec. 20, 1879.]

The Telephone.—Messrs. Bass & Co. have placed the whole os their extensive works in telephonic communication ; indeed, it if said that they now possess the most unique and comprehensive telephone department of any firm in England. There are 12 wires (some of them 2 miles in length), worked on the same principle as the telephone exchanges.

The Troubles of Telegraphic Management in Cyprus.—" A few days ago," says a correspondent, " a Cypriot young man handed into our Larnaca office a neatly sealed packet of some odoriferous powder, with the request that it might be sent on the telegraph to Limassol and delivered to the address written upon it. It was a difficult matter to make the man believe that the thing was impossible."

Turkish Supineness.—" For the space of one month," says a correspondent, " a long length of the Turkish landline from Larnaca to Nicosia was lying on the ground and across the main road. The diligence and lots of bullock carts were passing over it daily. We informed the Turkish telegraph officials of the fact, and for thanks got a shrug of the shoulders and the remark, " O, never mind, we are working all right. When the wire breaks we will send out a man to put it right."

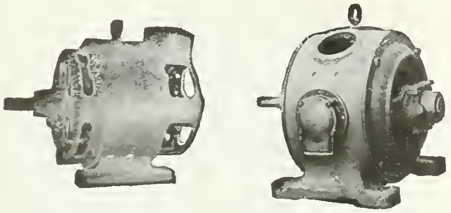
No. 10a. One minute rated motor starters, will carry heavy current surges without overheating. Carbon auxiliary contacts minimise sparking.

No. 27.—A magnet circuit breaker interlocked with the heavy duty starter makes "inching" harmless and always makes and breaks circuit.

Constant Breakdowns
and renewals to starters are avoided when
IGRANIC
HEAVY DUTY STARTERS
are installed.
IGRANIC ELECTRIC Co. LTD 147, Queen Victoria St., London.

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: Gerrard 860. Telegrams: "Siembralos, Vic, London."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

A PENDANT MAZDA REVOLVING SHADE.

About a year ago The British Thomson-Houston Co., Ltd., introduced an ingenious advertising novelty in the form of a revolving shade. This was intended for use with table, desk and other fittings in which the lamp holder is in an upright position. When the lamp was switched on, the shade rotated owing to an upward current of air heated by the lamp impinging upon a fan disc attached to the upper part of the cone shade and pivoted upon the pip of the lamp.

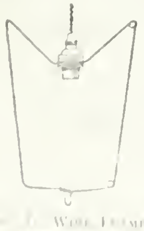


Fig. 1.—Wire Frame, [illegible] Position.

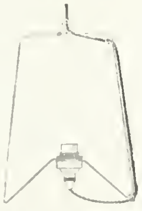


Fig. 2.—Wire Frame Reversed ready to receive Lamp and Shade.

This shade could not, of course, be used with pendant lights, but the company has now produced an adaptation of the design that permits [illegible] to plain pendants.

From the accompanying illustrations it will be seen how the revolving shade is fixed and how it appears when in position. Any ordinary shade having been removed from a lamp holder hanging from ordinary flexible cord, it is replaced by a specially designed wire frame, which is held in place by the shade carrier ring. When the frame has been attached, it is turned upside down and the flexible wire threaded through the hook at the apex of the coned frame and the two loops that are formed at the top and bottom of one side. The frame will then hang vertically, with the holder in an upright position. The ends of the curved shade of stout coloured paper are then brought together, projecting tabs at one end being inserted into corresponding slots in the other, the tabs being so slit that they hold the shade firmly in the form of a cone. A cardboard disc with metal centre to fit over the lamp tip is stamped with a number of sectors, and these must be bent upwards so as to form fan blades, the disc being then inserted near the top of the shade, being held by three tongues which project into corresponding slots in the shade. The complete shade is then placed on the lamp pip so that it is free to rotate within the wire frame. When the lamp is switched on, it illuminates the coloured shade, which immediately commences to revolve, the effect being both striking and attractive. If the adapted pendant be placed in a sunny position, its shade will rotate during the hours of sunlight without the lamp being lighted. The rapidity with which the shade revolves depends upon the velocity of the heated air current, so that the greater the wattage absorbed by the lamp the higher the speed attained.

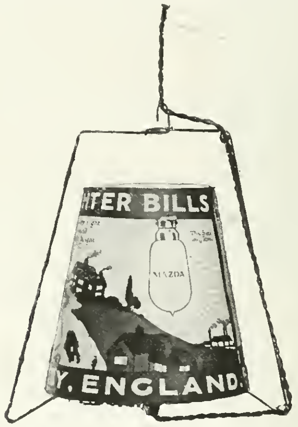


Fig. 3.—Mazda Revolving Shade, Complete.

Readers in the trade who have not received one of these revolving shades can obtain same upon application to the Publicity Dept., The British Thomson-Houston Co., Ltd., Mazda House, 77, Upper Thames-street, E.C., each shade being packed in a cardboard box suitable for sending through the post. This novel device forms an arresting advertisement for Mazda Lamps.

A GOOD LIGHTING INSTALLATION.

The untouched photographs from which the illustrations on p. 96 were obtained were taken at night with the lighting designed to adequately illuminate the hall at lectures and during service at the Southall Wesleyan Mission. This hall serves the double purpose of a place of worship and for recreative meetings, concerts, &c. It is also fitted with cinematograph apparatus. The architects, Messrs.

LEAD MELTING FURNACES
Hall's Patents
For Cable and Pipe Presses, Accumulator Grids, etc.,
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
ENORMOUS SAVING IN RESIDUE.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

GUARANTEED SECOND HAND
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THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicminster, Sowest London.

POPE "ELASTA" LAMPS
ENSURE A BRIGHT & HAPPY XMAS

Advt. of Pope's Electric Lamp Co., Ltd., Willesden, N.W.

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MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes. Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
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Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

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Established 1868.
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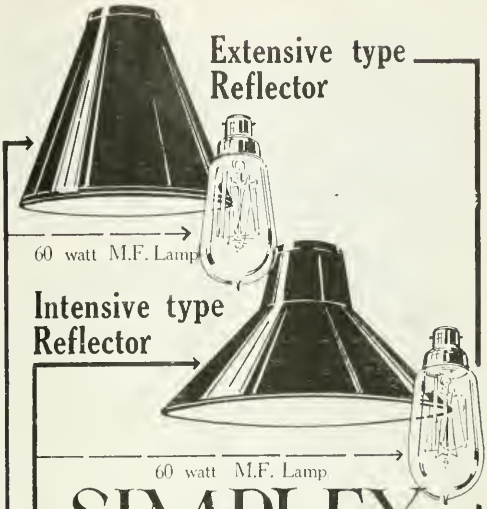
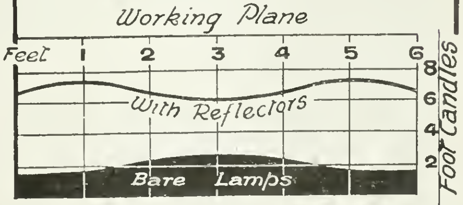
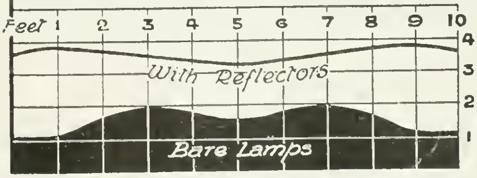


SIMPLEX
SCIENTIFIC INDUSTRIAL LIGHTING REFLECTORS





SIMPLEX CONDUITS LTD.,

Garrison Lane, Birmingham.

LONDON - 113-117, Charing Cross Rd., W.C.
MANCHESTER - 16, Corporation Street.
GLASGOW - 72a, Waterloo Street.
BRISTOL - 11, Denmark Street.
NEWCASTLE - 61-65, High Bridge.
LEEDS - 6, White Horse Street.
LIVERPOOL - 96, Whitechapel.
SWANSEA - 14, Heathfield Street.
CARDIFF - 4, Westgate Street.
ABERDEEN - 1, Crimon Place.

Regulating Resistances.

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ISENTHAL & CO.,
(DEPARTMENT 4)
Denzil Works, Willesden, London, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

Gelder & Kitchen, doubtless took this into consideration in designing the building, hence its somewhat unecclesiastical appearance.

Undoubtedly this novel departure from the conventional style of architecture for buildings set apart principally for religious services has much to commend it from an illuminating engineering point of view. The acoustic properties are excellent, and the seating accommodation is such that every person can see the pulpit. Apart from this the style of architecture lends itself for the employment of up-to-date and efficient lighting. The Sun Electrical Co., Ltd., who were invited to submit a scheme for lighting, at once decided that indirect illumination would give the best results. The lighting arrangements for the hall consist of one centre fitting (hung from the dome). This is a 36-in. bowl fitted with special Sunlite mirror reflector and four 400-watt half-watt lamps, approximately 1,600 c.p. This is sufficiently powerful to illuminate the hall proper, including the first three rows in the gallery, roughly 80,000 cubic feet capacity.

[illegible] View of Auditorium and Choir, Southall Wesleyan Mission.

View of Auditorium, Southall Wesleyan Mission.

For the gallery lighting eight 10-in. bowl fittings each with a 100-watt half-watt lamp, illuminating roughly 25,000 cubic feet are employed. Under the gallery there are eight 14-in. bowl fittings each with a 200-watt half-watt lamp. The choir and orchestra have two 14-in. bowl fittings with 200-watt half-watt lamps. In addition there are various schoolrooms, recreation rooms, &c., attached to the building, and in these are installed three 24-in. indirect lighting fittings with 300-watt lamps, twenty-one 14-in. bowl fittings with 200 watt lamps, and twenty-two 10-in. bowl fittings with 100 watt lamps.

The Sun Electrical Co. make a speciality of illumination installations and enquiries for catalogues of their lighting materials and proposals for complete schemes should be sent to them at Charing Cross-road, London, W.C.

THE ESSEX Accumulator and Dry Battery.
HAND LAMPS, INSPECTION SETS, TORCHES,
POCKET LAMPS, ACCUMULATORS, ETC.
List on Application.
THE ESSEX ACCUMULATOR CO.,
497 GROVE GREEN ROAD, LEYTONSTONE, LONDON, N.E.
[illegible] Phone: W[illegible] 749

A VALUABLE BUSINESS AID.

We have received from the British Thomson-Houston Co., Ltd., Mazda House, 77, Upper Thames-street, London, E.C., a copy of their quotation No. 53210, dated Dec. 11. This quotation tabulates and prices a great variety of wiring accessories, the prices for small and large lots being clearly shown. Electrical contractors and others who are on the firm's mailing list to receive quotations when issued

Our Manufactures include:

- Cables for Lighting, Power, Telegraphy and Telephony.
- H.C. Copper Wires and Strands.
- Aluminium Wires and Sheets.
- Phosphor Bronze Wires.
- Brass Rod.
- Brass Forgings.
- Enamelled Wires.
- Cotton Covered Wires.
- Aerial Cables.
- Joint Boxes and Pillars.
- Jointing Compounds.
- Primary Batteries.
- Exploders.
- Shot Firing Cables.
- Window Lead.
- Cable Racks.
- Static Condensers.
- Pole Line Steelwork.
- Paper Pinions.
- Fuses and Fuse Wire.
- Electric Welders.
- Telephone Cords.
- Annealing Furnaces.
- Tramway Insulation.
- Overhead Equipment.
- Electricity Meters.
- Knife Switches.

PRESCOT SEMI-FLUID JOINT COMPOUND.

A special Joint Compound designed by us for Extra High-Tension Cables. It has been largely used on 20,000 volt cables in various climates with the most satisfactory results. For all practical purposes it is unalterable by exposure to air, ozone, or oxides of nitrogen and unaffected by being heated to any temperature desired for the purpose of filling the joint.

Described by leading E.H.T. experts as more nearly approaching their ideal than any other compound.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

OVERSEAS BRANCHES:

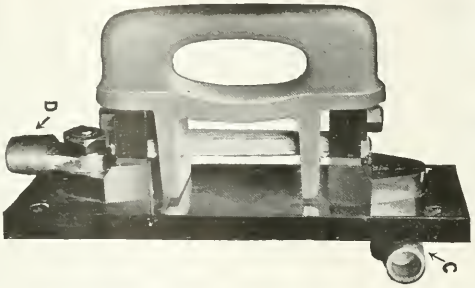
AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

D. & S.
"HANDLE" FUSES.

50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.



DORMAN & SMITH Ltd.,

Ordsal Electrical Works,
SALFORD,
MANCHESTER.

will find them highly important as showing the prices ruling at the time of receipt.

The issue of these quotations is, so far as we know, unique, but we understand that the B.T.-H. Co. have issued quite a number of them recently. Those of our readers who have not received a copy of this quotation by post should apply to the above address for a copy of the latest issue. We understand their names will then be put on the mailing list so that they will receive future editions.

MAINTAINING ELECTRIC COOKER PRICES.

We have not yet reached the stage at which the sale of electric cooking and heating apparatus is organised upon a scale which would justify the discussion of price maintenance. It is true that the manufacturers are getting together and are to a great extent agreed upon the need for uniformity in selling prices and the minimum of competition and rate cutting. But the situation, from a purely selling point of view, is such that the public are not yet sufficiently interested, or is there any agreed sales campaign whereby electric cookers and heaters are to be made universally popular.

Practice in this country has tended towards the hire of such domestic articles, and it is doubtful if that procedure will be departed from, especially as after the war the spending power of the nation may be considerably lower than it is to-day. None the less, there is some commercial interest attaching to the discussion of the price maintenance of electric cookers which we reproduce below from the columns of the "Electrical Review & Western Electrician." The plan suggested is obviously one which is peculiarly suited to a country having no preconceived notions in such matters and certainly no customs such as have become engrained, as in our case, during several generations. The parallel drawn between the electric cooker and the sewing machine, gramophone, and insurance policy business, is also hardly correct for this country, but should the purchase outright of cookers and fires become the accepted practice then the suggestions of Mr. J. E. Bullard, the writer of the article, are of considerable value.

The only measure most people have of quality is the selling price. It is often easier to sell an article at a higher price than those charged for other articles of a similar nature already on the market than it is to sell it at a lower price. The higher the price the higher the esteem in which the buyer tends to hold the product. It is apparently easier to create a desire for an expensive article than it is to create a desire for a cheap article. A latent desire to cook with electricity already exists to a far greater extent than most people realise. This desire has been fostered to a considerable degree by the fact that in the past everything connected with electric cooking has been so expensive that one who had enjoyed the privilege of eating an electrically cooked meal was prone to mention the fact with considerable pride. Now that the desire has already been created all that is necessary to make the sale of electrically heated appliances the greatest and the resulting sale of electric current the most satisfactory is to place electric-cooking methods within the reach of the people, not by reducing the selling prices of the appliances, but by making it easy for people to pay the present or even higher prices, and selling electric energy at low enough rates so that the average family can afford to cook with electricity after it has purchased the range and other appliances.

Take a census of a hundred homes, and the total investment found to be represented by the phonographs, pianos, sewing machines and life-insurance policies found in these homes will be astounding. In a great many homes the sewing machine alone costs more than a good electric range. The phonograph or the piano may represent an investment greater than the cost of a complete electric kitchen. The practice of investing a certain percentage of the family income in life insurance has now become almost universal. The most surprising fact to be learned in connection with all this, however, is that an astonishingly large percentage of the money invested in these different items has been or is being invested on the partial-payment basis.

High-priced phonographs are paid for in 20 monthly payments. The purchase of a piano may cover an even longer period than this. Sewing machines are purchased on terms which vary from actual cash at the time of purchase to payments covering a period of four years or more. The longer the term of payments the higher the selling price. This gives every purchaser of a sewing machine a constant incentive in the way of cash discounts to complete the payments in the shortest period possible. This plan tends to reduce the amount of capital required to carry the accounts and also reduce the cost of collecting.

Life insurance which has come to be looked upon as a household necessity is paid for both by the week and by the year. The immense volume of life-insurance business which is now transacted on the industrial or weekly-payment plan demonstrates the popularity of small weekly payments. This life insurance is sold to even the poorest class of people, but it is by no means cheap insurance. The cost of selling and collecting the premium rates of this class of life insurance is very high. This agent must be paid about 30 per cent. of the first year's premiums for selling it and thereafter an additional commission of something like 15 per cent. for making the collections. This added to all the other expenses of carrying on the business brings the cost of weekly paid insurance to the insured up to nearly twice that of the same class of insurance where the contract calls for annual payments.

Both the life-insurance business and the sewing-machine business, as well as the phonograph and the piano business indicate that the maximum results can be secured only by selling goods on long terms. The cash buyer may or may not be given a discount for prompt payment depending upon how advantageous it will prove to have him visit the store or office or have him visited by a representative of the company at least once each month.

All selling prices should be ample to cover every item of cost and not like those of gas ranges cover only part of these items. High prices do not curtail sales. There are a great many more homes that

One, Two & Three Phase MOTORS.

LANGDON-DAVIES MOTOR CO.

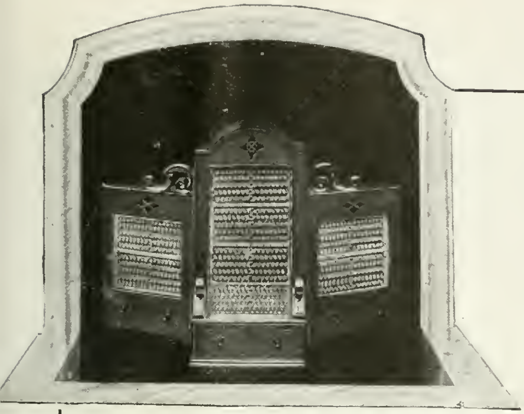
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

"THOR" High Grade Specialities

CASING and CAPPING
CONDUIT
CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.

WRITE FOR PRICES & DISCOUNTS.

HASLAM & STRETTON, Ltd., Windsor Place, CARDIFF & Bristol Bridge, BRISTOL.



A handsome Electric Fire in an attractive setting. Designed and Manufactured by Carron Company. Supplied for one of the Public Rooms of a leading Corporation.

By Appointment, Ironfounders to H.M. the King.

"Once Used always Used."

Electrical Contractors and Engineers who handle CARRON ELECTRIC FIRES know of the Service and Satisfaction they give and the business they bring. This increasing sale is the outcome of their proved value—once used always used.

Carron Company manufacture all kinds of Electric Fires in Bronze or other Metals, suitable for public rooms, etc. Designs and Estimates free on application.

¶ A Free Copy of the Company's latest Electric Heating Appliance is at your disposal. Write for a copy to-day.

CARRON COMPANY INCORPORATED BY ROYAL CHARTER 1773

Works:
CARRON, STIRLINGSHIRE, and Phœnix Foundry, Sheffield.

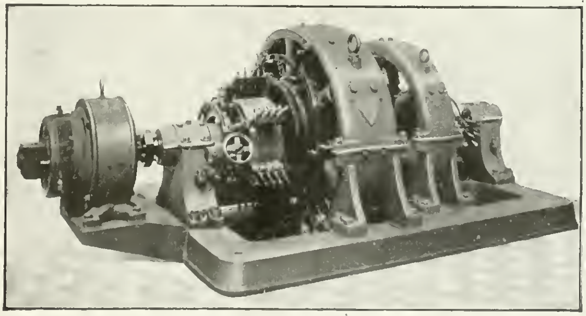
Showrooms: LONDON—(City) 15, Upper Thames Street, E.C.; (West End) 50, Berners Street, Oxford Street, W.; LIVERPOOL—22-30, Redcross Street; GLASGOW—125, Buchanan Street; EDINBURGH—114, George Street; BRISTOL—6, Victoria Street; NEWCASTLE-ON-TYNE—13, Prudhoe Street; BIRMINGHAM—218, 220, 222, Corporation Street.

VICKERS LIMITED.

Motors and Generators of all types.

Rotary Converters.

Complete equipment for the electrical lighting and driving of Machine Shops, Factories, Mills, etc



Patent Automatic Reversing Drive for Machine Tools.

250 K.V.A. Rotary Convertor. 6 phase, 50 periods, 480/560 Volts. 1,000 r.p.m. Inverted type.

River Don Works, SHEFFIELD.

Jas. Jaquet, Ltd., Basle
Switzerland.
Combined Revolution Counters, with Chronograph.
Very Accurate Timekeepers.
CHRONOGRAPH AND STOP WATCHES.
Lists on Application.

own sewing machines and life-insurance policies than own gas ranges. This is the case, in spite of the fact that industrial life insurance, sewing machines and gas ranges have been on the market for about the same period of time. The points in which the difference in methods is greatest are that, whereas gas appliances have been sold at less than cost and there has been no semblance of price maintenance, in the other two lines of business everything is done at a profit and there has been a pretty rigid maintenance of prices. Gas ranges are scarcely ever sold for the same prices in any two different cities supplied by one company. For instance, in one city a gas range costing $12 at the factory is sold completely installed in the kitchen of the consumer for $10, while in another city the same range is sold for as much as $25. It would seem wise to study the methods pursued by these companies that have been able to sell their product to the home and realise huge profits enough in the aggregate to make the building of immense home office buildings in our largest cities possible, and adapt these methods to the sale of electric appliances rather than to study and adapt the methods of gas companies. The electrical industry surely should not be satisfied with any but the very best methods.

If we adapt the best and most successful selling methods to the selling of electric ranges we will, when making up the selling prices, figure in all the costs. First we have the cost at the factory. To this we must add the freight, cartage, storage, cost of installing, cost of selling and the overhead costs of all departments connected with the sale and installation of the appliance which are chargeable to it. This gives the cash selling price, and under the present state of the business would probable total up to about 100 per cent. increase over the cost of the appliance at the factory. If standard prices were to be maintained throughout the country it would probably not be able to place the selling price of an appliance subject to some installation expense at less than twice the cost of the appliance at the factory. For long terms it would probably be necessary to add something to this price.

Under the head of easy terms or partial-payment plans one finds two general classes. Both of these have proved successful. For convenience we will call these classes plan No. 1 and plan No. 2. Plan No. 1 allows no discounts for cash in full at the time of purchase. There is no difference between the net cash price and the price when 20 or more payments are made. Under plan No. 2 discounts are allowed for cash in full at the time of purchase and for short terms of payment. The advantage of the first plan lies in the fact that thrifty people do not so often delay their purchases of the appliances until they have saved up enough money to pay for them in full and save the discounts. This plan, therefore, tends to assist the salesman in bringing the prospects to immediate decisions and may therefore result in more sales than plan No. 2.

The advantages of offering discounts for cash in full at the time of purchase and for payments which will complete the purchase in a shorter period than the maximum allowed lie in the reduced expense [illegible] and the smaller amount of capital required to do a given volume of business. Under this plan more cash sales are [illegible] than under plan No. 1. This is shown by the fact that people who will buy a phonograph sold under plan No. 1 and make 20 monthly payments, will save up their money and pay cash for a sewing machine sold under plan No. 2.

Regardless to which plan is used the cost of collecting should always be included in the selling price. The first plan, of course, is a great deal simpler than the second. If under plan No. 1 it is found that the cost of the range plus the average of all other costs makes it profitable to sell it for $100, this will be the price regardless of whether it is sold for cash in full or for 40 monthly payments of $2.50 each. Under the second plan, however, a table of selling prices, discounts, &c., would have to be tabulated. Such a table for the range which under plan No. 1 would sell for $100 might look something like this:—

Number of payments.	Total amount paid.	Amount of each payment.	Saved by paying in shorter term.
1	$75.00	$75.00	$57.00
6	84.00	14.00	48.00
12	90.00	7.50	42.00
18	99.00	5.50	33.00
24	108.00	4.50	24.00
30	112.50	3.75	19.50
36	126.00	3.50	6.00
48	132.00	2.75	...

To be effective the discounts must be large enough to offer a real incentive for prompt payments. This will be the case if they are arrived at in the following manner. The cash price includes the cost of the appliance, the cost of selling, the cost of installing and all other costs chargeable to the appliance plus a reasonable profit. To this price there is added the interest on the money invested, the cost of making the collections, the cost of the additional book-keeping, the money lost through uncollected accounts and lost or stolen appliances. These costs are made up for each six or twelve-month period for the four or five years the accounts are to be allowed to run and added to the cash selling price as shown in the table above. If the discounts are arrived at as indicated here they will vary to a certain extent with different companies and in different communities, but the case exhibited in the table above will be found to be approximately correct.

It is apparent that plan No. 2 is much more complicated than plan No. 1. It offers greater opportunities for making mistakes and will cost a little more to operate than plan No. 1. The great incentive it offers to make prompt payments, however, results in easier and quicker collections, and for a given volume of business a smaller amount of capital is required. For these reasons it would appear that plan No. 1 would work well for a company or dealer with plenty of capital to invest in the appliance business, while plan No. 2 would recommend itself to the company or the dealer with limited capital. Either plan would result in large sales of appliances at profitable prices, would not cheapen the electric appliance business and would permit housewives to exhibit with pride their $100 ranges.

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1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 22, 1916.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—America " discovers " the shrinkage of gas and coal cooked meat at the same time that President Wilson discovers the immediately prospective shrinkage of Allied war orders.

* * * *

A FURTHER CHRISTMAS STORY (electrified) : " Well, Willie, and did you see Santa Claus last night ? " " No, daddy, but I can tell you what he said when he fell over my electric radiator ! "

* * * *

" Atmosphere—A Business Asset," says a newspaper headline. Hardly correct, I think, of the drawing office that overlooks a cabbage patch or a refuse dump, eh ?

* * * *

" Trousers for women," says a Glasgow magistrate, in what will become a famous munition workers' case. But, really now, what could the ladies expect but that such manly accompaniments should go with votes ?

* * * *

A train on the electrified North London Railway during the fog this week ran into a side section in which the third rail had not been laid. This suggests the paradox that when an electric train over-runs " the juice " it is the train that goes dead ; if the train over-runs you—well, as a rule, *you* go dead.

* * * *

Now that the heat of energy of volcanoes has been successfully utilised for electricity generation, we may not despair of heated arguments being applied to power purposes—the Adjectival Electric Power Co., to wit !

* * * *

AN " ELECTRIC " CHESTNUT (re-baked).- In the North " countrie " it is not unusual for respect to be paid to the departed by relatives and " mutes," who walk by the side of the hearse with bowed heads the while. It is recorded that on one occasion two of the mutes were so reverential that they did not look up until a particularly powerful smell compelled one of them to do so. (The cortège meantime had turned up a side road.) " Here, Bill," he cried out, " t' funeral's gone and we've bin followin' an Edison electric tippin' wagon ! "

* * * *

The mind of Bumble (but had he ever a mind ?) has evidently not experienced any expansion from parish pumpisms, even in spite of the war. When reading an extract from the " Rotherham Advertiser," I wondered if war with Germany will ever give us national unity and efficiency. The following are some of its remarks :—

> Sheffield is now throwing off its mask, and is showing itself as a grasping, thieving and unprincipled municipality. Its attitude is so German-like in respect to the interests of smaller municipalities that comparison between its actions and Prussian truculence forces itself upon us. In plain language, Sheffield is now renewing its efforts to obtain powers to take into the city area a portion of the county borough of Rotherham, and it is also asking to be permitted to erect a generating station, to lay electric cables, to carry water mains through, to erect a wharf and to do a lot of other things in the county borough, *all of which would be most prejudicial to the interests of Rotherham.*

Will all ELECTRICIAN Hotplatists who have not yet had delivery, note that I have not succeeded in obtaining Class A certificates for the completion of these. Meantime, they must roast their chestnuts in front of the fire, electric for preference (and extractives). I beg respectfully to state that I have resisted all efforts to supply the distinguished awardees with gas rings in the meantime, T.N.T. notwithstanding !

* * * *

There was a young lady of Ealing,
Who casually glanced at the ceiling,
Where the Westinghouse fan
So quietly ran,
While the others were scraping and squealing.
[From " British Westinghouse Club News."

* * * *

The " Blighty " issue of the " British Westinghouse Club News " makes most amusing reading, though the matter is chiefly of " Westinghouse " interest. There is, however, one item which I extract which will be understood and appreciated by Round Table readers :—

THE ZEPPELIN RAID.

(*To the tune of " Cock Robin."*)

Who warned the works ?
I, said the buzzer, one blast then " anuzzer,"
I warned the works.
Who doused the glim ?
I, said old Brown, I turned it down,
I doused the glim.
Who drew the fires ?
I, said the stoker, stopped my game of poker,
I drew the fires.
Who calmed the workers ?
We, the volunteers, with buns and free beers,
We calmed the workers.
Who saw the Zepps ?
I, Ananias, " fact - without bias,"
I saw the Zepps.
All the girls and the men were a'wondering of what next,
As they clocked on in the morning, became a little vexed ;
But they did not care, as we'd bagged two Zepps.

N. L. L.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Dec. 27, 1879.]

ROUMANIAN TELEGRAPHS.—M. Philippart has been for some time in treaty, through the medium of Prince Battenberg, with Baron Hirsch, the famous Viennese financier, for the concession of the railways and telegraph lines in Roumania and Roumelia. The affair is successfully concluded.

ATMOSPHERIC ELECTRICITY.—On November 20th last, while M. Delamare was walking in the environs of Cherbourg, a thick snow came on, and suddenly his umbrella emitted a buzzing sound. At the same time a little white glow was seen surrounding the points of the ribs of the umbrella, and each of these very quickly gave place to a small spark. Several examples of this phenomena are related in Arago's Notice sur le Tonnerre.

THE ELECTRIC LIGHT.- The electric light has begun to take part in the Christmas decorations of shops. Several Woolwich tradesmen now illuminate the fronts of their establishments by Siemens lamps suspended from the roofs over the middle of the thoroughfare. Messrs. Newton, Chambers & Co. have introduced the electric light into their extensive works at Thorncliffe. At the meeting of the Court of Common Council on the 1st inst. it was resolved " that it be referred to the Bridge House Estates Committee to consider as to the 'practicability and advisability of lighting London Bridge by electric light.' " The Victoria Station is lit by Jablochkoff's system, the source of power being at Charing Cross.

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ELECTRIC LIGHTING OF A "MOVIE" STUDIO.

With the phenomenal growth of the motion picture industry, so familiar to everyone, many details in the design of apparatus used in photo-play production have of necessity been only partially worked out. The electrical equipment of motion-picture studios has, as a rule, suffered particularly in this respect. A notable exception, however, is the equipment of the studio of Wharton, Inc., located on a 45-acre tract on Lake Cayuga, Ithaca, N.Y., where many well known films have been made.

Most of the studio photography is done by artificial light in a one-storey building, 70 ft. by 90 ft., from 90 1,000-watt photographic blue-bulb Mazda lamps. These lamps, with 110 others, making 200 in all, comprise the main lighting equipment of the studio. In addition, there are four 30-ampere 110-volt double-carbon arc lamps, known as "broadside arcs," and two 25-ampere 110-volt carbon arc spot lamps. The connected load of all these lamps is 219 kw. Altogether, the motors used in the carpenter shop for pumping, &c., taken with the lamps used for general lighting, form a load of about 11 kw., making a total connected load of about 230 kw.

The carefully installed distribution system in this studio stands out as one of its most distinguishing features. All terminals are controlled so as not to invite short-circuits, which might injure equipment or the personnel of the staff. The main switchboard has no live points exposed on its front. The open switchwork on the back of the board is protected by an enclosure, the doors of which may be opened only by the electrician in charge.

The switchboard distributes the three-phase 120-volt current from transformers located in a vault just outside the studio. The energy is supplied at 2,200 volts, the voltage being adjusted by an induction regulator located in the transformer vault. The switchboard is connected with the transformers by 400,000 circ.-mil asbestos-covered cables. Each phase is protected by two 425-ampere enclosed fuses in multiple. The energy consumed is measured by a watt-hour meter, the rate of charge being determined by a 15-minute maximum-demand indicator. The usual monthly consumption is from 20,000 kw.-hour to 25,000 kw.-hour.

There are eight principal branch circuits, controlled by switches located along the bottom of the board, and six minor circuits controlled by switches located at the top of the board. Each principal branch circuit is protected by a 350-ampere enclosed fuse on each side of the line. These switches are in turn connected by No. 0000 asbestos-covered cable, with wall boxes located about 4 ft. above the floor at various points around the studio. On a panel in the box the branch circuit is divided into four circuits, each of which is connected to a plug receptacle of 100-ampere rating. Each side of the line of these circuits is protected by a 100-ampere enclosed fuse. The circuits of three of these panel boards include water-barrel rheostats.

The efficient operation of a motion-picture studio demands a lighting equipment which is highly flexible. Experience has shown that special work like trick photography can be done to advantage in a studio equipped with incandescent lamps, because of the flexibility of such equipment and the preciseness with which the intensity of light may be controlled by rheostats.

The 200 1,000-watt lamps used in the studio are mounted on floor and ceiling racks. The rack is equipped with a switch cabinet containing a double-pole switch and two 10-ampere plug fuses for each lamp. These switches are all connected to a single 100-ampere plug. The lamp stands are rugged in construction, and are so designed that all lamps may be moved vertically through a range of several feet, and so that either row of lamps may be turned in a vertical plane through an angle of about 90 deg. Experience in this studio indicates that the adjustable features of the rack are rarely used. The rack is equipped with large rubber-tyred castors and weighs in the neighbourhood of only 200 lb., so that it may be easily moved about the studio by one man, who can readily pass it over the stage cables or other obstructions.

The overhead racks consist of trough reflectors made of galvanised iron. Each lamp is protected by a knife switch and 10-ampere plug fuses, similar to those used on the floor racks. The ceiling racks are mounted in pairs on a light steel frame, which holds them about 3 ft. apart. This frame is supported at the centre by light block and tackle from trolley wheels, which run on rails attached to the ceiling. Through the medium of this trolley system the overhead racks may be readily shifted about the studio.

The equipment of the studio includes 21 ceiling racks, seven of which are equipped with five lamps, while the remaining 14 are equipped for six lamps each. There are 11 floor racks in all. Two of these racks are equipped for four lamps, three for six lamps, five for eight lamps, and one for 12 lamps. There are, besides, two racks requiring six lamps each and a single stand lamp, which are of special design for use in places where it is impracticable to use the larger racks. The two six-lamp racks are so constructed that they may be readily taken apart, and are therefore suitable for use outside the studio.

Any uncomfortable effects of high temperature that might be expected from the dissipation of so much energy are practically eliminated by burning the lamps for only short periods at a time. In the Wharton studio the lamps are rarely left burning for more than five minutes at a time, so that they do not have time to heat up the air of the room noticeably. In the "directing" of a set, one or two lamps are turned on simply for purposes of general illumina-

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tion. The director rehearses the scene by this light until he is satisfied with the action. He then calls for "lights." All of the lamps required are instantly thrown on. In a few seconds the action begins, the photographer starts his film, and in from one-half to three minutes the action is finished.

The special blue bulb of the lamps cuts the luminous intensity of the light down to one-third of what it would be with the clear bulb without reducing appreciably its photographic power. This, together with the fact that the contrast, and hence the degree of glare, is reduced by having so many sources of similar intensity all in the same plane, results in the glare effect being comparatively unnoticed.

Perhaps one of the most striking instances which demonstrate the lack of any particular discomfort due to glare or heat occurred last summer when the people of Ithaca were invited to the Wharton studio for a ball. The entire studio was used and illuminated with 200 1,000-watt lamps and two 30-ampere broadside arcs. The broadside arcs were used to illuminate the principals, who were photographed with the guests as a background. The visitors were informed that pictures would be taken of the ball some time during the evening. They were not notified exactly when, and the ball proceeded and was over with only a few of them knowing when the pictures were made.

Arc lamps are used in this studio on occasions to secure a large volume of light on a comparatively small area or through a comparatively narrow opening. Arcs are also sometimes used outside of a window in a set to produce the effect of sunlight streaming in.

In lighting up a bank, court room or any other such scene outside of the studio it is obviously impossible to connect all of the lamps directly to the lighting circuits in the building. To deal with such work a transformer is placed on a truck and connected directly to the 2,300-volt primaries of the lighting circuit at the nearest available point to the room to be lighted. Heavy stage cables are run from this transformer in through a door or window of the building to portable plug receptacles known as spider boxes. The equipment of the studio includes two of these spider boxes, one capable of taking four 100-ampere plugs and the other six 100-ampere plugs. The two six-lamp collapsible racks, together with ceiling racks, are generally used for this class of work, since they are the most readily portable part of the lighting equipment. These racks are connected directly to the spider box with the usual cables.

The average no load voltage in the studio is about 120 volts. The actual socket voltage during operation ranges from 110 to 115 volts, according to the loading of the circuit. Continuous records of the voltage are kept by means of a Bristol recording voltmeter. Since the lamps used are rated to give 1,000 hours' life at 105 volts, they may be expected to give from 300 to 600 hours' life at this operating voltage. The apparent disadvantage of shorter life is offset by the higher voltage. The advantage of over-voltage burning is so well established that studios in various parts of the country burn their lamps anywhere from 10 to 30 volts above the voltage at which they are rated on the basis of a 1,000 hour life.—[W. E. BREWSTER in *Electrical World*.]

"ANTI-ZEPP" SHADES.

The lighting regulations which are now being enforced with considerable rigour have given rise to a demand for shades which will effectually meet the conditions without shutting off more light than is absolutely necessary. In order to fill this demand, the General Electric Co. (Ltd.) are putting on the market a series of cardboard lamp shades with special features which commend them for general use. These shades, instead of being fixed to the lampholder, are held by cords which are tied to the flexible wire above the lamp at the height necessary to screen the rays from the window. Different sizes and shapes of shade are available, so that their adjustability to all conditions is complete. One form is made with a wide collar shallow towards one side and deep towards the other, so that windows

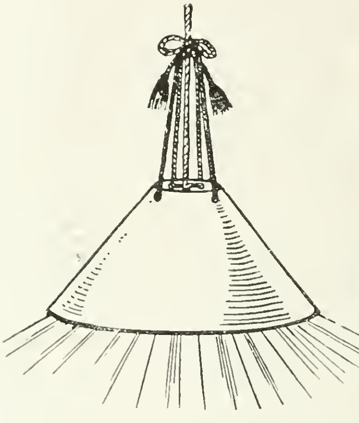
FIG. 1.—LARGE SIZE ANTI-ZEPP SHADE.

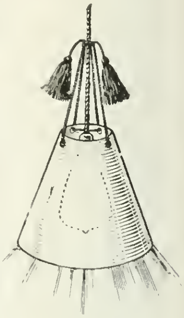
FIG. 2.—SMALL SIZE ANTI-ZEPP SHADE.

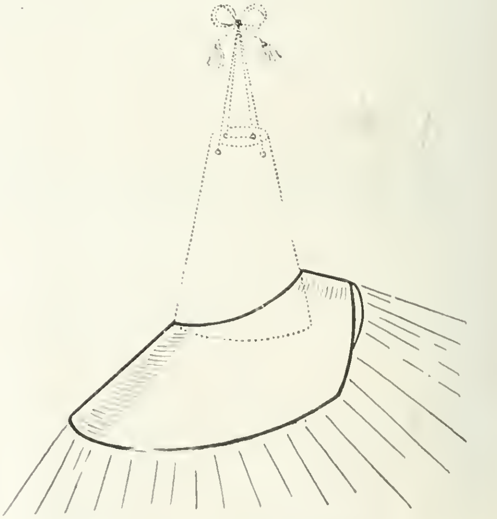
FIG. 3.—COLLAR ANTI-ZEPP SHADE.

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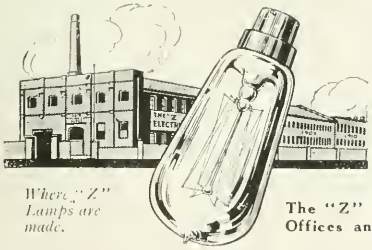

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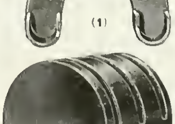

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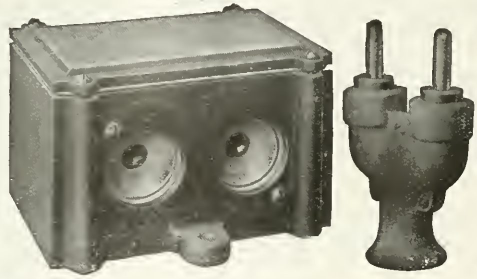

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may be fully protected without shutting off much light from the remainder of the room. The collars may also be obtained separately for fixing on to shades of the other patterns. All these shades are made in various tints, such as dark green, pink, brown, &c. As they are sold at a very low price they represent a quick-selling line, which should be very popular at the present time.

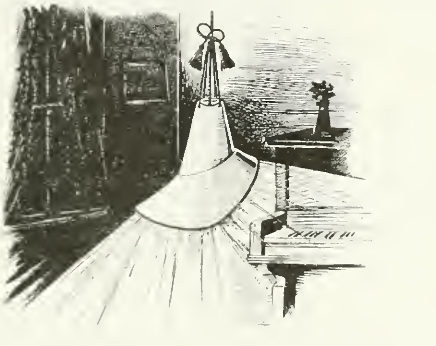

Fig. 1.—Complete Unit, Anti Zepp Shade.

AFTER H_2O C.A.V.

When a Mex motor spirit lorry, through skidding, ran into the brook at Bransford, near Worcester, at midday on Nov. 27, and was precipitated into 16 ft. of water, it was not until five in the evening of Dec. 1 that it was got on to the bridge again. One of the engineers of the Bowring Petroleum Co. (Ltd.), who was in charge of the operation, turned on the switch and, much to his surprise, found the light set intact and in perfect working order, nor has it required any attention since, although it has been in frequent use. This may be taken as a typical instance of the excellence of design and workmanship of the C.A.V. lighting set for heavy vehicles, and shows that the waterproof qualities and insulation of this famous system are practically perfect. Mr. Chas. A. Mott, the Birmingham and Wolverhampton manager for the Bowring Petroleum Co., vouches for [illegible] fact.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
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PUBLICITY WITH IDEALS.

The following editorial comment upon the second annual Electrical Week held in the United States by the Society for Electrical Development, while it makes excellent reading from an electrical point of view, is none the less a little aggravating by comparison with our own position in these matters. The chief lesson to be learned from this organised effort in giving national publicity to domestic, industrial and commercial electricity is the preparation by the manufacturers of huge quantities of goods, many months beforehand and the distribution and sale of these throughout the country, accompanied by the necessary "beating of the band." At such time that we are able to embark upon a National Electricity Week our manufacturers must have this fact in mind and prepare their plans accordingly. We have in the past been too parochial in these matters and have been too fond of crying the goods in the market with an empty stall before us.

"America's Electrical Week, now being celebrated, from a narrow viewpoint is simply a concentrated merchandising effort. All over the country central stations, dealers and contractors are engaged locally in special drives to sell more electrical appliances. While this stimulus to local effort is important because it helps to teach the industry merchandising values, the wider significance of the movement ought not to be overlooked. Last year, Electrical Prosperity Week came at a time when business was just beginning to improve and as a result the Week helped materially to increase local sales. This year the industry has been faced with the problem of filling orders rather than getting more business, and so from the narrow view the impetus to sales will probably be less pronounced than last year. America's Electrical Week, however, is more than a sales drive. No industry is more blessed with associations and societies than the electrical business. But, in our opinion, in all our efforts in these societies and associations, we talk too much about ourselves and too little about the realtion of our work with the great market place of activity outside our own profession or branch of the industry. As engineers we talk to other engineers, as public utility men we discuss problems with other public utility men, as merchants and manufacturers we exchange experiences with others of our own chosen circle. Of our professional or business relations with the great world outside we say little or nothing and they know too little or nothing.

"The Society for Electrical Development has the opportunity to interpret the electrical industry in the world's market place—the public outside the industry. America's Electrical Week in this broader aspect is part of such a movement. The poster exhibit conducted by the Society as the beginning of this year's propaganda, the electrical issues published by several popular periodicals and fostered by the Society, the lighting of the Statue of Liberty, which the Society has helped to promote, each are part of a worthwhile movement, intangible and hard to measure concretely, but certainly of advantage to the industry and far outweighing, on any measurable basis, the money put into the effort. Publicity is an art by itself. Its cheapest form is puffery. Given ideals, it is a powerful educational force to acquaint the average man with the significance of a movement in which thinking men agree. The 'Electrical World' believes in publicity with such ideals. It believes that the industry as a whole needs more such publicity, interpreting to the sister arts and industries and to the public the advantages of electricity.

"America's Electrical Week this year, as last, will result in local sales, but its lesson in educational publicity is of greater significance."

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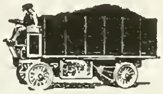
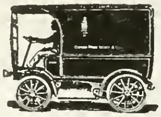
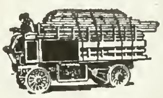
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 29, 1916.

ELECTRIC VEHICLE PROGRESS

ELECTRIC VEHICLES IN LAUNDRY WORK.

Electric commercial vehicles, after a protracted test, have solved the collection and delivery problems of laundries. The proprietor of the Brunswick Laundry, Jersey City, N.J., recently gave some instructive facts to Mr. A. Jackson Marshall, demonstrating the superiority of the electric commercial vehicle for laundry service. In the course of a lengthy interview he said: "About four years ago, after having had some 12 years of the usual experiences with horse-drawn and petrol delivery wagons, with their attending high cost and comparatively unsatisfactory operation—and having had the opportunity to study and partially appreciate the efficacy of electric commercial vehicle operation in many other lines of business—I decided to experiment with a few electric vehicles for the collection and delivery of the material handled by the Brunswick Laundry. After four years' use of the 'electrics,' during which time careful and complete cost accounting records were obtained, I can more thoroughly appreciate why most of the large commercial fleets, such as those of department stores, breweries, express companies, bakeries, &c., are chiefly composed of electric vehicles.

"As soon as the all-round efficiency of the vehicle is realised by the laundry industry, I am convinced that most laundries will use the 'electrics,' well-nigh to the exclusion of all other means of collection and delivery. I am able to cite facts and figures which I believe will convince even the most sceptical that the claims that I put forth on behalf of the electric vehicle are reasonable and conservative.

"The daily load average of the Brunswick Laundry is approximately 1,500 lb., and at least 65 horses are necessary to do this work, allowing for emergencies. During the time we were using horse-drawn wagons it was often impossible to give our patrons good service. This was particularly true in the winter, when the horses were incapable of covering their usual routes because of the severe weather and the slippery streets. Added to this was the extra loss of time occasioned by the necessity of sending the horses to the blacksmith to be 'roughed.' Even with the greatest precautions accidents were bound to happen, and especially on the steep grades, all of which was not only a loss to us financially, and a detriment to our service, but also inhumane.

"Under the same conditions the 'electric' quickly proved its worth. Thirty-three electric vehicles are sufficient to replace the 65 horses, and during inclement weather the only extra preparation necessary is the addition of chains, and each driver can equip his car with non-skid chains in 15 minutes. Last winter during the unusually severe weather we were able to make all our collections on time, much to the surprise of many of our patrons, who were being inconvenienced by continued delays in their milk and grocery deliveries, where electric vehicles were not employed. In fact, I may say that the 'electric' is so dependable that our customers can always expect deliveries at a definite time each week within 15 minutes of the hour.

"In electrifying our delivery service we were not obliged to discharge our former drivers and engage experienced chauffeurs, as the simplicity of the 'electric' enabled the men who had been driving the horses to learn to operate the new vehicles very successfully in a few hours. This saved us expense and inconvenience, as there is a distinct advantage in employing men who are familiar with your patrons and routes as well as your policies.

"The comparative operating cost and upkeep of the electric vehicle and the horse are as interesting as the facts concerning the dependability of each. Figures for the comparative investment follow:

Investment for Horse-drawn Equipment.	£	s.	d.
One wagon	80	0	0
Two horses	100	0	0
Two sets harness	18	0	0
Two blankets	2	16	0
Two rain covers	2	0	0
Stable accessories	0	4	0
Stable room	100	0	0
Total	£303	0	0

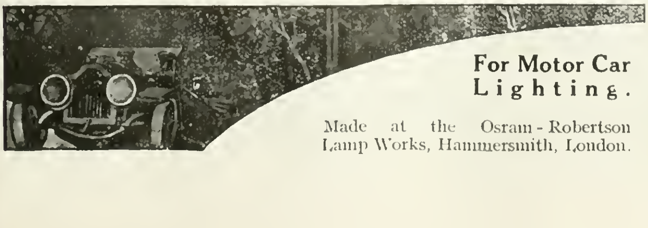
Investment for electric delivery car, complete, £500

"The extra investment necessary for the 'electric' is, therefore, approximately £200. But the initial cost is not the only thing to be considered. The following figures furnish conclusive evidence of the economy in the operating cost of the 'electric':—

Monthly Cost of 65 Horses and Wagons.	£	s.	d.
Monthly feed bill at £3 8s. per horse	221	0	0
Four stablemen at £12 per month	48	0	0
One harness cleaner	12	0	0
One wagon washer and helper	20	0	0
Horse-shoeing at 10s.	32	10	0
Harness bills at 2s. per horse	6	10	0
Veterinary	2	12	0
Total	£342	12	0

Monthly Cost of One Electric Delivery Car.	£	s.	d.
Six per cent. interest on £200 per month	1	0	0
Electric current	0	16	0
Night mechanic per car	0	12	0
Day mechanic per car	0	12	0
Washman and helper	0	16	0
Battery depreciation	2	0	0
Total	£5	16	0

Total for 33 cars, £191 8s.



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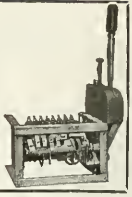

"The depreciation of the car is not included in these figures, but this is balanced by the depreciation of the horses, wagons, harness, &c. Thus the 'electric' shows a saving of over 40 per cent

"The 'electrics' of the Brunswick Laundry average 25 miles per day, visiting all the outlying suburban districts. Some of the best drivers deliver as many as 900 bundles per week, and make an average of 32 miles per day. At an average of 25 miles per day and a current cost of 16s. per month, the current cost per mile is about $\frac{3}{10}$d. on this basis, figuring 900 bundles delivered per week, the energy cost of each bundle delivered is about $\frac{1}{200}$d. In other words, the current consumed in delivering 100 bundles costs about $\frac{1}{2}$d. This is bringing economy to well-nigh the irreducible minimum.

"As for repair bills, I find that they are a negligible quantity in electric vehicles operation. We have a system which enable us to keep our cars in the best condition possible, and which eliminates blacksmiths' bills. Every week one of our 'electrics' is taken down, carefully looked over, cleaned and put in first-class order. Thus every 33 weeks each car goes through a thorough overhauling, and as this work is done by our men in their spare time, no additional labour is required. The vehicles never show any particular wear, except possibly the driving chains.

"The average life of the tyres on the petrol cars which we have used for long hauls is about three to four months, while those on our electric vehicles last from a year and a-half to two years. This is not only a considerable saving in the cost of tyres, but is reflected in another direction. A petrol car that is hard on tyres generally depreciates rapidly, as the vibration affects the body and engine also. The smooth running electric eliminates the jerking and slipping of the wheels in starting and is much less affected by vibration.

"The advertising value of the electric must also be considered. As compared with a horse-drawn delivery wagon or petrol car, the 'electric' has the distinct advantage of being clean and odourless, and is almost noiseless. The cleanliness is an especially important feature, as any woman in selecting a laundry would be rather sceptical of the efficiency of a company whose men looked like a lot of blacksmiths from the dirt and grime of a petrol car, or who had the disagreeable odour of horses and stables about them.

"The safety element of the 'electric' should be mentioned. Collisions are very rare things with these cars, even in congested traffic, as they are started and stopped so easily. Our cars are geared for a maximum speed of 10 miles per hour, which I consider sufficient for any heavy vehicle running through the city streets.

"In purchasing electric cars for laundry work, as for any service, the load must be considered, and a vehicle of suitable size and capacity should be chosen. The bodies of the delivery cars which the Brunswick Laundry use are $1\frac{1}{2} \times 5 \times 7$ feet behind the driver's seat.

"Since we have been operating the electric delivery cars our business has more than doubled itself, and while I do not credit this entire growth to the 'electric' I believe the improved service made possible by the 'electric,' the attractively painted, silent, clean car and the neat appearance of our drivers have all played large parts in gaining new customers.

"As in most large laundries where everything is run by electricity, we generate our own power and charge our electric vehicles at night, then with the exhaust steam we heat a sufficient volume of water to be used the next day, thus eliminating the necessity of the use of live steam in the water heaters during the day. The distilled water which we use for our nickel iron batteries is available in any laundry—the condensed steam from the ironing machines—and is, therefore, a by-product as well as the current used in charging the batteries.

"The Brunswick Laundry has collected, washed, ironed and delivered an output of bundle work amounting to £6,000 at an expense as follows:—

Coal	£110	0	0
Petrol and oil (four petrol cars)	22	0	0
Electric bill (power)	5	10	6
Electric bill (light)	4	2	0
Gas	12	0	0
Total	£153	12	6

"If you will compare this bill with the monthly feed bill for the horses, £221, you will find an interesting proportion.

"The item of £5. 10s. 6d. for electricity used for power represents the amount allowed monthly for breakdown service. The Public Service Electric Company furnishes this current, and it is as important to the laundry as insurance, as it makes it possible to meet any emergency and is regularly made use of on Saturday afternoons in the rush hours of finishing the week's work. The garage of the Brunswick Laundry is 50 × 140 feet, and this is now being duplicated, which will provide space for about 45 electric vehicles.

"Our laundry now operates only machines which are motor driven directly, 80 H.P. being employed, which is a saving of $33\frac{1}{3}$ per cent. over the old method of employing steam belt transmission. A further saving of about £24 per month has been made by substituting electricity for ironing. Thus every possible use of electricity is employed, not only in the interior operations of the laundry, but in the collection and delivery service." That the satisfactory performance of the electric commercial vehicle in laundry service *is* being appreciated is attested by the fact that in the last few years a number of laundry concerns have installed the nucleus of what will probably prove to be large and exclusive electric vehicle fleets.

The Keystone Laundry Company, one of the largest and most progressive in Pittsburg, after a thorough investigation of its collection and delivery costs, recently decided that the electric truck was the most economical means of transportation, and as a result ordered five electric commercial vehicles. One of these "electrics" on a test run over the hills of Pittsburg showed 63 miles on a single charge of the battery. At all times during the run the car carried a load of 612 lb. in addition to the driver and an official observer. The cost of the electric current for this mileage was but 2s., or $\frac{2}{5}$d. per mile. The Keystone Laundry's experiment illustrates the fallacy that electric vehicles do not satisfactorily perform in hilly territories.

It should also be borne in mind that the "electric" is an unusually free and easy coaster, and that while proportionally more current is utilised in climbing hills, on the down grades, even of slight pitch, the electric speedily moves without the assistance of current, which materially compensates for the current used in climbing. When the electric comes to a stop for collection or delivery the current is entirely shut off, and the waste energy experienced in the ordinary operation of gas cars is eliminated.

A further example of the progress of the electric delivery car in laundry service is that of the Sanitary Laundry, of Hartford, Connecticut. On Sept. 6, 1913, this laundry installed one electric vehicle, and between this date and Oct. 23 of the same year the car had covered 1,515 miles. Before purchasing this "electric" the

"CONSULT KEMP re ELECTRICS."

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ALL WITH EDISON ACCUMULATORS.

The Simplest and Most Economical Forms of Industrial Transport. Can be driven by UNSKILLED Men and Women at less than ONE-THIRD the cost of Petrol.

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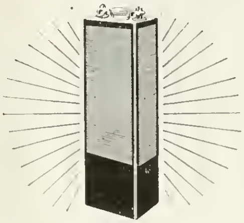
ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

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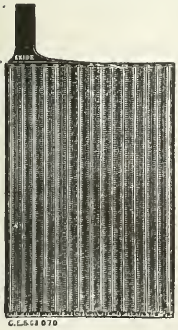
THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



The number of repeat orders received is the best testimony of the results obtained. Continuous hard work with a minimum of attention day in and day out aggregating 10,000 miles per annum is the record of many sets over the past two years. Some of them have completed

25,000 MILES

on the road without a single cell having to be removed from the vehicles for any electrical defects whatever.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION,
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LONDON OFFICE:
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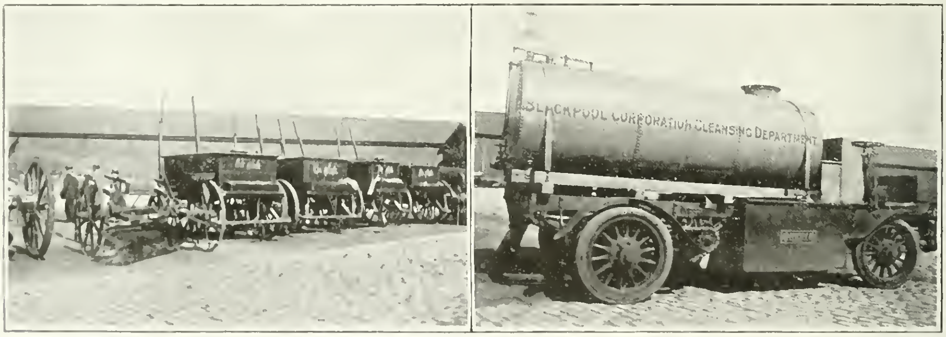
SIEMENS BROTHERS & CO., LTD.
WOOLWICH.
ESTABLISHED 1858.
Telegrams: "Siemens Woolwich."
OVER 4,000 EMPLOYEES.
Telephone: City 6400 (7 lines).

CABLES & WIRES,
MOTOR-CAR LEADS
(Weatherproof, Strong, Flexible and Durable),
BATTERIES
&c., &c.

Sanitary Laundry was operating 4 horse-drawn wagons and covered 400 miles per week, or 100 miles for each wagon per week. Two teams were disposed of when the "electrics" went into service, and the two remaining horses at that time were covering 70 miles per week instead of 100 miles which they formerly covered, the difference representing additional work satisfactorily discharged by the electric vehicles. This economic and efficient service of the "electric" has been maintained.

The Charity Organisation Society of New York City reports that the three electric vehicles in the service of its laundry have reduced their cost of delivery at least 20 per cent., and the general results are much better.

Probably the most conclusive evidence of the "electrics" ability to make good is indicated by the orders for additional electric vehicles which have been placed by laundries after they have had an opportunity to experiment with one or more "electrics." As an illustration the Salem Laundry, of Salem, Massachusetts, in December, 1915, installed one electric delivery car. This proved to be so entirely satisfactory that within six months an order was placed for six more cars of the same type. Another example of a repeat order in this case in four months after the first installation, is that of the J. Arthur Anderson Laundry of St. Louis. In April of this year the first car was put in use, and in August four additional cars were in service. Both the Pilgrim and Crystal laundries of Brooklyn are operating three electric vehicles, repeat orders having been given for two cars each, after the first car had been well tested.



The displacement of horse vehicles by the electric in British municipal service has been one of the features of the past year. The illustrations are typical of the extent to which a single modern electric road-watering vehicle will economically replace a number of horse-drawn carts. Blackpool has been the *venue* of this remarkable change, and the Corporation of that progressive watering place cannot now speak too highly of its "G. V." electric water wagon. Its experience has counterparts in all parts of the country.

With the comparative cost data as the premise, and with the practical endorsement of a number of laundries successfully using the electric vehicle, a few of which have been indicated, the extended use of the "electrics" in laundry service seems assured.

BUTTER DELIVERY BY ELECTRICS.

New York receives, among other things, 161,000,000 lb. of butter annually. The city, perhaps, does not consume all of that great quantity, but it is safe to say that at least three quarters of it spreads Gotham's bread. Butter is rated among the daily necessities, for the city demands a certain amount of it every day. But this creamy yellow product of the dairies is quite perishable, and consequently the supply must be moved without delay and disposed of quickly. And since this matter of transportation of butter is the point of this story, it is just as well to state at the outset that electric vehicles have been selected by several of New York's butter dealers as the best means of distribution from the wholesale warehouse to the various retailers.

One dairy in particular is that distinguished by the bright splash of blue that enlivens the more or less prosaic "produce" street on the west side of Harlem, known in the directory as 12th Avenue. Here the Blue Valley Butter Co. of Chicago, New York and elsewhere maintains its metropolitan distribution centre, and from this point 20 electric vehicles, 1-ton trucks of the Walker make, start on their tours of the city, each carrying its supply of the well-known blue and gold packages of Blue Valley butter.

One of the problems and the most difficult in the way of hauling that the Blue Valley Butter Co. faced was the number of short hauls, or, to state it more clearly, the number of stops to be made by their vehicles during a day's deliveries. It was estimated that trucks carrying butter to various retailers made anywhere from 50 to 110 stops during a day. In reality this meant 110 short trips from one establishment to another, and it was a problem to find a delivery system that would meet the situation.

The problem presented itself first in Chicago, where the main office is located, and the officials there had, after careful investigation, the satisfaction of finding the solution. They finally determined on a fleet of electric wagons to do the work. First it was found that the electrics could cope with the peculiar situation arising from the frequent stops incidental to wholesale butter distribution. Then the officials, realising that cleanliness must be considered far above everything else in the dairy business, decided that petrol trucks or horse-drawn vehicles had no place in their delivery system. Both were bound to produce soiled hands at least, and such conditions were not to be countenanced among the drivers of their cars.

Everything considered, electrics presented the strongest appeal, and the management decided to adopt them forthwith. The Walker 1-ton truck was accepted after exhaustive tests, and several were put into service. So satisfactory was their work that the entire Chicago fleet, some 30 cars, consists of this type of vehicle.

Soon after this the Blue Valley Butter Co. decided to enter the New York territory, and the West Harlem headquarters was opened. In view of the experience in Chicago, the officials had little difficulty in deciding what vehicles were to be used in this new field, and a New York fleet of 20 cars equipped with Edison A 6 batteries was established. This fleet has cared for all deliveries in the metropolitan district for the past year, giving excellent service. According to the manager in the local field, the electrics are proving their worth every day, and their operation constantly shows a saving to the Blue Valley Dairy Co. of time, money and worry. And the rapid growth of the business here is in a measure accounted for by the efficient delivery system.—"New York Edison Monthly."

BE UP-TO-DATE

and install BUDA Electric Battery Trucks in your works

TIMKEN-DAVID BROWN WORM DRIVE.

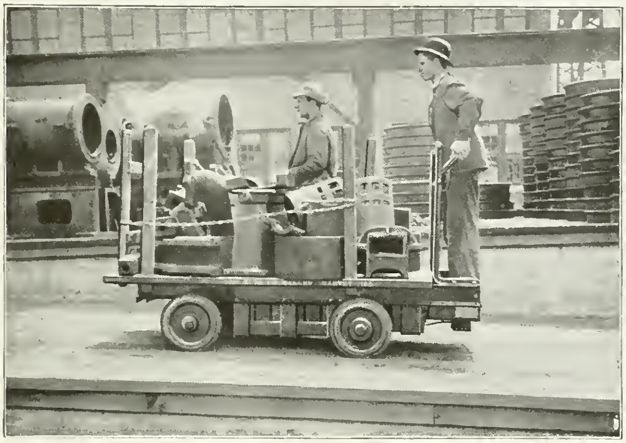
FULL FLOATING REAR AXLE.

FOOL PROOF CONTROL.

ALL PARTS ACCESSIBLE.

COSTS ABOUT 8d. PER HOUR TO RUN.

WILL SAVE ITS COST IN A FEW MONTHS.



BUDA TYPE A TRUCK.

WRITE FOR DETAILED SPECIFICATION TO

The ELECTROMOBILE (Leeds), Ltd., Neville Street, Leeds.

Telegrams: "ELECTROMOB, LEEDS."

HAS THE CHEAP ELECTRIC ARRIVED?

A line of what is described as the lightest, lowest-priced and highest efficiency electric vehicle ever built will be manufactured by the Dey Corporation, New York. The company will specialise on a runabout intended primarily for utility work, such as travellers. The car is not a passenger type, nor yet a truck, but essentially a utility vehicle. In addition to this runabout a closed type of passenger vehicle will be produced. The company will manufacture what might be termed a utility chassis suitable for taxicab purposes, as well as passenger bodies and light truck uses.

The price of the new lowest-priced electric to be built by the Dey Corpn. has not been determined, but it is understood that it will be under £200, and that eventually the dream of Dr. Steinmetz of a £100 vehicle may be attained, if not carried further.

At the same time this announcement comes out others appear, one in Chicago and one in New York. The New York company has been formed to place 500 electric taxicabs in that city, while a similar one is projected for Chicago. At the same time the Walker Vehicle Co., of that city, have brought out a utility chassis on which a runabout body has been fitted for the Commonwealth Edison Co. for the use of its travellers about town.

In the first of these cars the lines are very graceful, the hood tapering into the dash in a pleasing manner. The lines of the body, however, are strongly reminiscent of the well-known Ford car, while the chassis is of the same substantial quality that has always characterised the company's Chicago electrics. Pneumatic tyres will be fitted. The car provides a type far more suitable for salesmen and travellers than the converted and electrified weak Ford chassis used in New York city. The present car being a real electric motor car, that central stations should welcome with open arms.

Whether the new Walker and the Dey are a step towards the £100 electric, as it was styled two years ago by Charles Steinmetz, remains to be seen. Such a car has been a cherished matter with Dr. Steinmetz. It has been known for several years that he has been perfecting features of design which would make it possible to produce a utility electric vehicle at practically the same price as the cheaper gasoline machines. Dr. Steinmetz strongly advocated this type of vehicle before the different electric interests, as well as before the electric vehicle manufacturers. It was generally considered impossible to build such a vehicle that would give the desired service. The possibility of producing such a vehicle resulted in many strenuous arguments on convention floors, between central station concerns, or companies manufacturing electric current, and those engaged in vehicle manufacture. The central station interests were strong for such a vehicle, as it would naturally be a great source of revenue if manufactured in large quantities. On the other hand, electric vehicle makers were catering to public requirements for larger and more luxurious types of electric vehicles.

With the sphere of the electric widening, with electric taxicabs in four large American cities, the cheap electric on its way, and the small industrial truck and tractor going strong and electric trucks it looks propitious for a rosy future.

THE IMPORTANCE OF THE ELECTRIC TRACTOR AND TRUCK.

The project was recently announced by the Society of Automobile Engineers to amalgamate the technicians of the automobile, the aeroplane, the motor-boat and the tractor under the broad title "Society of Automotive Engineers." It is worth noting that while the electric vehicle is tacitly included under the general division of "automobiles," the electric industrial truck and tractor has no special place in the scheme. The division labelled "tractors" naturally relates to the agricultural variety upon which the internal combustion engineers are working with intense application just now.

The petrol tractor is essentially an outdoor affair, primarily devoted to the improvement of the soil. The electric truck or tractor, on the contrary, is properly a denizen of the crowded warehouse and railway terminal an exponent of the highest industrial efficiency. They are alike only in the common use of the term tractor "an instrument for drawing."

The agricultural tractor, sordidly mechanical as it is, is nevertheless spectacular. It pleases the popular fancy. The idea of the farmer overcoming the resistance of the stubborn earth by the aid

TUDOR
ACCUMULATORS
FOR ELECTRIC VEHICLES.

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of science gives another excuse for that added respect we have long wished to pay the tiller of the soil.

That is why so few people really appreciate the tremendous importance of the electric tractor and industrial trucks and the vast field that lies before it. The significance of its operations, interesting as it is to the efficiency advocates, is concealed from the public eye by the very nature of its employment. Only a handful of observant men know that the electric industrial tractor is driving along the edge of a usefulness nearly as great as that of the hauler of farm ploughs and harrows.

In other automotive fields, the internal combustion engine is in direct and active competition with the electric motor and battery, with the advantage now on one side and now on the other, but with each a worthy opponent of its competitor. But in the field of the industrial tractor the electric is supreme and unquestioned. The fact that it is absolutely satisfactory in its work is sufficient explanation for this condition.

The industrial truck and tractor (the adjective "electric" can be omitted, for the reason mentioned) is a desirable product from the manufacturer's standpoint. Instead of being sold one at a time to difficult and hesitant buyers they are sold in lots of up to 50 or so to large corporations, which have no doubts as to what they want.

The trade circle of the electric vehicle industry in its ordinary [illegible] does not include the industrial tractor.

The industrial truck and tractor may be the least spectacular of vehicles, but it is destined to become one of the most important, and [illegible] is the motive power that will benefit by its widespread [illegible] "Electric Vehicles," Chicago.

THE DEVELOPMENT OF THE ELECTRIC VEHICLE.

[illegible] defined as "a vehicle propelled by the [illegible] electrical storage batteries on board," [illegible] the [illegible] all electric [illegible]. There have been [illegible] of this particular vehicle, but these have [illegible], even in war time, that it is now pos[illegible] in the business of distribution. [illegible] American engineers have been chiefly responsible, and it is from the States that the best comparative statistics are obtainable. Remarkable progress has, however, also been made in this country. This was clearly shown in a Paper read by Mr. Brockman to the Institution of Engineers and Shipbuilders in Scotland in the Technical College, Glasgow. Of all power vehicles, Mr. Brockman averred, electrically-driven vans and lorries have proved themselves best suited in every respect to supersede horse traction in city and suburban service, and for these fundamental reasons: The cost of energy is low, and no power is consumed while at rest; the speed is double or treble that of horses with equal loads; they are self-starting, and easily controlled by cheap labour; they have a short wheel-base, taking up a minimum space on streets and in garages; they have a reliability equal to 95 per cent. of the working hours, due to simple mechanism, consequently the upkeep charges are low; they are clean, sanitary, and free from fire risks. Smooth and rapid circulation of traffic in our streets, regardless of weather conditions and steep gradients, can, therefore, be ensured by their employment. Further, the inclusive expenses entailed by operating within a radius of from 8 to 10 miles from any centre—or from 40 to 60 miles run per day—compare most favourably with all other means of animal and motor traction. In fact, the more closely investigation is made into every principle and detail of modern electric vehicles the most convincing their merits will become. It is important to notice that the coefficient of reliability—*i.e.*, the ratio of working days in commission to total number of working days during any given period—as already stated, comes out at the fine average of 95 per cent. The relative values for other haulage systems are: Petrol lorries, 90 per cent.; steam lorries, 85 per cent.; and horses, according to severity of service, from 65 to 85 per cent. Official statistics prove that on tramcars 500-volt motors have run 250,000 miles without repairs other than renewals of brushes, and an occasional turning down of commutator surfaces. On delivery vehicles the pressure is eased down to either 60 or 80 volts, and, by reason of this being maintained practically constant, racing by "sporting" drivers is made impossible. To this fact, bracketed with the effects of sturdy design and ideal simplicity of mechanism, the immunity from breakdown is largely due. Beyond a critical speed limit the repairs bill is raised as the square of the speed excess. Starting, steering and stopping could not conceivably be made easier for the driver; no clutch, gear changes, ignition, carburettor compression, oil pump, and cooling system to trouble about; power consumption at every movement is visibly indicated, providing a constant check on the condition of the vehicle, and enabling the driver to stop any waste of current which may be due to a dragging brake of other external cause. In short, a machine as nearly as possible automatic over the entire range of its operations has been evolved, which any average person can be trusted to handle correctly after a short course of instruction. Consequently, the class of labour from which drivers may be selected is large, and wages are reasonable. Current can be drawn readily from the energy stored on board for lighting and inspection purposes during loading and unloading, while electrically-actuated power appliances, such as winches, capstans, tipping gear, &c., are served by a separate motor supplied from the car battery.

Discussing in detail the question of speed, Mr. Brockman pointed out that the reasonable speed insisted upon in commercial electric vehicles is adversely contrasted sometimes with the great pace at which petrol motors can be driven on top gear by making use of the excess engine power available. The advantages this feature gains for the latter "on the open road" is freely admitted: it gives them a field of usefulness entirely their own. Battery motors, however, are principally intended for service in town and suburban traffic, where the legal limit of 12 miles per hour is rigidly enforced, and the average speed possible barely exceeds 10 miles per hour. This distinction should be clearly realised; petrol and steam motors compete in the main with railways; battery motors with horses. Rivalry between these types of motors on short-haul work, while possible, is not an attractive proposition for mechanically-propelled machines; economic reasons are against it. High speeds, on the other hand, are expensive in repairs and maintenance costs, and in shortening the useful service period of the chassis. This discovery has led to the introduction of sealed governors on petrol motors, limiting the pace to 17 miles per hour with clutch engaged. The fact that on an electric vehicle speed is not within the discretion of the driver beyond a sensible maximum rate on the level, suited to the carrying capacity of the truck, accounts largely for its long life and high coefficient of dependability. Speed caution may have been carried too far in some instances, but, even so, owners will be much better off than when having to finance the joy rides of their drivers. In traffic, the electric vehicle, due to self starting and rapid acceleration, "gets there" as quickly as the speediest machine, while for work in hilly districts it possesses quite exceptional qualities, notably with a four-wheel drive.—"The Scotsman."

Printed and Published by the Proprietors "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 29, 1916.

THE ROUND TABLE.

By "KVA."

Event of the Week.—According to the "Daily Telegraph" Mr. W. P. Durtnall "has designed for the trans-continental railway across the waterless parts of Australia certain kerosene electric locomotives designed for hauling 600 ton trains at thirty miles an hour."

* * * *

I am asked to contradict the rumour that Mr. A. P. Trotter is just now busy taking photometric tests of London's street lighting when there is no moon.

* * * *

Our old friend the "Journal of Gas Lighting" will in future be known as the "Gas Journal," with the sub-titles "Light, Heat, Power, Bye Products."

* * * *

"Owing to the war this useful publication appears later than usual, but advantage has been taken of the additional period to insert information of a later date than in previous years."

Thus a contemporary on a well-known electrical directory, but is it meant to be a compliment?

* * * *

Thus Prof. H. E. Armstrong, in "The Times":—

"If gas ever rank as an equal of the electric light let alone as its superior, it will be when it is supplied not only free from noxious impurity but of constant quality, and at such pressure that it can be burnt at constant rate in standardised fool-proof fittings—so that the public have nothing to do but just set light to it, then pay for it and look pleasant, because they have no fault to find with it, and have been put to no trouble in using it."

To all of which the answer remains a query "If?"

* * * *

Mr. W. Perren Maycock will, I am sure, be distressed to hear that switches are likely soon to be on the market with knobs which are luminous in the dark. The introduction of such devices will be a severe blow for "switching": the householder will doubtless be taught to fix his eye on the bright spot and make a "bee" line for it. When he can do this without barking his shins he will, perhaps, be given a certificate of proficiency!

* * * *

It is a long time now since I awarded Mr. H. Talbot, city electrical engineer, Nottingham, a Hot Plate for maintaining his electricity supply from no less than 37 Willans reciprocating units and one exhaust turbo-unit. Evidently this award did not have a salutary effect, because I now see that Prof. H. E. Armstrong, criticising the plant of the electricity department. When you come to think of it, Willans sets are a "bit old" for a city like Nottingham!

* * * *

According to the "Daily Chronicle," a youth of 16, who was not served quickly enough in a restaurant, ran amok and proceeded to break up the crockery and other effects. During examination at the police station he described himself as a "gas-fitter." Now, if gas induces such methods of frightfulness in one of such tender years, what will be its effects when this youth reaches man's estate? We like to see gas encouraged for T.N.T. and other patriotic reasons, but surely not to this extent!

ELECTRO-HARMONIC SOCIETY.

3rd Concert, 31st Season, 1916-17.

Holborn Restaurant (Venetian Chamber), London, To-night, 8 p.m.

Unofficial Programme.

In the Chair, "Hello" W. E. Kingsbury.

Trouser-ettes Chorus	"We all Walk the Wibbley Wobbley Walk." Glasgow Munition Girls.	*Long & Pelham*
Drawn Wire Glee	"That Broke up the Party." ... Duram Limited.	*David & Lee*
Central Valve Solo	"In an Old-fashioned Town." Mr. "Nottingham" Talbot.	*Squire*
Photometer Flicker	"You, just You (My Lumen)" Mr. F. W. Willcox.	*Thompson*
"Dry" Chorus ...	"Drink to Me only with thine Eyes." ... Boys of the Water Transport.	*Jonson*
"Coherent" Patter	"In Trouble Again." ... B.T.-H. Co.	*Foy*
Advert Humoresque	"I must have my Little Joke." "C.T.S." Brooking.	*Pleasant's*
Burn Out Medley	"I'll Sing thee Songs of A.E.G." Mr. "Shanghai" Aldridge.	*Chard*
Embonpoint Solo (w)	"I can't do my Bally Bottom Button up." "Baby" Beevor.	*Collins*
Khaki Comb(ed) Band	"Are WE downhearted, Nocoooooo!" ... The Jan-One Called Ups.	*Hipped*

God Save the King.

* * * *

OUR HOT PLATES.

No. 224 to

Electromotors Ltd., for their new "Lo-Thermo" motor.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Jan. 3, 1880.]

The Electric Light at Sea.—The passengers by the Inman steamer "City of Berlin," during her recent trip to New York, with the electric light on board, have addressed a note of congratulation to the company. The experiment of lighting the vessel by electricity has proved highly satisfactory. Not only was the saloon brilliantly illuminated, but the steerage, usually the gloomiest part of the ship, was lighted up in all parts.

Stored Light.—The luminous paint of M. Balmain has been brought recently into prominence by Messrs. Ihlee & Horne, of 31, Aldermanbury. The paint is rendered self-luminous by mixing with it a sulphide of lime or other "phosphorescent" material, and on exposing the painted surface to daylight, the light of burning magnesium, or of an electric arc, the light waves seem to set the molecules of the salt into a vibration which lasts for several hours. The result is that on taking the painted surface into a dark place a pale violet light is emitted from it. The projected applications of the paint are for buoys at sea, lamps for powder magazines, wine cellars, compartments of ironclads, and advertising purposes, but the uses to which it may be put are almost infinite.

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THE “KINGSWAY” SIGNALLING SYSTEM FOR MINES.

The attention of electrical manufacturers and colliery engineers has for a considerable period been concentrated upon the production of electric apparatus capable of controlling satisfactorily the power plant in collieries. The endeavours that have been made to secure the widespread introduction of electricity as a signalling agent have, however, been quite inconsiderable in comparison. That electricity should be extensively employed for signalling was inevitable, and its inherent advantages have been clearly recognised and turned to good purpose.

It has almost entirely displaced mechanical signalling on haulage ways, whilst a telephone installation in a pit is of even more utility than the ordinary commercial telephone, for not only does it facilitate work in the colliery, but there are many instances well known to the colliery engineer when the telephone has rendered invaluable service from other than commercial points of view.

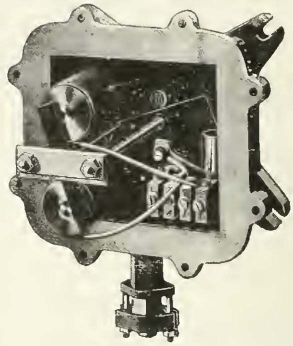
In general there are three classes of communication in colliery work:—

1. Signalling along main and branch haulage roads to the driving plant.
2. Signalling between onsetters, pit bank and engine room.
3. General telephonic communication about pit.

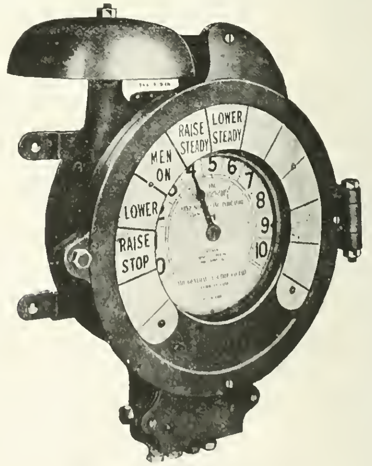
The extensive application of electricity for the purpose of signalling has demonstrated that much of the earlier plant already installed was not suitable for its work in every contingency likely to occur in a colliery. Some of the signalling plant has in consequence [illegible] been rejected, whilst some has been replaced by better installations, and in other cases it has fallen into disuse. It is an unfortunate fact that opinion in regard to the utility of electric power is [illegible] unfortunately biassed by the prevailing tendency to [illegible] caused by fire, even where there is no [illegible] are to blame. In the case of electrical signalling [illegible] this tendency has had the good effect of [illegible] attention to be paid to the improvement of electrical signalling [illegible] with a view to obviating the possibility of explosions arising from the use of electricity.

The old forms of signalling were capable of producing a spark sufficiently strong to cause an explosion of gas, and so electrical signalling was laid under a charge which it must be made impossible to bring in the future.

Applying themselves to a solution of the problems involved in supplying suitable electrical signalling plant, the General Electric Co., Ltd., have produced and are manufacturing a number of new forms of signalling gear. They inform us that they are now in a position to offer a complete signalling plant which, while realising to the full the advantages of electrical over other forms of signalling, provides such safeguards that no danger is to be apprehended; this is confirmed by exhaustive proving in the gas testing stations. At the same time the apparatus is so constructed that it fully complies with the requirements of colliery work and with the Home Office regulations.


Interior View of the Davies-Railing Relay.

The old form of signalling involved in signalling along main and branch haulage roads to the driving plant comprised a pair of wires extending perhaps the whole length of the road and forming part of an electrical circuit, including batteries and a bell. While this system left some room for improvement from the point of view of electrical maintenance, it was in the main satisfactory considered from its performance as a signalling system. But the danger of this system was the fact that the spark forming between the wires at the moment of breaking contact was often sufficient to ignite gas. Some



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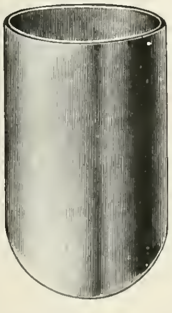

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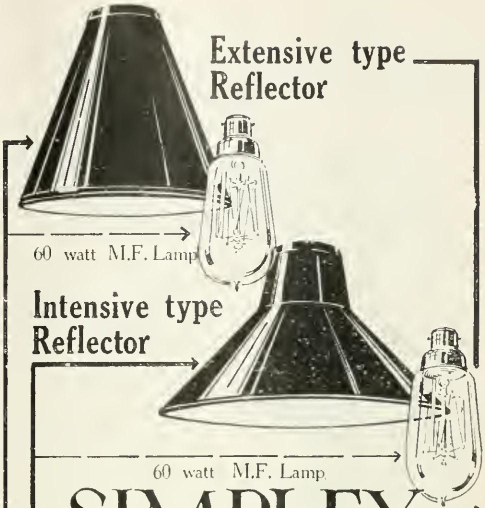

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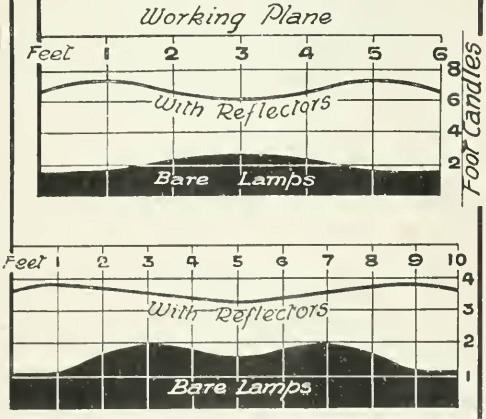

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device was needed whereby this danger could be overcome, and various schemes have been suggested, but we gather that no satisfactory solution had been reached until some time ago The General Electric Company introduced the Davies-Railing patent signalling system. In one colliery alone there are 40 miles of signalling with this system, a valuable testimony to its efficiency.

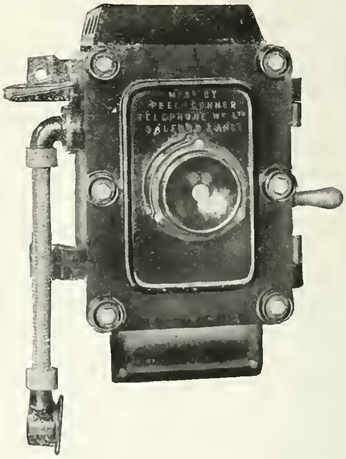
To give a satisfactory ring, a current must be employed which will inevitably give a spark at the moment the contact in the bell circuit is broken. In the Davies-Railing system, instead of permitting this spark to occur at the signalling point, a relay circuit is introduced and the bell circuit made and broken inside an explosion-proof box; this bell circuit being purely local and distinct from the signalling line. The actual operation of the bell is effected through the relay which is so delicately poised that it requires merely a telephonic current to actuate it. This current is derived from a three-volt battery. The inductive rise, though of negligible extent, is damped by a special patent shielding winding round the relay coils. The cumulative effect of the precautions taken is that there is no spark whatever at the contact of the wires and all possibilities of danger are removed.

The actual contact of the bell circuit is made by the relay, which [illegible] circuit on a mercury cup. The whole mechanism is contained in an explosion proof box, comprising the usual cast iron enclosure provided with wide machined joints between the box and cover. No change in the old method of signalling is involved, except the position of the relay at a point near the bell. Exhaustive tests have, we understand, been taken in a colliery gas testing station which have shown that not only is no visible spark produced at the point of contact between the signalling wires, and that the most explosive mixture of gas cannot be ignited, but that the explosion proof box which encloses the relay thoroughly accomplishes its purpose.

There is no limit to the length of the signalling wires. In the installations laid down at present two miles is the maximum hauling distance, and the signalling covers the same length. Were the roads longer the system could be lengthened. There is a noticeable reduction in the cost of battery upkeep which is effected through the reduction from the usual high voltage to the three volts required by the relay.

The apparatus is of the simplest possible description. It requires no special maintenance and involves no special wiring. Suitable glands are provided on the box for leading in armoured or any other form of cable which it is desired to employ.

Mechanical signalling for shaft work is at the best a cumbersome method, and colliery engineers have long been enquiring after an electrical system capable of replacing it. For some time now the "Kingsway" shaft signalling system has been installed in South Wales collieries, and, we are informed the experience gained has confirmed the anticipations of its success. In essential features of operation the indicator is similar to the mechanical system, so that its installation involves no change in the signalling method, one merely gives the operator a button to push, instead of a handle or wire to pull.



G.E.C. Mining Telephone.

The "Kingsway" signalling system comprises merely indicators for engine room, a bell for the banksman, another bell is required for the onsetter, together with the necessary pushes for the operator, batteries and wires. Two indicators are recommended for the engine room, these being of the audible and visible type. An ordinary mining bell is fitted at the pit bank and also two mining tappers to be used by the banksman, one for signalling to the onsetter and the other to the engine room. The onsetter is provided with a flame-proof mining bell and a tapper. By depressing the tapper the onsetter signals to the banksman and engine room simultaneously, as required by the regulations.

Two small wires only down the shaft are necessary for the electrical connections between the top and bottom of the pit. If re-

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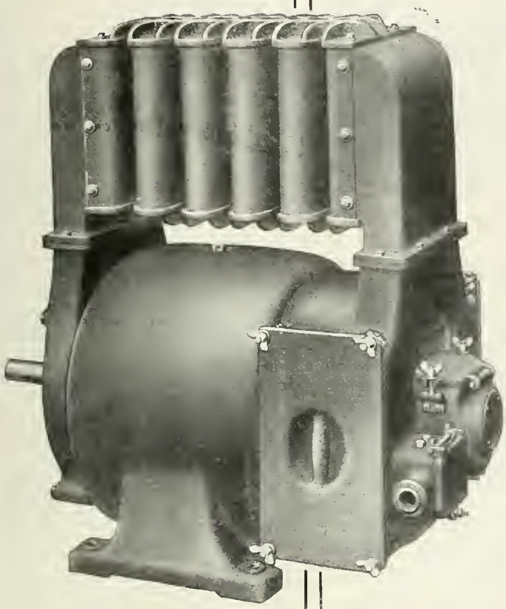

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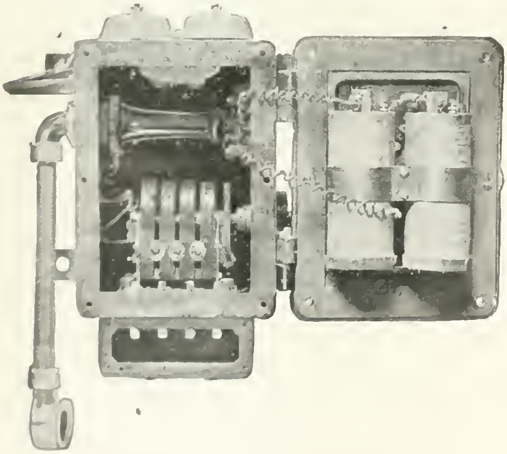
quired, the onsetter can signal mechanically by means of the usual pull rope, which is fastened to a pull contact at the top of the shaft, making the necessary electrical contact for operating the banksman's bell and the indicator in the engine room. A modification of the system is possible for mines having more than one level by means of luminous indicators, one fitted at pit bank and the other in the engine room. An indication of which level is signalling is visibly indicated by a lamp lighting up a corresponding number or name of the level giving the signal.

The "Kingsway" indicator fitted in the engine room has been designed to conform to the Home Office regulations and is enclosed in a cast-iron case. The mechanism is mounted on the front lid, which is hinged, consequently it is easily opened for inspection or adjustment. A signal is made by one of the operators pressing the push as many times as the number of the signal to be given. On completion, the indication finger remains standing at the last signal until the next signal is given, whereupon the finger returns to zero and registers step by step the number of rings. Thus there is no confusion, the actual signal given being plainly registered by the pointer.



Interior of G.E.C. Mining Telephone.

The mechanism which accomplishes the signal is contained in the indicator case (with the exception of the batteries). It comprises a [illegible] type relay, which, when energised, completes circuit ringing the bell and moving the finger. The completion of the signal is determined by a suitable lapse of time between strokes, and a neat device determines this interval, which may be adjusted over a considerable range. Suppose the operator gives seven rings and completes his signal. After the lapse of an interval of two to three seconds the instrument itself decides that the signal is complete, and the next push (i.e., at the commencement of a fresh signal), the finger being sent back to zero and then on to the figure indicating the number of strokes given.

The "Kingsway" [illegible] has the following characteristics:

(*a*) It affords a perfect and complete method of signalling between any two points.

(*b*) For communicating the signals it involves no change in actuation from the operator.

(*c*) It combines the simplicity of the mechanical with the ease of installation and certainty of operation characteristic of electrical signalling.

(*d*) It keeps each signal standing until the next is delivered; a valuable feature in case of accident or dispute as to the preceding signal.

(*e*) Its maintenance cost is negligible.

(*f*) Its cost of installation is less than mechanical signalling.

(*g*) It combines visual and audible signalling in one and the same piece of apparatus.

For telephonic communication between various parts of the pit it is essential that the instrument complies fully with the special requirements of colliery work. Much of the apparatus hitherto used has been different in this respect, but the General Electric Company have designed a flame-proof mining telephone which is now being extensively installed in collieries.

The instrument is enclosed in a strong, well-finished cast-iron case, with a flame-proof and watertight joint between the lid and the case. Attention has been paid to keeping down the internal unoccupied space to a minimum, in order to limit its capacity for explosive gas. The telephone comprises a four-magnet tropical type generator, operated by a strong handle worked through a flame-proof and watertight gland. The ringing movement is polarised, and is fitted with two 3-in. gongs protected by an iron cover. A solid-back long-distance transmitter is fitted in an iron chamber on the front of the door, the diaphragm being protected from damage by a fine-mesh brass gauze. An induction coil wound with enamel wire is fitted inside the case.

The double bell receiver is enclosed in the case, and is arranged to revolve when the listening tube (fitted on the left hand side) is lifted to the ear. At the diaphragm end of the receiver a cam is lifted, which revolves with the receiver and at the same time operates the switch springs controlling the speaking battery and receiver circuits. The gland through which the tube passes is flame-proof and watertight. Two dry cells are required for operation and these are included in the outfit, being fitted on the inside of the door by a small band. A terminal box is attached to the bottom of the case, and contains strong and well-designed line terminals. Four fixing lugs are fitted on the side of the instruments.

These details have been taken from a pamphlet on the subject just issued by the General Electric Co., 67, Queen Victoria-street, London, E.C.

POCKET BOOKS, CALENDARS, BLOTTERS, &c.

The stream of New Year reminders in the shape of blotters, pocket books, desk calendars, wall tear-off calendars, &c., has just commenced to trickle. It is only a trickle by comparison with pre-war days, when it could only be described as an inundation. Naturally, the shortage of paper and staff reductions generally have laid their hands upon what is usually regarded as a very necessary and undoubtedly a very welcome form of trade literature.

Simplex Conduits (Ltd.).—Electrical installation men would experience a big blank in their affairs if the Simplex pocket diary did not turn up as usual. It has, however, arrived and our copy is nicely bound in dark green leather. The diary section is prefaced with a number of pages which give in tabular form prices of the principal lines of Simplex Conduits, both light and heavy gauge, and those Simplex Conduit fittings which are likely to be in constant demand. Following these are pages which are devoted to striking illustrations and designs of electric light fittings, industrial heating apparatus, bulkhead fittings, distribution boards and knife switches, and

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

HELSBY
CAB-TYRE SHEATHED CABLES

Patent No. 3996/11.

In these strenuous days when time counts above all things, the risk of delay arising through the breakdown of Movable Cables in Collieries, Chemical Works, and other places where the working conditions are exceptionally onerous, can be largely discounted by the use of these cables.

The highest tribute to their outstanding merit is the extensive and growing demand which exists for this type of insulation.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

OVERSEAS BRANCHES:

AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

WE SPECIALIZE *in Electrical*
Varnishes, Compositions,
Enamels etc.
Write for List :—
JENSON & NICHOLSON LTD INSULATING VARNISH DEPT
GOSWELL WORKS. STRATFORD. E.

Cork for Insulating
(Compressed similar to "Suberite").
Having the agency from cork manufacturers in Spain, we solicit inquiries.
JULES LANG & SON, Charlton Works, Charlton Place
Islington, London, N.

Simplex industrial reflectors. As in past years the diary section is printed on squared paper. It is followed by the usual number of pages containing useful tables, technical data for heating apparatus, power required to drive machinery, cable formulæ, tables of conductors, comparison of wire gauges, fuse wire data and conversion tables. Accompanying the diary is a substantial blotting paper holder, which we shall immediately put into use for drying the ink on cheques and other important business documents. This is a most acceptable present, particularly as it is embossed with a quite unobtrusive reminder of the company.

Hart Accumulator Co.—This firm is issuing its annual desk blotting pad, copy of which has just come to hand. It will serve as a reminder to those who receive and use it, that the company are makers of storage batteries for all purposes and that they specialise in patent non-corrosive terminals.

W. H. Willcox & Co.—This company is again issuing its date remembrancer, a copy of which is usually to be seen in every engineer's office. It contains the usual monthly date sheets, the calendar portion in the centre being surrounded by illustrations of the company's multifarious products and engineering supplies. There should be no excuse on the part of users of this calendar for not knowing what Messrs. W. H. Willcox & Co. supply. As before, the calendar is fitted with a neat arrangement whereby each sheet can be turned back over the hanger and can be referred to again if necessary.

The Victa Electrical Co.—This firm specialises in electricity meters and are again sending out their monthly tear-off calendar. Accompanying it is a leaflet entitled "Concerning Revenue," which will doubtless be read with interest by central station engineers who are, of course, the principal users of electricity meters.

Pope's Electric Lamp Co.—In a particularly bright and breezy tear-off calendar this company asks its clients to go through the year with the "Elasta" man. The bold daily tear-off slips are surrounded with reproductions in miniature of a selection of the now famous "Elasta" man advertisements. In the pictures chosen he is depicted in many of his characteristic attitudes. One feels so cheerful in looking at this calendar, that we anticipate the demand may be considerably in excess of the supply. We don't know how the stock stands, but would recommend our readers who haven't had a copy to send in for one at once.

The British Aluminium Co. The monthly tear-off calendar issued by this company is an especially attractive and appropriate reminder of its operations. On a card some 10 in. by 8 in. is a large photographic illustration of the dam at Kinlochleven. This in itself is a particularly clear and impressive picture. Mounted well above it, up in the clouds, are the monthly tear-off slips. On the [illegible] side of the card is a Roll of Honour of the staff and employees of the company who are serving with the Forces. Particulars are also given in red of the brave fellows who have died in the service of their country; of these the list shows a total of 13. This does not include a very considerable number of casualties, nor prisoners of war.

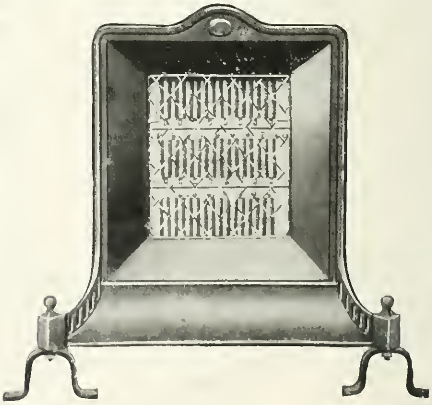
A NEW PYROMETER.

The Wedge pyrometer is a new design of instrument, requiring no [illegible] and it may be placed in the hands of any intelligent [illegible]. The pyrometer can be used wherever the object to be [illegible] a distinct coloration that is to say, for any temperature above 500°C. provided the article is visible either directly or by reflection. The size of the object or its distance makes no difference to the reading. The Wedge optical pyrometer is calibrated to cover any range of temperatures desired, between the limits of 500°C. and 2,100°C. A single instrument is, as a rule, arranged to read up to 400°C., the scale being divided in intervals of 20°. Thus, for a pyrometer suitable for annealing, hardening or similar operations, the range should be 600°C. to 1,000°C. The scale on such an instrument will be sufficiently open to easily read, by estimation, to 10° if desired. Any similar range not covering more than 400°C. can be supplied, divided in the same way in intervals of 20°C., as say 950°C. to 1,350°C., 1,400°C. to 1,800°C., &c. For those requiring a greater range of temperature reading in a single instrument, a range of 800°C. can be provided, in which case the scale would be divided in intervals of 50°C. One pair of instruments can thus be made to cover the temperature range from 500°C. to 2,100°C., the first from 500°C. to 1,300°C., the second from 1,250°C. to 2,100°C. Any other scale can be supplied, providing the range does not exceed 800°C.

Prices are obtainable from the Optical Pyrometer Syndicate, Temple Chambers, London, E.C.

NEW ARORA LIST.

We have received from the Arora Co., Loughborough, a copy of their new complete list which they now have ready for distribution to the trade. Copies of the list will be supplied to central station engineers, contractors, merchants, &c., overprinted with name and address. The list describes and prices Arora electric fires, in 2 and 3 bar sizes, having respectively a consumption of 1½ and 2¼ units an hour when full on. Prices are graded in accordance with various finishes, from matt black to enamelled (four colours). A hearth-stand for use with these fires is illustrated and priced. Other electrical apparatus dealt with are a 3 section boiling plate (with simmering slide) and a rapid grill, the former has a maximum energy consumption of 1½ units an hour and the latter of about 1 unit per hour. The apparatus is all made at the company's Loughborough works, and copies of the list will be supplied on application.



3 Bar Arora Fire.

TINNING FURNACE
Hall's Patents
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

QUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026 Grams: Vicminster, Sowest London.

[illegible] The Electrician Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices, [illegible] London, Friday, January 5, 1917.

THE ROUND TABLE.

By "KVA."

"Wanted, a spare crank," says an advertisement. Why only one? I know of hundreds, some "spare" and all cranks.

* * * *

"Mr. A. P. Trotter presents his compliments to KVA and begs to correct him. He recently took a photometer calibrated by a standard candle at 100 ft., and found the minimum illumination in Cambridge-street, Paddington, to be well under 0·0001 ft.-candle."

* * * *

A correspondent asks me if I have yet had the "Victoria-street Glad Eye." I must confess that I have not been in that neighbourhood lately, but this seems to be an inducement to take a stroll there "on the off chance."

* * * *

The Electro-Harmonic Concert held in the Venetian Chamber at the Holborn Restaurant last Friday was a great success; every gondola was full, and the overflow had to be accommodated in the "Grand Canal."

* * * *

Chairman W. E. Kingsbury remarked upon the fact that the Society had had to give up the King's Hall, for so many years the venue of electro harmonics; but "in these days of the commandeering of privilege" the members were not going to grumble because the hall was "needed of the Government."

* * * *

The concert itself went very well, and a few chestnuts were successfully pulled out of the fire by the Scottish comedian. For instance: Two Tommies, somewhere in France, one Irish, the other Scottish, succeeded in catching a fowl behind the lines. "Now," said Pat, "we'll have a foine hot supper." "Noo," said Jock, "we'll no; we'll just wait till mornin'; that hen might lay an egg." The good old bearded one of the two belated Scottish travellers produced quite a roar, though many of us had heard it before. These two "lads" had to be put up in the "kirk" near by the local inn, which was too full to accommodate them. About three in the morning the village was aroused by the tolling of the church bell, which was the signal for the turning out of the volunteers, the fire brigade and the special constables and the anti-aircraft corps. A Zepp attack was considered imminent, until one of the elders came running over from the church, shouting: "It's all recht, it's all recht, it's just twa whiskies and sodas for pew number 59!"

* * * *

"Functions of a Complex Variable" is the title of a new book by T. M. MacRobert, M.A., B.Sc., which has just come in to us for review. I have looked at the contents and am sure that it will make quite exciting reading. For instance, "Asymptotic Expansion of Euler's Constant," "The Weierstrassian Elliptic Integral," "Integrals of Meromorphic Functions," "Spherical Harmonics," &c. The last item I am inclined to question. We have not had a spherical Harmonic since the war broke out!

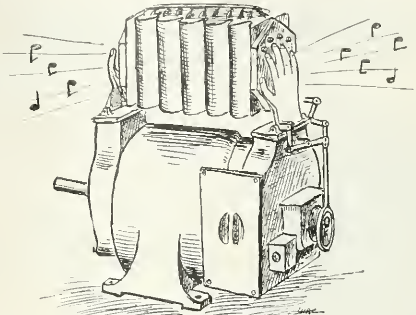
* * * *

OUR HOT PLATES

No. **225** to

Mr. Edmund L. Hill upon his appointment as secretary to the Federation of British Industries.

A correspondent sends me the adjoining sketch, "with apologies to a current advertisement." The idea has possibilities, and Messrs. Electromotors might take it for what it is worth as a suggestion for a motor doing some very monotonous duty, that wants cheering up a bit—say, a machine driving a sinking pump!



The Sweet-and-Low Allegro Motor (or Cheero-concertina Motor).

* * * *

To Knott Mill Station every week
Six times I come, and vainly seek
A tram to put me (rather late)
Down at one ninety-six Deans gate.
The trams they come, the trams they pass;
God's blessing on each bonny lass
Who lolls against the tramcar stairs,
And never troubles about fares.
They pass us by and we are left,
Of fifteen minutes oft bereft.
Now, Mr. McElroy, with ease,
Some six of us you'd greatly please
If you would ask your charming girls
To cease to bother with their curls,
And when theyre passing next Knott Mill
To stop and take up—Edmund Hill.

Dear Sir, I note with keenest joy
How very well your girls employ
Their time now when they reach Knott Mill
They stop and take up Edmund Hill.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Jan. 10, 1880.]

Advice Gratis to Shareholders.—Whenever shares are thirty times the par value, sell.

London Bridge.—There is some idea of adopting the electric light for illuminating this bridge. The sooner the idea is put into effect the better, for a more important improvement can hardly be conceived.

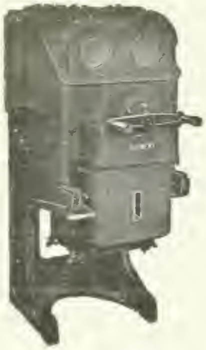
Another Use for Electricity.—It is suggested that some practical work should be done by the crews of torpedo-vessels in attacking icebergs. Of course, the work would be more exciting than firing at dummies, and the results could be better estimated. The suggestion might be extended, and results of the action of various explosives ascertained.

An Observatory in Cyprus.—The establishment of an astronomical, magnetic and electric observatory on one of the mountains of Cyprus has been advocated by Prof. Piazzi Smyth, the Scotch Astronomer Royal. The clear skies of that island as compared with our own cloudy atmosphere would eminently fit it for such a purpose. Let the old Gods give place to helioscopes and instruments of precision, Jove's thunderbolts to Thomson's quadrant electrometer.

L. P. S.
CLIPS, TIPS & TERMINALS
of all descriptions.
Write for Booklet, with Illustrations, of 75 types to:—
THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

SIEMENS



IRONCLAD
SWITCHGEAR
FOR ALL
PURPOSES

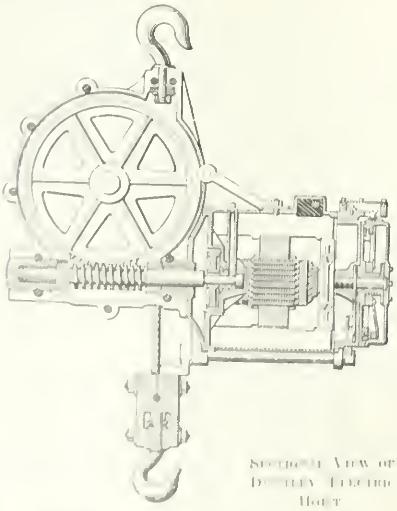
Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to—

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: Gerrard 860. Telegrams: "Siembralos, Vic, London."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood [Bldgs
Sheffield—22, High St.
Southampton—46, High Street
Branches in Principal Towns Abroad.

DUNTLEY PORTABLE ELECTRIC HOISTS.

Of all the various hoisting and conveying appliances the electric hoist is the most universal in scope and the most easily applied. The energy required to operate it is insignificant while the rapidity of operation and ease of control of a well designed electric hoist



Sectional View of Duntley Electric Hoist

[illegible] other uses. The Duntley Electric Hoists [illegible] in many newspaper offices, found [illegible]. The hoist is of the worm gear type with [illegible] on each side of the worm gear The standard drums are grooved and arranged for a lift of 15 ft. They are sufficiently wide so that only one layer of the cable on the drums is necessary. Where a greater lift is desired wider drums can be furnished capable of carrying enough cable for a maximum lift of 25 ft. The worm is provided with a ball thrust bearing and together with worm wheel and bearings, runs in oil. The transmission between the motor and worm is by means of hardened spur gearing.

The motor is well built and thoroughly insulated and enclosed. The controller, located on the outer end of the motor, is handled by means of two cords within easy reach of the operator. It is provided with a centering device, which throws it to the "off" position when either cord is released by the operator. An upper limit stop prevents damage by running the hook up too far. The hooks are provided with a ball bearing swivel, overcoming any tendency to twist the cables. The Duntley hoists are made in three sizes and for direct current of 110 and 220 volts only.

Capacity, pounds.	Speed of lift feet per minute.		Shortest distance between hooks, Inches.	Weight complete.	
	No load.	Full load.		15-ft. lift.	25-ft. lift.
250	37	30	26	175	190
500	33	26	26	190	205
1,000	23	20	30	225	240

The above particulars are taken from Bulletin E 45, issued by the Chicago Pneumatic Tool Co.

THE WATER POWER OF CANADA.

Water-power has been a most important factor in the industrial development of Canada, and with the advances in electrical science will play an even more important role in the future. Probably no country in the world possesses such enormous water-powers. Practically every industrial centre from coast to coast has abundance of water-power available, not only for present needs, but for all anticipated requirements. Indeed, the fortunate situation of Canada's water-powers is the outstanding feature of her resources. Excluding the north-west territories, practically all the Yukon, and the northern and eastern portions of Quebec, it is estimated that 17,746,000 h.p. is available, this amount being inclusive, in the case of Niagara Falls, Fort Frances and the St. Mary's River at Sault Ste Marie, of only the development permitted by international treatise; and, further, does not contemplate the full possibilities of storage for the improvement of present capacities. The developed powers, which are inclusive of all water-powers, whether for electrical production, pulp grinders, or the great many other uses, aggregate only 1,712,193 h.p. Nearly all this power has been created within the last 20 years, and the last decade has seen practically two-thirds of the total produced. With water-power as a fundamental necessity in the industrial future, the regulation and conservation of the river waters is to-day being demanded on a large scale, and this will become more insistent as time goes on. In Canada, the titles to the water-power rights have largely remained under the control of the Dominion and Provincial Governments. The Dominion Government controls navigable streams and their water-powers, and the water-powers in general of the provinces of Manitoba, Saskatchewan and Alberta. The administration of all water-powers in British Columbia, Ontario, Quebec, New Brunswick and Nova Scotia is under provincial control.

HIRING.

"The opposition which the Electrical Contractors' Association has so strenuously maintained for the past 14 years to the granting of powers to trade in electrical goods to municipal authorities has been discussed in these pages so often that it would seem there was little more to say on the subject; these discussions, however, have always been directed primarily to the question of selling, and that of hiring has been overshadowed and only dealt with incidentally. It may, therefore, be useful to state our views in this relation, and so clear the ground for the more detailed consideration of the I.M.E.A. Bill which, sooner or later, will again occupy the forefront of our attention.

"We do not for one moment question that the hiring of electrical apparatus at a cheap rate is an essential to the best progress of the industry, and our Association has never specifically opposed the granting of hiring powers, but has only done so where they have been applied for in conjunction with powers to sell. On the contrary,

Our Manufactures include:

Cables for Lighting, Power,
Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

THEN AND NOW.

"If Cables you'd have which never will trouble you, you should purchase them from the B.I.W."

So sang our customers in joyous chorous during the nineties. The metre was halting, but there was nothing lame about the sentiment.

To-day they and those who have since joined the happy band, carol:—

"If of cable vexations you wish to keep free, you should buy from the famous B.I. & H.C."

They ought to know.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

OVERSEAS BRANCHES:

AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.
ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.
New Works and New Editions can be had from the Library immediately on Publication. Telephone: MUSEUM 1072.
SUBSCRIPTION, Town or Country, from ONE GUINEA. READING ROOM open Daily to SUBSCRIBERS.
H. K. LEWIS & Co. Ltd., 136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

if any scheme could be put forward for hiring which absolutely precluded the possibility of selling or other interference with our trade it would undoubtedly receive the support of a large section of the E.C.A. We cannot say that as matters stand at present unanimous support could be obtained from the contractors because there are certain districts in which the contractors themselves already have large hiring interests which would obviously be seriously affected.

"But we are of opinion that, in common with the business of selling, that of hiring can best be operated by a system of co-operation between supply authorities and the local contractors, supported where necessary by the funds of the N.E.C.T.A. It must be remembered that the hiring of electrical apparatus is not in any way upon a par with the hiring of gas stoves and cookers. The recommendation of suitable electrical apparatus and the installation of the same is a highly technical matter, and must be in the hands of technical people. It involves knowledge that has nothing whatever to do with central station engineering or the generation of current. Granted that the municipal electrical engineer or his assistants have this knowledge, it is no more their work than it would be for a doctor to improve his goodwill by undertaking veterinary work in his patients' farmyard, or for a lawyer to work up a future connection by teaching Latin. In fact, every man to his trade; the station engineer should know all that is to be known about his own business, and not waste his time in handling detail trade outside of it.

"When an electrical installation is complete, it involves a very much more complicated system of maintenance than does a gas stove. Many trades are involved, including some of the most highly skilled there are in the industry, as, for instance, armature winding and instrument making. It is the contractor's place to provide this service and employ these tradesmen. The business of maintenance of small electrical plant is entirely alien to that of the central station.

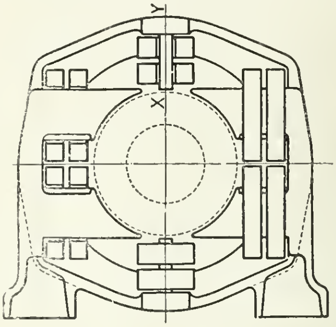
"Electrical contractors have experimented with the hiring of electrical plant, and, charging the same rates as the municipalities which have powers, are able to make a larger margin of profit. This is only what is to be expected, seeing that the business is one which the contractor can manage with the maximum of efficiency, and which lies entirely within the scope of his normal organisation. The only hindrance to the wholesale adoption of such schemes has been the question of finance, and the uncertainty which the shadow of the I.M.E.A. and preceding Bills have cast over the trade.

"We believe that the organisation of N.E.C.T.A. (Ltd.) is capable of dealing with the financial difficulty by supporting local companies wherever required to do so, the local contractors, supply authorities and possibly manufacturers also taking a commensurate interest. In this way goodwill among the parties concerned would be promoted, and each party would reap the utmost benefit from the arrangement which a maximum of efficiency can provide.

"Incidentally, the public at large and the electrical industry as a whole would benefit by a wholesale influx of new consumers."
—Electrical Contractor.

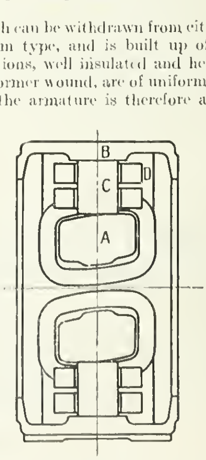
TAUNTON DYNAMOS AND MOTORS.

The patent interpole dynamos and motors described in a new list of Messrs. [illegible] (Ltd.), Taunton, are of the open protected, enclosed ventilated, or totally enclosed types. The field winding can be either shunt, series or compound, as desired. All machines of the open protected type are rated with a temperature rise of not more than [illegible] F. after six hours' full load run; enclosed ventilated not over 80 F. and totally enclosed 90°F. These machines will give an overload of 50 per cent. for half an hour, or 30 per cent. one hour, with fixed position of brushes. It is stated that the natural ventilation is so excellent that a fan is in no case required. With the brushes fixed in the geometrical neutral position these machines are sparkless for either direction of rotation. The efficiency is high and the machine is quite silent in operation. All the machines listed comply with the Engineering Standards Committee specification No. 36.



CROSS SECTION

The armature, which can be withdrawn from either end of machine, is of the slotted drum type, and is built up of specially selected charcoal iron laminations, well insulated and held rigidly together. The coils, which are former wound, are of uniform shape, size, weight and resistance, and the armature is therefore accurately balanced both electrically and mechanically. The coils are impregnated under vacuum and securely bound down with wire insulated from the core by mica. The commutator is of hard-drawn copper, is insulated with mica throughout, and is mounted on and suitably insulated from a bush, which is keyed to the shaft.



A-SECTION THROUGH MAIN POLE
B-SECTION THROUGH XY
C-INTERPOLES
D-VENTILATING APERTURES

The bearings are of great length and bearing surface, and are fitted with phosphor bronze or white metal bushes, according to size, and self oiling rings, ensuring perfect lubrication. The machines can be run fixed to the wall or the ceiling by turning the bearings to suit. All parts are made to gauge and are interchangeable.

The machines dealt with in the list are supplied for pressures

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire, etc., for flexible leads etc. AMPLE STOCKS.
HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

The Electric & General Works, Ltd.,
128, Stamford Street, London, S.E.

High Tension Switch Boxes
for 3,000 and 6,000 Volts.
TRIPLEPOLE AUTOMATIC OIL-SWITCH.
DOUBLE INTERLOCKED DOOR.
OVERLOAD & UNDERLOAD RELEASE.
AMMETER.
INVERSE TIME LIMIT ATTACHMENT.
FIRE-DAMP SAFETY DEVICE.

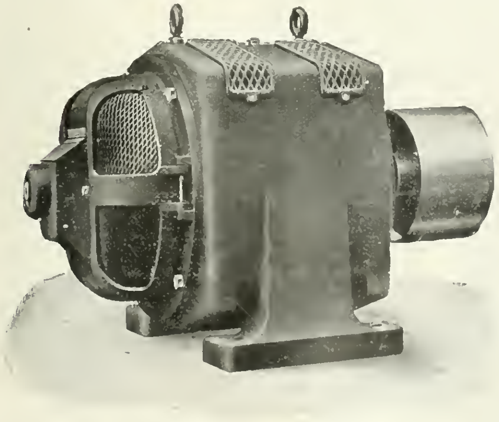
OPEN. CLOSED.

Other Types for all purposes.

ELECTRICAL APPARATUS up to 80,000 Volts.

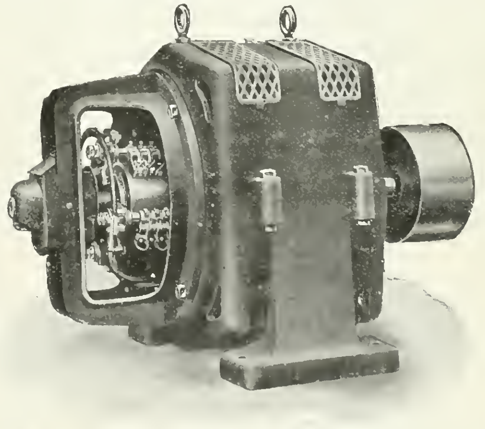
Telephone: 5223 HOP. Telegrams: "GABIONAGE FRIARS LONDON."

from 110 volts to 500 volts. The standard machines are made in outputs which range from $1\frac{3}{4}$ H.P. to 25 H.P.; there is also a heavier range of machines, of which the smallest is 10 H.P. and the largest 100 H.P. Tabulated particulars are given of the company's standard reversible crane rated motors, which are made for pressures from 110 to 500 volts, the smallest motor in this series is rated at $1\frac{3}{4}$ H.P. and the largest at 35 H.P.



Open Protected Newton Motor.

All these motors are fitted with the company's patent system of interpoles (Burleigh's patent). One of these machines was tested in 1914 at Faraday House, the machine being of 10 H.P., 210 volts, 790 revs. per min. Some of the particulars of this test are given herewith, the details relating to the commutation and the dispersion factor tests and the heating test.



Enclosed Ventilated Newton Motor.

"We find that owing to the combination of one pair of commu-

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PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
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CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

tation poles with a four-pole main field of the special form adopted in your machine, the dispersion factor of the commutation pole field is lower than it would be in an ordinary machine of this size. Further, since the flux density due to the main field is very low in the portion of the yoke which carries the commutation pole, the saturation characteristic of the commutation pole bends over only slightly with loads up to 50 per cent. in excess of the normal output. This is shown by the curves which accompany this report. Therefore the adoption of your form of field enables a machine to be designed with commutation poles and windings of normal size and weight, which would be capable of withstanding larger overloads than a machine of the ordinary type. Alternatively, for a given overload capacity, a machine of your type may be designed with commutation poles and windings of considerably smaller size and weight than would be possible with a machine of the ordinary type.

"We have carried out our standard heating tests on your machine and find that the heat dissipating qualities of your machine are excellent. This is due largely to the disposition of the field windings and the ventilating apertures in the carcase. The temperatures of your motor after six hours' run at full load are: Armature, 126 F.; commutator, 101 F.; main field coils, 126 F.; main field coils (by resistance), 151 F.; interpole field coils, 128 F.; air, 57 F.

Copies of the list referred to may be obtained from Newtons (Ltd.), Taunton.

MAGNET MAKING IN SHEFFIELD.

The Sheffield "Daily Telegraph" states that Sheffield promises to become the centre of the manufacture of magnets, which were obtained before the war almost exclusively from Germany. On the outbreak of hostilities only one or two firms in this country had given any attention to this particular product, although Sheffield had been for a long period supplying the steel to makers in Germany and elsewhere abroad. The collapse of the German supply placed the electrical trade in a serious difficulty and for some time matters looked [illegible], especially in the magneto department. Sheffield, however, [illegible] the situation. Our contemporary states that half-a-dozen local firms have been producing magnets on a large scale and of satisfactory quality for a considerable time, and there is every reason to hope that when peace returns this country will be self-contained in this particular branch of industry. The trade calls for great accuracy of workmanship and finish and considerable scientific knowledge.

CALENDARS, DIARIES, &c.

Thermit Ltd.—This company again sends out its handy pocket diary containing ruled scribbling pages prefaced by a quantity of useful data regarding the Thermit process. Instructive illustrations are given of examples of repairs by the Thermit process to electrical and other machinery. One of these shows an armature shaft 3½ in. diameter, provided with an extension piece to allow of an half coupling being fixed to the shaft; another shows a repair of a "compound fracture" of a tramway motor case.

Alfred Graham & Co.—We have received from Messrs. Graham & Co. the loud-speaking telephone specialists, a hardy annual in the shape of a pocket Tide and Speed Tables for the ensuing year. We do not notice any reference or table relating to the "tide in the affairs of men," about which the immortal William had something to say, but perhaps this omission will be remedied in a future edition.

Haslam & Stretton Ltd.—Now here is a particularly charming lady who has come all the way from Cardiff to brighten the dull moments of the ensuing year. She rejoices in the name of "Annabel" and she also brings the following pretty message: "May every day this whole year through Bring health and wealth and joy to you." We are sure that she will keep the name of the company who has sent her out fresh in the memory of their customers present and prospective. She is a "Bryson" girl and according to a printed description attached to the calendar is the work of Mr. J. Ross Bryson, America's foremost artist in pastel.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

FURNACES for MELTING WHITE METALS, Etc.
(Hall's Patents).
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
PATENT MIXER PRODUCES HOMOGENEOUS ALLOY.
Monometer Heat-Controlled Furnaces for Heating the Moulds.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM

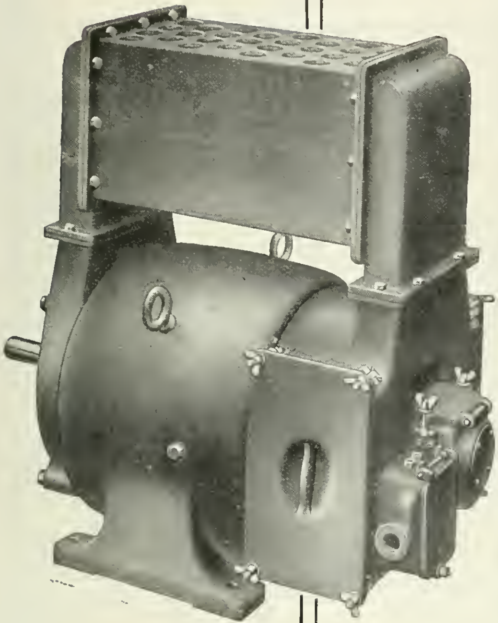
NEW CATALOGUES.

Ferranti (Ltd.).—We have received from this company a copy of their pamphlet Ma 56, which gives complete instructions for the use of types FC and FCT a.c. house service watt-hour meters. There are notes upon the installation of the meters and also upon their testing. In this latter particular very clear diagrams of connections are given. The list also contains a number of typical accuracy curves, which relate to normal and overload, varying frequency, varying voltage and varying power factor. The instructions upon the adjustment of the meters are illustrated with photographic views, showing the meter interior and index fingers pointing out from the illustrations to the instructions in type for each separate part.

Langdon-Davies Motor Co.—We have received from this firm a copy of their price list of single-phase motors, 40-125 periods, and polyphase motors, 20-50 periods. The prices are clearly set out in tabular form, and are prefaced with instructions for the use of the company's code. From the same source also comes a neat pocket notebook, the ruled pages of which have as a preface a number of useful tables relating to the company's standard motors, both a.c. and d.c. We understand that copies of this little book will be sent out on receipt of trade card.

Western Electric Co.—We understand that the Western Electric Co. have in preparation a catalogue relating to the Davis Flood lamp, which has been designed on cargo light lines, but in place of the cluster lamps a single 1,000 watt lamp is employed. This lamp is housed in a special metal casing, which can be either cast iron or steel, and which is finished in black enamel and weatherproofed. The lamp itself is backed by an extra heavy mirrored glass reflector, which is attached to an adjusting rod; the rod admits of the adjustment of the reflector, so that either a solid beam of light or a diffused light is thrown by the lamp. It is claimed that there are no dark spots or circles. The lamp casing is provided with both horizontal and vertical adjustments, and the supporting standard is provided with a large cast-iron base, which is sufficiently heavy to give the lamp stability without the need for holding-down bolts. The front of the lamp is removable by four screws and a bayonet lock, and the lamp itself is protected by wire glass which is laid in in strips to allow for expansion and contraction. This glass may be splintered, but will not fall out. We understand that there is likely to be a considerable demand for these lamps for flood lighting purposes.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026 Grams: Vicmineter, Sowest London.



THE

Lo-thermo MOTOR

Patents Applied for.

A practical totally enclosed motor which can be run at high speeds and which is moderate in size and price.

It is no longer necessary to employ makeshifts such as pipe ventilated motors, and it comes as a boon to Engineers in Ammunition Factories, Chemical Works, Collieries, Foundries, Flour Mills, Bleach Works, Steel Works, Wood-working, Breweries, for Outdoor Use, in fact anywhere where it is necessary for motors to be placed in an explosive, dust-laden, or wet atmosphere.

"Magnet," Manchester
"Orders," Cannon, London.

Electromotors Limited

OPENSHAW:
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ENGLISH
EDISWAN
EVERYTHING
ELECTRICAL

The house of Ediswan is the best equipped to deal with all enquiries for
Everything
Electrical.
ENTIRELY BRITISH.

The Edison Swan Electric Co., Ltd.
PONDERS END. MIDDLESEX.
London and Provincial Depots.

COMMERCIAL
ENGINEER
WANTS
POSITION

Sixteen years' electrical experience; 14 years' outside representative; 2 years' executive position buying and selling. Age 37. Exempt. Sound & well-established connection London to Glasgow.

Address letters: "Salesman," care of A. J. Greenly & Co., 37, Strand, London, W.C.

LIBERTY AND ELECTRICITY.

At the recent opening of the new scheme of lighting of the Statue of Liberty a number of addresses were given by well known Americans. Speaking on "The Science of Electricity," Mr. H. L. Doherty, of the Society for Electrical Development, said :—

"I assume that the word science shall be interpreted in its broadest sense. The great epoch of making electricity the servant of man was ushered in by the discovery of how to generate electricity by mechanical methods. The whole science has been developed during the lifetime of a majority of the men who sit about these tables.

"If any one of you has occasion to talk to a body of real scientists, do not loosely repeat the old, worn-out statement that 'the science of electricity is only in its infancy.' The science of electricity is far in advance of every other science of its general class.

"Every transformation of one form of electricity to some other form of electricity is accomplished with marvellously high efficiency, leaving little to be gained even if perfection should be reached.

"But electrical energy must be derived from and converted into other forms of energy, and it is within these kindred and allied sciences that [illegible] attained, and it is these sciences which may be said to be [illegible] their infancy, even though centuries old.

"The [illegible] of the task before us can only be appreciated when you remember that whenever you see a man, woman or child doing any kind of human labour, that that labour can either be reduced or wholly eliminated by the use of electricity. Millions of [illegible] with labour that it is not necessary [illegible] can state the case in any terms you want; [illegible] human labour more productive; that it [illegible] will make human labour more efficient, [illegible] that every form of human labour can [illegible] by means of electricity.

HEATING HOUSES BY ELECTRICITY.

There is no denying that electricity for any purpose, but especially for house heating, is ideal. A chimneyless city is a consummation devoutly to be wished, but, alas! we fear never to be realised except in sunny climes where winter is unknown and where the inhabitants are as anxious to rid themselves of heat as we are to get it. Coal at $10 a ton is a cheaper source of heat than electricity at $10 a kilowatt year, and it is well for central station managers to face the fact. In some sections of the country where water power in sufficient quantity is available, in the absence of a better market, there has been a tendency to indulge in the hope of obtaining the money which usually goes to the coal man. So long as this is confined to supplanting other froms of stoves by electric ranges for cooking purposes, the movement is reasonably sure of success; but beyond that it is doomed to failure.

There have been a few special cases of electric heating such as at Rupert, Idaho, where the Government supplies the school houses with energy from the reclamation service generating stations which otherwise would be idle during the winter. But one swallow does not make a summer; if there have been successful installations in Idaho with Government help there have been failures there also, as witness Twin Falls.

A wide field exists for portable electric heaters which are used intermittently when severe cold does not obtain and for removing chill from the atmosphere of rooms; but except in rare cases there is no field for a system of electric house heating to replace the standard forms now in use employing coal, with coal at present prices.—"Electrical World."

EXTRA COPIES OF
ELECTRIC VEHICLE PROGRESS SUPPLEMENT
[illegible] Engineers for distribution [illegible] Rates on application to
"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY,
1, 2 & 3, Salisbury Court, Fleet Street, London, E.C.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

[illegible] Ltd., at the Editorial, Printing and Publishing Offices, [illegible] in the City of LONDON, FRIDAY, JANUARY 12, 1917.

THE ROUND TABLE.

By "KVA."

"Noise may be defined as sound out of place," says an American contemporary, "it represents a dissipation of energy without useful result." I think the first line German "trenchers" would flatly contradict the last statement, however much they might agree with the first.

* * * *

According to a recent report, two Zepps. were destroyed in their shed owing to a short circuit in the wiring of the building. In Hunland this disaster was probably attributed to British spies (why not ?). Over here it might have had favourable notice in the gas journals, but it seems to have excited no comment.

* * * *

Regarding my note a couple of weeks ago about luminous knobs, it seems that the idea is not novel after all. Nearly 50 years ago Mr. Gus C. Lundberg was presented at birth with a "luminous knob" which might easily have been mistaken for a nimbus. Its luminosity was so noticeable that had the present day lighting regulations been in force it would have had to be subdued or its owner placed in "durance vile." The luminous matter used in this case appears to have been of a very lasting nature, as Mr. Lundberg informs me that some 30 years ago, when in the United States, an Irishman after a close scrutiny said, "Look here, Lundberg ! I've been thinking it over very carefully, and have come to the conclusion that your father must have been very rich, or else very extravagant." On being asked to elucidate the remark, he proceeded, "He has provided you with a mahogany head, when a deal one would have done just as well." Father Time has evidently been at his old tricks since then, for Mr. Lundberg's "knob" now has a pie-bald effect, and silver threads appear amongst the copper. He tells me he not long ago wrote to the Irishman :—"Dear Billy,—What you took for mahogany turns out to be veneer only—the deal has now begun to show through."

* * * *

How often in a lifetime can one lift the telephone receiver and after calling "Hello" hear the voice of the man who wants you on a *trunk* line without giving the number to the exchange operator ? I have had it happen to me over a local exchange, but never on a trunk. Mr. M. J. Tilney (of the Tilney Mfg. & Testing Co.) tells me that recently he wanted to speak from Watford to his co-director, Mr. F. Jensen, at Southall, and took off the receiver to call up the exchange for the trunk. His "hello" was immediately answered by Mr. Jensen's voice, and the desired conversation proceeded without interruption from the exchange. I believe the explanation is that Mr. Tilney had just previously concluded a trunk call to the works of the company at Bull Inn-court, Strand, W.C., and this had not been cleared. Mr. Jensen, from his house at Southall, had also been on with the works, and wanted a further call, and at the precise moment that he lifted his receiver Mr. Tilney did the same at Watford and they were connected. Will this ever happen again before peace is declared ? I think it is a clear case of telesympathics, and am awarding the parties concerned Hot Plates accordingly.

"The Condition of the Power House : Some Acrimonious Exchanges," says a "Northern Whig" headline. This is, I believe, not the first time that my contemporary has had to complain of the Belfast telephone system.

* * * *

In a certain munition works that I wot of there is a notice to the effect that card playing in any part of the works is strictly forbidden ; and yet the time of the men and the whole costing scheme is worked on cards ! Seems to me, stranger, that notice don't hold good !

* * * *

An interesting function was performed last week at the Connaught Rooms. My old friend "Jimmy" Rook, otherwise occasionally known as James Rook, Esq., was presented with a silver cigar box, filled to the lid with the best brand, by a few of his friends and admirers in the electrical industry. I am not going to say how long "Jimmy" has been associated with electrical factoring, but it's a decent long time ; in fact I'm told that he can claim the title of patriarch in his line of business, and I'm sure no one will dispute it. I hope he may live long and continue to prosper.

* * * *

"A vague idea of the impetus women have given the war machine by their physical labour," says a newspaper par, "crystallises into poignant realisation before these very wonderful pictures (exhibited at Harrod's, Ltd.). Frail young girls handling the vital parts of instruments of titanic destruction ; earnest women who, in pre-war days, were probably incapable of putting a defective carpet-sweeper to rights, now running complicated machines with aplomb ; bright young mechanics in short skirts skilfully putting up electric fittings in one of his Majesty's ships ——."

Here the writer shows signs of straying from his subject, so I will not continue the quotation.

* * * *

OUR HOT PLATES.

Nos. 226 and 7 to—

Mr. M. J. Tilney and Mr. F. Jensen for being telephonetically sympathetic.

No. 228 to—

"Jimmy" Rook upon his attainment to the position of patriarch of the electrical trading business.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Jan. 17, 1880.]

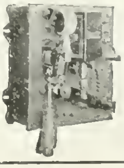
WIRE.—The greater portion of the wire used in cable work is supplied by Germany. This is partly due to the fact that the cost of carriage by water from Cologne is less than the cost of carriage by rail from Manchester.

WANTED, A HOUSEHOLD MOTOR.—From the numerous inquiries which have been addressed to us from different parts of the country, as to where and at what price the small electric motor of M. Deprez for household purposes can be obtained, we think it only fair to infer that there is a neat, cleanly, and economical little electric motor for home uses, such as driving a sewing machine or coffee mill, which would be welcome to certain classes of the community. Will our electric mechanicians take the hint ?

SIR ROWLAND HILL MEMORIAL.—A telegram of the Lord Mayor, on behalf of the "Sir Rowland Hill Memorial Fund," has been despatched to all parts of the world connected by the submarine telegraph system over which Mr. Pender, M.P., presides, namely, Turkey, Egypt, India, South Africa, China, Straits Settlements, Australia and America ; and the replies already received from the Mayors and representatives of the cities to which the message was forwarded express warm interest and sympathy with the object in view, all testifying to the boon conferred upon mankind by the introduction of cheap postage, of which Sir Rowland Hill was the originator.

No. 110
Self-acting Motor Starter, "Z" Type.

IGRANIC
AUTOMATIC STARTERS
save Time and Money and cannot be mis-used by the operator.
IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, LONDON.



No. 115
Self-acting Motor Starter and Magnetic Circuit Breaker

SIEMENS

STANDARD
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for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
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Telephone: Gerrard 860. Telegrams: "Siembralos, Vic, London."
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HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood [Bldgs
Sheffield—22, High St.
Southampton—46, High Street
Branches in Principal Towns Abroad.

WORKSHOP ILLUMINATION.

Considerable interest is now being taken by industrial light users in the more modern high efficiency electric lamps, both high candle power straight filament and high candle power half-watt filament. The economies in energy consumption which these lamps make possible are in themselves a great attraction, especially to owners of factories

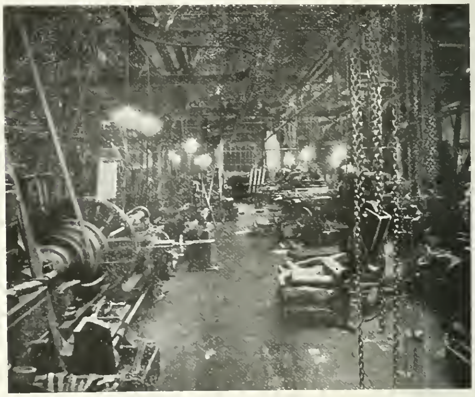
[illegible] 35 yds. by 50 yds.
[illegible]

and buildings. However, [illegible] number of cases the driving [illegible] the necessary energy [illegible] Sometimes the [illegible] and the cost of the modern lighting installation [illegible]

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

compared with gas, and where this is the case the electricity undertaking is confronted with an incongruous state of things occasioned by electric driving and *gas* lighting. Once the gas installation goes in, it is very difficult to displace it, and electrical contractors need to make every effort to install both power and lighting in the initial stages of the conversion from steam or other driving.

Now the industrial light user is "up against" a rather difficult



Machine Shop—45 yds. by 35 yds.
Ninety-five 60-watt Wotan Lamps.

problem in deciding whether he shall install gas or electric light. His difficulty chiefly resides in the fact that more often than not the initial outlay involved is much lower with gas, and this consideration may have to weigh with him more than any other. His decision is then immediately made and the gas installation is put in. He will probably not hesitate even upon the matter of the increased in-

Machine Shop, Grinder Bay—45 yds. by 35 yds.
Ninety-five 60-watt Wotan Lamps.

surance premium with gas as against electric light. This is the aspect of affairs in quite a number of industrial installations, and it will serve to explain why electric driving and gas lighting are seen together within the same factory walls.

The high first cost of the electric light installation is not always a

Canadian and Indian
MICA
CUT, SLAB & SPLITTINGS.
MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.
Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
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Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,
Telegrams: Attwaters, Preston.
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Hopwood St. Mills,
PRESTON.
Established 1868.
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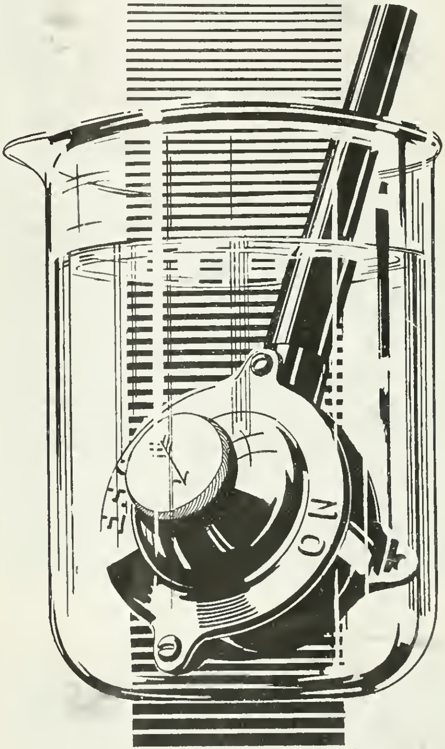
ARORA
ELECTRIC
FIRE

Has given Universal satisfaction.
LOW PRICE, ROBUST, CHEERY, ECONOMICAL

NO ADVANCE IN PRICES.
DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers),
to Sole Manufacturers
THE ARORA CO., LOUGHBOROUGH.

Simplex
Watertight
Switches

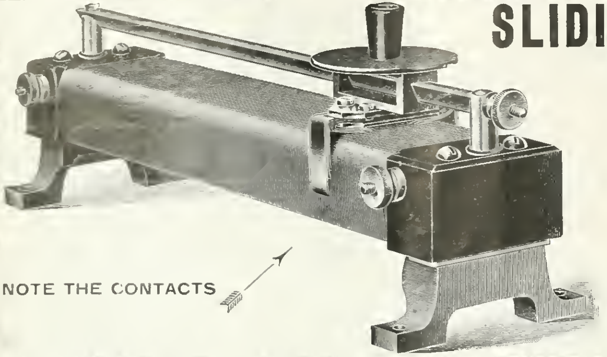


One of the smallest, cheapest, and most effective watertight turn switches on the market.

Made in 5 and 10 amp. sizes in brass and iron cases.

Will operate under water.

SIMPLEX CONDUITS LTD.
GARRISON LANE - - BIRMINGHAM.



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FOR
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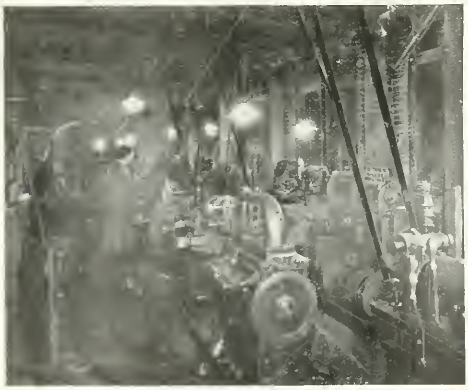
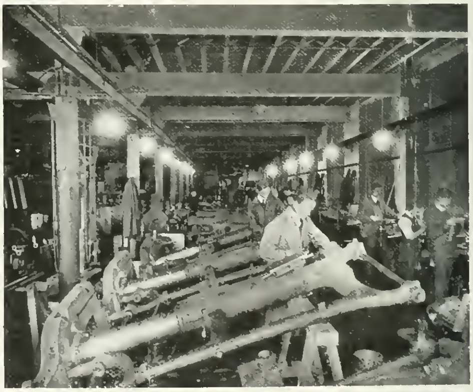
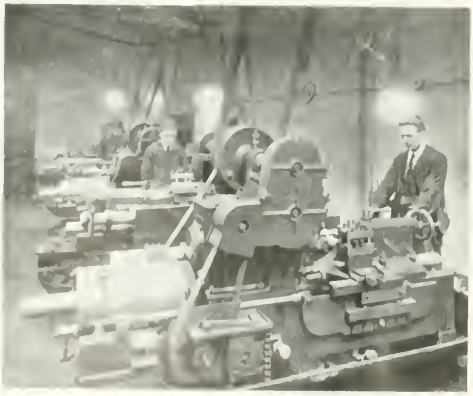
ACCUMULATOR CHARGING.
FURNACE WORK. LOADING.
LABORATORY WORK, Etc.
BRITISH-MADE THROUGHOUT.
List Post Free.
ISENTHAL & CO.,
(DEPARTMENT 4)
DENZIL WORKS, WILLESDEN, LONDON, N.W.
Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.



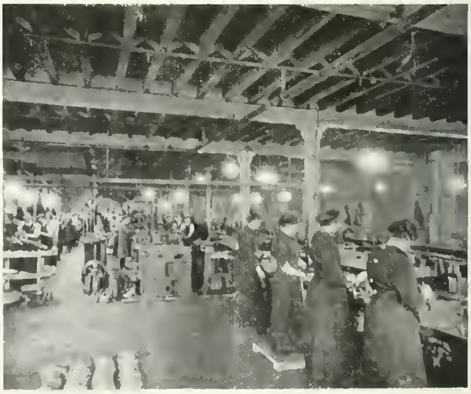
Automatic Machine Shop—30 yds. by 10 yds.
Twelve 60-watt Half-watt Lamps.



Erecting Shop. Heavy Drills—40 yds. by 20 yds.
Forty 100-watt Half-watt Lamps.



[illegible] Shop [illegible] 40 yds. by 10 yds.
[illegible] Half-watt Lamps.



Assembling Shop—50 yds. by 30 yds.
Sixty-five 100-watt Half-watt Lamps.

matter of the lamps themselves. The electrical contractor comes along with a proposition that special reflectors should be used and a "scientific" equipment put in, perhaps regardless of his prospective [illegible] (possibly) [illegible] the fact that the surroundings may be unt[illegible] [illegible] installation. Perhaps the industrial ligh[illegible] [illegible] installation of electric light with plain [illegible] and perhaps (tell it not in Gath!)

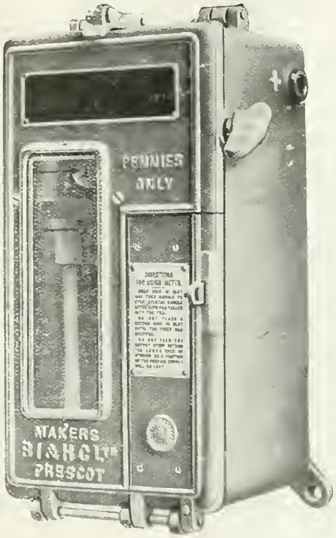
carbon filament lamps. He is a little taken aback when the electrical contractor tells him that he must scrap all this and go in for large reflectors with big light units, new wiring and fittings for these and a host of other alterations. On the other side of the account is probably an extremely small outlay for the gas piping and burners with a maintenance contract for mantles, &c.

We have always upheld the need for improved factory lighting,

PRESCOT ELECTROLYTIC PREPAYMENT METERS FOR DIRECT CURRENT.

No Motor.

No Switch.



No Clockwork.

No Counter.

BRITISH INSULATED & HELSBY CABLES. LTD.,

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but probably only the electrical contractor knows how difficult it is to bring the workshop proprietor up to the scratch to pay for these improvements. He also has an idea that he is transgressing the unwritten as well as the written laws of illuminating engineering in suggesting any alternative scheme. For instance, the prospective customer may suggest that he should use half-watt or other high candle power lamps in his existing fittings, pendants or otherwise; that is, of course, for the general illumination. To this proposal the contractor may not agree and the order will then probably go to gas, or the factory owner may continue with his installation—modified to the extent of a few metal filament lamps.

The adjoining illustrations kindly supplied by Siemens Bros. Dynamo Works are typical of heterodox illumination in a factory, but they are of interest because they show how the installation was saved to electricity, at the expense of the "correct thing" in illuminating engineering. While it is in this latter respect a transgression, it is an excusable one, for the construction of the factory was such that to have put in a "scientific" installation would have made

Machine Shop 45 yds. by 35 yds.
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[illegible] appear extortionate and have deprived the industrial light user of the advantages of modern economical electric light units. Installations of this kind do not detract in the slightest degree from the sound principles of "good lighting" for factories, so ably laid down by illuminating engineers. They may be taken as an intermediary class of lighting installation in which the light user can be given satisfactory lighting with units which are undoubtedly economical and which may in these cases be employed with quite ordinary shades. Having thus secured the business for electricity and proved its economy by use, the electrical contractor may in the [illegible] of the factory proprietor install fittings and other illuminating accessories which will render the light unit itself even more economical.

[illegible] we feel sure welcome some licence in [illegible] from illuminating engineers and take courage in recommending [illegible] half-watt and high candle power lamps [illegible] fittings.

FABRIC BRAKE AND CLUTCH LININGS.

The extent to which fabric has replaced all other substances as a friction material for brake and clutch linings is hardly realised even by engineers. Practically every motor 'bus in London, for example, has now fabric linings on its clutches and brakes, whilst all the underground railways in London and Paris, as also in the Glasgow subway, now use fabric brake-linings in place of metal blocks. Mr. J. Oswald, of Glasgow, in a Paper read a few weeks ago before the Association of Mining Electrical Engineers, dated the use of cotton for this purpose back to 20 years ago, when cotton brake-blocks were first tried on horse-trams, and were found to have points of very great superiority over wood, especially as regards their efficiency when heated by friction. Since that time great improvements have been made in the manufacture of friction fabrics. The bonding cement has been rendered more heat-proof, and a process has been developed whereby the burning point of the fabric itself is raised 75 per cent. Fabric lining is of two main kinds—that made of cotton, and that made of asbestos. According to Mr. Oswald, the cotton fabric has the highest coefficient of friction, *i.e.*, 0·5 to 0·7, and is capable of absorbing much greater work in foot-pounds per square inch at a given pressure than asbestos material. The coefficient of friction rises with increased temperature, and is practically unaffected by oil or water. In actual test results obtained by the National Physical Laboratory on cotton material, the wood absorbed in foot-pounds per square inch per minute was 72,000 dry and 70,000 when lubricated, the pressure being 39 lb. and 160 lb. lubricated. The choice between cotton and asbestos is determined in part by the amount of heat that is likely to be generated. The heat limit with cotton is 400°F., and in all cases where this heat limit is likely to be exceeded it is advisable to adopt asbestos material. The coefficient of friction of this material is 0·3, and it is remarkable that it practically remains constant under varying conditions. Its value lies in its great heat-resisting qualities, which recommend its use on exceptionally heavy and prolonged braking or similar duties. Owing to its nature, asbestos material is usually reinforced with brass wire, which makes it more expensive than cotton. Failures with fabric linings are not unknown, but the majority of them Mr. Oswald ascribes to preventable causes: (*a*) To the use of wrong material; (*b*) to failing to keep the fabric face clear of the opposing face when the brakes are out of action; (*c*) failing to ensure that the fabric is kept well home when applied, or, in other words, "followed up"; (*d*) incorrect fixing of linings to the engaging media; also (*e*) through expecting too much from brakes which have been under-dimensioned by the makers for the duties they have to perform. Collieries, it appears, are now taking up fabric linings extensively for brakes on main winding engines and haulage gears. Their use saves the rope considerably on account of the smoother action, the upkeep cost is even less than with wood, and there are further advantages in the shape of improved control and speedier working.

The immediate reason for introducing fabric linings for the brakes of the underground railways is interesting. Iron brake blocks give off an amount of iron dust which totals to surprising figures. Three-quarters of a ton of brake dust per mile has been proved to be produced every month in the New York subway. This dust not only short-circuits the electric signalling apparatus, and causes stoppage of trains daily, but as it settles on the track the oil from the motors becomes mixed with it and forms a highly inflammable mixture. It was the accumulation of this and the red-hot sparks from the metal blocks which caused the Paris fire a few years ago, in which 480 people lost their lives. Fires in London underground railways have also been attributed to this cause. The rapid running of the trains throws off oil from the motors under the coaches, and the atmosphere

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—*Extract from "Sporting Life,"* 14/6/1916.

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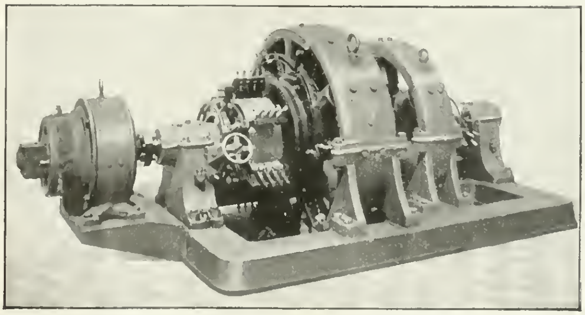

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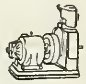

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being charged with metal dust, a very inflammable mixture is scattered all over the train. It was partly to prevent these troubles that the cast-iron blocks were abandoned in favour of cotton linings. Since their introduction not a single fire has been reported on any of these railways. Continued use led to the discovery that there was no appreciable wear on the tyres, both tyres and rails being highly burnished. A further very important result is that since fabric linings have been used, rail corrugation and flats on wheels, which commonly existed with the use of metal brake blocks, have disappeared.—"Times Engineering Supplement."

CO-OPERATION AND FOREIGN TRADE.

In a recent article on the subject of "What Co-operation Means in Foreign Trade," our contemporary, "Electrical World," N.Y., effected some interesting comparisons among the groups of electrical manufacturing firms in Great Britain and on the Continent of Europe. The suggestion is also made that there should be greater co-operation among American electrical firms. We give the following abstracts from the article:—

British Investments and Co-operation.—British investments in foreign public service or utility corporations related to or dependent upon the electrical industry, not including the United States and Canada, are in excess of $1,000,000,000. The British organisation and control of these undertakings is reflected in the British export trade, for British factories are the chief feeders of these consumers of electrical goods. It is but natural that contract specifications dictated by British executives and engineers call for British or British standardised equipment and supplies.

Effective Beama Organisation.—In the export of electrical supplies and equipment British manufacturers co-operate in a comprehensive and effective organisation, the British Electrical and Allied Manufacturers' Association. The avowed activities of the Association are directed toward fostering and protecting the electrical and related industries in Great Britain through co-operative action. The Association further provides machinery for the prosecution of claims before the Government, Municipal Corporations and the Board of Trade, and against common carriers. Government Bills and Home Office Regulations affecting the electrical and allied industries receive prompt and practical attention. Conferences have been held with British Colonial authorities respecting tariff [illegible]. Overseas committees in the Colonies and in foreign countries have been appointed, and the efforts of these Committees have [illegible] practical lines. Such as reports on (1) the [illegible] to British trade susceptible of removal through the [illegible] or through the Government, whether of the [illegible] of the country under consideration; (2) the [illegible] of British manufacturers in such connections as price, deliveries, design, behaviour of plant, &c.; (3) the success of methods employed by foreign competitors, with a description of them and recommendations flowing from such investigations. The central office in London also acts as a clearing house for information in regard to important tenders in the export field.

Co-operation Among American Manufacturers.—Under prevailing conditions it is not profitable for smaller concerns to maintain independent selling organisations abroad, however efficient individually that representation may be. The individual or specialty manufacturer, however, ably represented in his line, obviously would hesitate, and probably would be unable, to bid with safety on a whole contract. His better prepared foreign competitor, with a widespread organisation at his back, would not be affected by similar limitations. In the cases of the General Electric Co. and the Westinghouse Electric & Mfg. Co. there is little, if any, inferiority, as compared with their foreign competitors so far as industrial combination affects their efficiency. Co-operation of American electrical manufacturers would permit the joint financing of many foreign enterprises in which such financing must be done to secure the business. Moreover, it would permit the extension of credits, where necessary, to compete with the credits offered by foreign manufacturers. In seeking the removal of restrictions or obstacles to freer trade in American goods, in propaganda favouring the adoption of American standards and designs by Governments and others, and in education abroad touching the merits of American electrical products, united action would be invaluable.

Monopolies in Certain Lines in Germany.—A special report by Julius G. Lay, United States Consul-General at Berlin, dated Nov. 2 to 16, 1915, refers to the electrical industry as follows: In certain lines there are occasionally absolute monopolies. For instance, the Vereinigung Deutscher Starkstrom Kabelfabrikanten is a cartel for high-tension cables. The contract runs until 1917. This cartel is composed of Bergmann, Siemens-Schuckert, Felten & Guilleaume, A.E.G. and Süddeutsche Kabelwerke, and is an absolute monopoly. Also Akkumulatorenfabrik Berlin u. Hagen is a monopoly of the storage battery manufactories. Siemens, Halske and A.E.G. have bought up about 30 different storage battery manufactories, leaving only one outsider, the Accumulatoren und Elektricitäts Werke A.-G., formerly W. A. Böse. The monopoly pays 25 per cent. dividends.

The lamp business, which is of great importance, is the main field for sharp competition between the firms A.E.G., Siemens-Schuckert, Bergmann, and the Auer Gesellschaft (which makes only lamps, both gas and electric). However, patent conventions exist between these companies and between each one of them and the General Electric in America. Altogether, there are 11 competitors making metal-filament lamps. The German electrical concerns in European countries have their own foreign company; in South America they have their own company in the principal cities, but in some cases have agents to whom salaried engineers from the Home Office are accredited and paid by the Home Office. The A.E.G. alone has 100 offices in Continental Europe outside of Germany and 60 offices outside of Europe.

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[illegible] The Electrician Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices, [illegible], in the City of LONDON, FRIDAY, JANUARY 19, 1917.

THE ROUND TABLE.

By "KVA."

Event of the Week. Edmund Hill "comes to town" and breaks out into verse.

* * * *

The following is worthy of a place among those jewels of letters which electrical firms receive almost regularly in the morning mail :—

Dear Sirs —I have an invention for a new kind of electricity which should be profitable. It consists of a copper vessel 2 feet in square filled nearly full with turpentine. The vessel is then heated. A platinum wire touching the vessel is the producer. This electricity is much more powerful than generated. The turpentine does not need renewal. Ordinary electric wires can be attached to the platinum. The vessel should be closed. I offer you this invention for £200.

When letters of this kind are answered the reply is usually not quite suitable for publication.

* * * *

Anent the above, Mr. Scholey, of the Electric Suction Cleaner, has sent me the original of an inquiry letter which he received in response to an advertisement in "Punch" of his "Electric Housemaid" :

Gentlemen,

Please send me a Booklet No. 1. I send my love to you.

Jonney Pace.

2, Via Birchircara, G. Attard. Malta.

I understand that "Jonney" has had her catalogue and doubtless will send more love with her order.

* * * *

I came across quite a good story this week which relates to an order for a gas engine which was placed with a firm of manufacturers by a textile mill "up north." The name of the mill is famous and I need not therefore mention it. The penalty clause against non-delivery was something like £50 a week. A certain gentleman spending his holiday on the Thames discovered a friend, who showed signs of advancing years, living in state in a riverside mansion with houseboat, grounds, &c. "What are you doing here," he said, "I thought the textile industry was not particularly flourishing." "It isn't," came the reply, "but 10 years ago I ordered a gas engine from the Manufacturing Co., and there was a particularly good penalty clause attaching to the contract!"

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Jan. 24, 1880.]

Bradford.—The Town Council has decided to accept the offer of the Telephone Company for the supply of a telephone between the Bradford Town Hall and the Valley-road Gasworks, at the charge of £13 per year.

Paper Carbon. M. A. Vassard, on Jan. 17, writes to the "Globe" commenting on Edison's new departure, and in the course of his letter he says: "Gas proprietors may slumber in perfect quietness as far as Mr. Edison's new burnt cardboard lamp is concerned."

Carlisle.—The electric light has been successfully used inside Her Majesty's Theatre at Carlisle. We have long thought that its introduction into our London theatres would be merely a work of time, and we hope that the rivalry shown in the country will induce some manager to give it a trial. Success, however, will in a great measure depend upon the electrician employed.

SALVE ET VALE.

How memory turns to the Engineers' Club,
That wonderful mixture, half Church and half Pub!
Now exiled to London my thoughts fondly roam
To the Club's comfy smoke-room, "my spiritual home,"
At 2.30 p.m., where, digesting their lunch,
The Patres Conscripti meet all in a bunch.
The circle starts small but unlimited π
Will be seen as the clock turns to sweet bye and bye
Now usually first of the Circulars are
Nelson Bower and Satan (who wants a cigar).
As the jackal the tiger, so Satan doth toil
To follow that talkative Expert on Oil,
Who sits there supreme with a truculent air,
And talks of "Sir Charles" and "My friend, the Lord Mayor."
Old Satan talks, too, but responsible Prints
Of his manners and language can't even give hints,
But as he'll be Chairman and must drop his Vice
There's a chance his behaviour may sometimes be nice.
The next of the circle will be S. L. Pearce
(In manners most kindly, in looks somewhat fierce).
He will lunch at the Club, but he won't dine or sup,
Unless he is helping the rest to link up.
In those ecstatic moments he knows and can see:
"They have got to 'link up' and must do it with me."
Dr. Johnson once wittily said (and its true)
That the very best prospect a Scotchman can view
Is the high road to England; when Robertson moved
'Twas a big loss to Scotland but Johnson's words proved.
'Veni, Vidi,' said Cæsar, and added to that
One little word 'Vici' and J. A.'s done that.
Then the door opens wide, and in smiles H. N. Allott,
A member who'd get every vote on a ballot.
Should a poll be desired on the friends of the Club,
Elected he'd be both by Church and by Pub.
After him comes a man whom we always enjoy,
A civilised Scotchman, by name McElroy,
Whose system of running from bad goes to worse
Till he's stopped at Knott Mill by an impudent verse.
Now the circle enlarges. Here comes our friend Meek,
(And between you and me) if we set out to seek
A man with profounder, more knowledge of paint,
We should tire in our quest, and should probably faint,
Undisturbed he continues his feculent way
Making poles, pillar boxes, etc., like day.
Next appears, as we know both by scent and by sight,
Dear old Reid who is putting the Ship Canal right.
Though foul are its smells, yet the swell's in its div
Might a misanthrope teach to forget and forgive.
Another new comer, who Newcomen talks,
Is old Billy the goat, who an old engine stalks
Till he's got it in print and in talk out and out.
God bless dear old Billy the champion boy scout.
Hail, Gower! You come like a portent of fear!
Don't tell us you're raising the price of our beer.
Just think of those members, like me, with a daughter,
Be bold and charge 3d. for each glass of water.
(As to Alec and Billy's old brandy dispute
Serve each with the other's—'twill die at the root.)
When Allcock arrives he's acclaimed by the lot
As the final and ultimate word on the "spot".
Whate'er be the good of the Country he's planned
A Glover would never play Hell with a hand.
So I firmly believe that old Harry, like Nick,
Has a card up his sleeve that will win the last trick.
Then Wilkinson comes like a man in much haste,
"Indian Mail day to-day and I've no time to waste."
Like the Priest and his mare if you call "B.E.A."
To Hades with mails and for hours he'll stay.

[Continued on next page.

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NEWCASTLE—64-68, Collingwood [Bldgs
SHEFFIELD—22, High St.
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When we (if we ever) ascend to the skies
His place will be waiting, his job — organise.
Now I've left to the last one who constantly climbs
To heights that should make him quite giddy sometimes.
But the sure steady foot and the clear active brain
The precipice conquers again and again.
If we keep level-headed, like Walker, our friend,
We shall reach, both with safety and honour, ·

THE END.

EDMUND L. HILL.

CRANE AND HOIST MOTORS.

The motors described in descriptive list No. 2269 issued by the B.T.H., Rugby, have been developed for heavy duty crane and hoist [illegible] where reliability is of primary importance. They are totally enclosed, reversible, series wound, commutating pole motors designed for intermittent service. Motors are standardised for various ratings [illegible] as shown in the following table. These ratings are

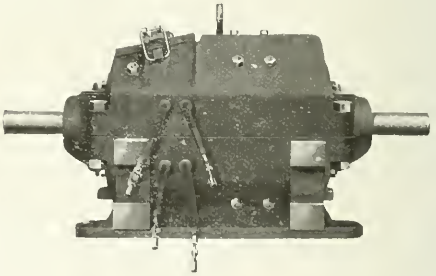
H.P.	Speed (r.p.m. on load)						
	[illegible] volts	[illegible] volts	1[illegible] volts	220 volts	230 volts	250 volts	500 volts
[illegible]	[illegible]	[illegible]	1,100	[illegible]	[illegible]	1,100	1,000
[illegible]	[illegible]	750	880	[illegible]	[illegible]	880	850
[illegible]	[illegible]	[illegible]	840	[illegible]	[illegible]	840	800
[illegible]	[illegible]	700	800	[illegible]	700	800	775
[illegible]	[illegible]	[illegible]	[illegible]	600	[illegible]	770	725
[illegible]	[illegible]	600	[illegible]	[illegible]	[illegible]	690	675
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	650	600
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	650	600
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	580	550
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	515	500

[illegible] for 30 minutes at full load with a [illegible] C., with temperature rise [illegible] [illegible] four pole series wound, and fitted with commutating poles. Series motors are liable to attain excessive speeds at light loads, and it is recommended that care should be taken to ensure that the maximum speed will not be destructive. The normal full load speed is given in the standard rating schedule.

All machines while hot are subjected to a flash test of 1,000, 1,500 or 2,000 volts A.C. for one minute, the value depending on the supply voltage on which the machine has to operate.

It is stated in the list that only the best and most modern insulating compounds are used in the treatment of the windings of these motors and the method of applying the compound is highly effective.

The magnet frame is of cast steel, made in two parts, so that the frame divides horizontally, the two halves when assembled being held together by bolts placed at each of the four corners. The frame is octagonal, such shape being valuable in giving flat seats for the removable field coils. Each half of the frame contains two main poles and one commutating pole, so that the arrangement of poles is symmetrical. The ends of the magnet frame are machined to receive the end shields which support the bearings. The top half of the frame carries the brush-holder studs, and has a large dust-proof inspection cover so that the brush-holders are accessible. This half of frame is also provided with lugs cast on each side to support the completely assembled motor. The bottom half of the frame has a strong foot extending along each side the full length of the magnet frame and drilled for holding-down bolts.



CRANE MOTOR FOR FLOOR MOUNTING.

Each side of this half of the motor is provided with facings which may be machined to take the second motion shaft bracket on back geared machines. The end shields carrying the armature bearings are of cast iron and contain reservoirs for oil lubricating the bearings. They are attached to the ends of the frame by four bolts spaced in quadrature, so that they can be swung 90° or 180° to keep the oil supply beneath the bearings when the motor is mounted on wall or ceiling. The end shields are interchangeable end for end of the motor; each is provided with an overflow hole to prevent overfilling of the oil reservoir, and with a drain hole for removing the oil. A large hinged cast-iron cover is provided over the bearing to facilitate oiling and permit inspection of the oil ring.

All pole pieces are rectangular in shape and are held in place by studs or cap screws tightened from the outside. The four main poles, two in each half of the frame, are made of laminated steel. The two commutating poles, one in each half of the frame, are made of solid steel. The field coils for both the main poles and the commutating poles are former wound, and are removable from the pole pieces. The bearings are babbit lined; they are generous in their proportions and are interchangeable end for end of the motor. The bearings are lubricated by oil rings which are mounted on the shaft and turn with it, so carrying oil to the bearing surfaces from the reservoir below.

The armature core and commutator are assembled on a sleeve, which construction permits the removal and insertion of a shaft without the necessity of disturbing the armature windings or the commutator. The armature windings are composed of former wound coils inserted in open slots. The coils are held in place by suitable

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Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

CORALINE PASTE.

"The Paste no menace is to eyes or nose,
But just exactly where its wanted goes;
And he who uses it as flux,
He knows about it—yes, he knows."

A safe and economical soldering flux which can be used on the most delicate work. Unlike most fluxes it gives off no spray, and can be used continuously without danger to the worker.

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Works: PRESCOT and HELSBY.

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NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

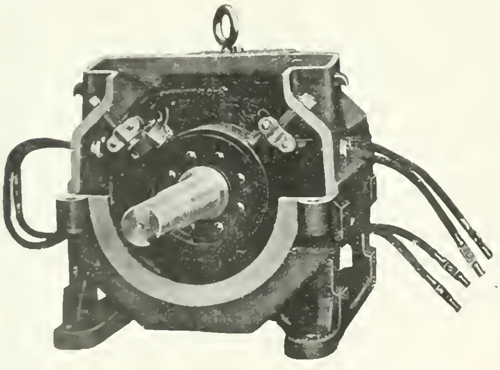
OVERSEAS BRANCHES:

AUSTRALASIA: The Wool Exchange, King Street, Melbourne.
EASTERN INDIA: 11, Clive Street, Calcutta.
SOUTH AFRICA: Telegraph Manufacturing Co. (Colonial), Ltd.
P.O. Box 2827 Johannesburg.

BASTIAN METERS FOR DIRECT CURRENT ONLY.
Made in ENGLAND with
BRITISH CAPITAL and BRITISH LABOUR.
THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

binding wire of high tensile steel, and that portion of the coils projecting beyond the core is tightly drawn down against a cast shelf or ring extens on to the armature spider. The shelt on the back end projects beyond the windings and is flanged so as to protect the coils when forcing the shaft from the armature. The shaft extensions on each end of the motor are of the same length and diameter, a valuable feature, as it permits the spur gear or the brake to be mounted on either end of the shaft.

Both the brush-holder studs are supported by the top half of the frame. They are located above the commutator, 45° from the vertical, and at an angle of 90° from each other. Brush studs are of the insulated type, all insulation being directly on and solid with the stud. There is one brush-holder to each stud, and means are provided for adjusting the brush-holders vertically on the studs to follow the wear of the commutator. The brush-holders are of very simple construction and carry carbon brushes equipped with flexible connections.



Motor with Frame cut away to show Brush-Gear, &c.

The motor leads are brought out, four on each side of the motor, and the ends are provided with suitable terminals. The leads on one side of the motor are left open for attachment to the control equipment; those on the other side are joined. The open and closed sides may be reversed by merely opening the leads on one side and properly joining those on the other. There are no inside connections to be opened when removing the top half of the frame. Series wound magnetic brakes can be furnished designed to exert their braking action when the motor is idle, but releasing when the motor is drawing current from the line. When brakes are furnished in connection with motors they will be mounted ready for service. Disc brakes are furnished when the brakes are merely required to retard the momentum of the moving parts. Such brakes are ordinarily furnished to hold half the full load torque of the motors.

Shoe brakes are furnished when it is desirable for the brakes to have a high retarding power. These brakes are furnished to hold full load torque of the motors, but they can be adjusted to hold more or less than full load torque. They have steel wheels of small diameter, [illegible] closed solenoids, and are self adjusting, so that as the brake shoes wear the air gaps are kept constant, thereby insuring constant braking value. On account of the rough handling to which crane motors are subjected during erection and in operatio all "CO" Motors are given a heavy coat of anti-rust paint whic effectively protects the motor and at the same time gives it a goo appearance.

The List from which these details are taken will be sent on appl cation to the B.T.-H. Co., Rugby.

ELECTRIC LIGHTING AND STARTING SYSTEMS.

The following article from the pen of "Runabout" in "The Aut car" should be of interest to those electrical manufacturers who a engaged in the big problem with which the article deals. Th battery makers may have something to say regarding their par of the problem.

As soon as the full flood of competition between the motor cars o various countries re-commences on open markets, one of the chie problems for the maker of light cars will be whether or not to fit ful electric equipment. The question is already settled as far as verdict go. The public wants it, the makers believe in it, and the American have long since given us a lead by standardising such equipment o many of their cheaper vehicles.

There are still two serious obstacles in the way. The first is cost. America manages to produce full electric outfits at a far lower pric than our own makers. One hears stories of their misbehaviour, an from a casual inspection of their exteriors (so far as some of th cheaper cars go), one can readily believe the worst that is said o them; on the other hand, some users profess to find them perfectl satisfactory. However, the real point is that, if we do not cheape our electric starters, it is questionable whether our light cars make can afford to fit them as standard.

I was talking to one of our most wide-awake manufacturers abou his post-war plans, and he said he wanted to fit a starter, but coul not yet see his way, first, because it would raise his selling pric more than was desirable, and second, because he wanted to find reasonably-priced starter which would give no trouble; and, i respect of trouble, he specially emphasised the battery.

This brings me to the second obstacle. It is useless to blink th fact that the average owner-driver is a very careless person. H hardly ever refills his greasers, and he frankly disobeys the dynam maker's pathetic pleadings that he should keep up the water leve in his battery; if he occasionally remembers the battery he swishe in anything but distilled water, and never dreams of adding acid even if the liquid has sunk very low indeed. Such makeshift treatment is not good for an accumulator burdened with the comparativel light task of feeding the lamps, but it spells early ruin for a batter which has to sustain the heavy discharges of starting an engine— an engine, too, which is often gummy, and seldom in good tune Moreover, the cost of such batteries approaches the premium of a insurance policy, and is a large item to the average light car owner.

The Alternative.

I suppose all these risks, both of first cost and of maintenance will be faced by makers and public alike. But it should be remembered that there is an alternative to the full electric equipment It does not pass the wit of man to devise a pedal or lever starte which will start a 65 mm. engine from the driver's seat with ver limited effort indeed. If there is a price-war between English light cars and any imported rivals (and such a war is humanly certain) the idea of a mechanical starter should not be scrapped withou serious consideration, as it would effect a reduction of at least £1

BURNER & HEAT CONTROL
Equipment for Lead Presses
(HALL'S PATENTS).
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026 Grams: Vicminster, Sowest London

ENGLISH
EDISWAN
EVERYTHING
ELECTRICAL

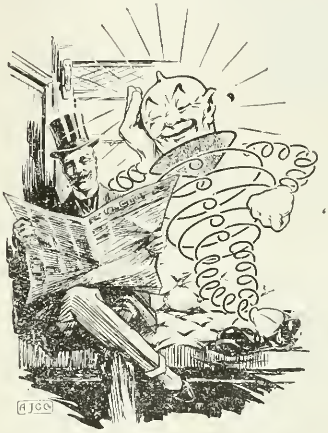
The house of Ediswan is the best equipped to deal with all enquiries for
Everything
Electrical.
ENTIRELY BRITISH.

The Edison Swan Electric Co., Ltd.
PONDERS END, MIDDLESEX.
London and Provincial Depots.

"ELASTA" WIRE LAMPS
FOR TRAIN LIGHTING

Pope "Elasta" Lamps are made with a specially strong filament which withstands severe vibration; impervious to the jolts and jars of Railway Trains.

Strong... Brilliant... Economical.


"What would you do without me on your journey home?"
AJCO

Advt. of Pope's Electr. Lamp Co., Ltd., Hythe Road, Willesden, N.W.

in cost per chassis, and ought to be far more reliable and less expensive to maintain than the best electrical devices.

Mechanical starters may never have a chance with big engines, but the small four-cylinder stands in a class by itself, and it is really absurd to pay £20 for a starting equipment for it. On the same scale Rolls-Royce starters should cost about £150 apiece.

THE LIGHTING PROBLEM.

The solution of the lighting problem is much easier. Every hard night driver secretly prefers the old acetylene and paraffin combination on one count—he could always reckon on getting home with it, whereas with dynamos or any other imaginable single source system, one defect may put all five lamps out of action. The old gas and paraffin sets were killed by the dirtiness and uncertainty of the acetylene generators. They could be restored to their old popularity if the generators were scrapped in favour of *two* motor cycle size cylinders of dissolved acetylene. I say two, because the sole defect of the DA system is that it is very irritating to hand over a cylinder containing a certain amount of gas because you doubt whether there is quite enough to last you until you pass the depot again. On this change there would be a further gain in reliability, and a further reduction in cost per chassis of perhaps £10.

This alternative would thus seem worthy of a little thought, seeing that it offers the light car maker a gain in reliability and a reduction of at least £20 in chassis cost, a sum which may prove vital in coming competition, and which he cannot possibly save in any other way. Against it, we must rank the obvious fact that the public taste is all in favour of electricity, and that, until post-war conditions have made us all learn how to retrench, we shall continue to pay, say, £40 for the lighting and starting of a £200 car even in war-time, though we should write furious letters to "The Times" if we read in "The Autocar" that Lord X—— has paid £400 for the full electric equipment of his new 50 H.P. limousine.

PEEBLES Bruce Peebles & Co., Ltd,
ELECTRICAL MACHINERY
Engineers, Edinburgh. *See our Illustrated Advt. last week.*

AN IMPORTANT BRITISH INDUSTRY.

The perfection of the high-speed internal-combustion engine, which began with the introduction of the motor car 21 years ago, has re-modelled methods of traction and created an important industry with a large number of contributory trades more or less dependent on it.

Among the most important of these may be classed the manufacture of magnetos. But when war broke out there was only one British firm making magnetos, its output being under 100 a week. Practically every magneto which went on to the motor vehicles, motor boats and aircraft of Great Britain came from enemy Germany or from America. Till August, 1914, we had been content to go abroad for nearly all our magnetos. But in a few short months British manufacturers got steadily to work, and at the moment there are some 12 or more British firms making magnetos.

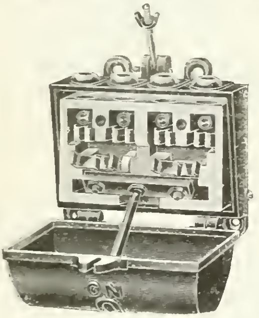
Their entire outputs, reaching a total to date of over 165,000 magnetos, have been made for war purposes, and are used on aeroplanes, seaplanes, airships, motor lorries, motor ambulances, motor cycles, "tanks," big gun tractors, motor boats, wireless sets, searchlight sets, lighting sets, &c. In fact, it may be said that the war is being conducted on British made magnetos. After the war the resources of the British magneto manufacturers will be at the disposal of the British public. There will be no need to buy enemy or other foreign magnetos.

SEEING AHEAD FOR THE ELECTRIC VEHICLE.

AN INTERVIEW WITH THOMAS A. EDISON.

"The growth of the electric vehicle has been hindered by lack of charging facilities. Selling electric current is a mercantile business just like any other business. Not enough central stations realise this, and very few search out *every* way that current may be marketed. As a result, undeveloped markets exist for the sale of central station energy. It's a funny business when so few central stations realise that there is a waiting market for the sale of current for charging electric cars. The public is in the curious position of wanting to buy something for which there is no place to go.

"In my opinion, the central station should go into the garage business and provide in this way the best means of furnishing a



IRONCLAD SWITCHGEAR,
STARTERS,
MOTORS
(A.C. & D.C.),
FANS (A.C. & D.C.),
FIRES, LAMPS.
MOTOR REPAIRS.
STOCK DELIVERY.
Enterprise Manufacturing Co.
(ASHDOWN & ROBERTS),
Gun Street Electrical Works,
BISHOPSGATE, LONDON, E.
PHONE US: AVENUE 5366.
(Dept. E.)

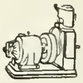
place to which the customer can go to buy what he wants, electric current, in the form of mileage.

"If I were in business to sell current I would find every possible way to sell current. If I were a central station manager I would put up a garage and go into the business of selling electricity for driving cars. I would put up or rent a four or five-story building and install a proper elevator. I would charge vehicles at night on banked tires, just as they do in Hartford, Conn., at the present moment. I would have trucks on the first floor and an elevator big enough to handle pleasure cars on the other floors. I would not sell current for charging, but for mileage, which is want the customer wants. I would make a service charge per mile that would include the cost of current. A garage charge of this sort could be made to be profitable to both the central station and the business man. Perhaps I would rent out, under a contract with a reliable firm or person, the washing and repairing of the vehicles at fixed and reasonable prices, relieving me of that detail, and confine myself to the selling of current.

I believe that the central station should go into the garage business because the electric garage needs the intelligent supervision and reliability that the central station can give it. One of the main difficulties in garaging both gas and electric cars is the lack of knowledge of the average garage man. The storage battery to-day doesn't need experts to supervise it, but it does need the same intelligent and responsible care that any mechanical or electrical equipment needs. The average garage standards of this country for either gas or electric cars are far too slow. The central station, if it went after the business on the basis of building up a profitable income, would raise the standard of garage service and reap the reward for it. When I say that I have known men in an average garage to pour sulphuric acid into our alkaline batteries, and to make outrageous charges to their customers, it is easy to see that we can never expect the electric to come into its own until we have more intelligence and reliability in the places where cars are charged.

"Even the big men don't seem to realise the opportunity for increasing their sales to the public by establishing charging stations and by making a profit on selling electric mileage to the community. There is an opportunity for big sales of current on a profitable service basis. Business need imagination. The electrical business is no exception. Sometimes I think the men who ought to see 10 years ahead see only next week."—*Electrical World.*

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.



Electrical Engineers and Manufacturers
The House for Electric Heating.
Telephone: Gerrard 7601 (2 lines).
Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.
Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.
Petrol Engine Sets.
F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON
Manufactured in sizes from 2 kw. to 20 kw.
Quotation for larger sizes on application.

SUCCESSFUL CASEHARDENING.

We have received from David Brown & Sons (Huddersfield) Ltd. a copy of an interesting booklet on the above subject.

Steel which is required to be casehardened should contain a low percentage of carbon (0·15 to 0·2 per cent.), and the amount of sulphur and phosphorus should be as low as possible. In their position as gear specialists they have paid a considerable attention to the subject of casehardening, as the teeth of gear wheels in general are subjected to heavy intermittent loads and frequent shocks demanding a uniformly hard surface of very high quality. The company's business consists of a large amount of case-hardened work of every variety, from small parts weighing a fraction of a pound, to large pieces weighing several hundred pounds. There is difficulty at present in obtaining many grades of steel, so that some parts have now to be casehardened that were previously left in their natural state, and in order to obtain uniformly good results it is essential that a highly efficient carburising medium should be available.

In the course of their business they have, we understand, tested and experimented with practically every compound on the market, but most of them left something to be desired either in inconsistency or quality. Experiments with their own materials have enabled them to improve the product in many ways, and they now believe they possess a carburiser which is "second to none." The mixture, which is known as the DBS Carburiser, possesses the following important qualities: Uniformity and freedom from foreign ingredients and dust; the penetrating power is such that at a temperature of 820°C. a depth of casing can be obtained equal to that given by most other compounds in the same time at a temperature of 920°C. This effects a saving of heat and of time; it is economical, since it can be used many times over, the loss in each heating being small. Afterwards it can be used for working up with the addition of new compound. Being a rapid carburiser, it can be worked at a low temperature, which is beneficial to the quality of the material carburised. The mixture is rich in carbon, which is so combined with the other chemical elements that it is readily liberated under heat treatment and combines rapidly and effectually with the steel. On account of the quality of the material and its energetic action, the parts to be hardened can be packed more closely, thus saving space in the boxes and muffles; a space of ½ in. between two separate pieces is sufficient. Certain ingredients are contained which tend to neutralise the effect of the sulphur which is present in the steel, thus allowing the carbon to penetrate more freely and making the surface uniformly hard.

All the components of the DBS carburiser are effective agents in the carburising process, and there is no addition of slow acting or neutral substances, such as are contained in many other mixtures for the purpose of making up weight and reducing cost.

The DBS carburiser is capable of being packed densely in the boxes, thus giving support to the pieces being carburised, and further, there is no shrinkage during heat treatment, which is an important factor in minimising warping.

The booklet from which the foregoing is extracted contains numerous illustrations which bear out the company's claims for the carburising material.

FERRANTI LTD
HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.

[illegible] THE ELECTRICIAN PRINTING AND PUBLISHING CO., LTD., at the Editorial, Printing and Publishing Offices, [illegible] LONDON, ON FRIDAY, JANUARY 26, 1917.

THE ROUND TABLE.

By "KVA."

My sympathies are with Mr. Staniland, Hornsey's electrical engineer, upon the following catalogue of troubles:—(i.) several men debadged, (ii.) no copper for consumers' extensions except for war purposes, (iii.) £300 repair to a defective crank shaft, (iv.) recent gales damaged a cooling tower to the extent of nearly £60. It only wants the engine room cat to kitten among the bus bars to make the thing complete!

* * * *

A new use for the Megger was suggested to me this week by a sales engineer of my acquaintance. He argues that if a Megger is used to ascertain the insulation resistance of an alternator cooled by a wet air filter it could be applied as a test of alcoholism, in other words the degree of saturation!

* * * *

I am asked to give publicity to the following from a Manchester reader:—"Certain members of the Manchester Engineers' Club, whose names are mentioned in the doggerel lines published in your issue of the 26th inst., over the nom de plume "Edmund L. Hill," are desirous of ascertaining the author's true name and address, in order that they may take such action as may appear to them appropriate. Much pain due to excessive mirth immediately after lunch—has been caused through the poet's references to the amiable weaknesses of some of the members, but grave as is this offence, it pales into insignificance when compared with the disappointment felt by certain of the club's choicest spirits, who are mortally offended by the author's studied neglect of their claims upon him. I am informed that the author is invited to attend a Meeting of Pretest, to be held at the club on the evening of February 20th, when the gentleman whose name he has dared to adopt as a nom de plume is also expected to be present."

* * * *

The American electrical advertiser sometimes lapses into rhyme but he prints it as prose. Here is a specimen which I have had put into verse as we know it:—

"Aha!" he cried in accents wild—
"Pluto come and catch your child,
For every time this gun I fire
I knock an Imp clean off the wire.
"Behind the pole old Pluto lurks,
To send his Imps and jim the works,
But I've joined the Guard and bought a gun
That puts the Imps all on the run.
"They used to burn my motors out,
And put the Mazdas all to rout,
And every time they nipped a fuse,
The whole blamed business I would lose.
"The fuses used to cost like sin,
But now I slip a cartridge in,
And cut out nearly all the cost
Of parts that formerly were lost.
The National Fuse is safe and sane—
There's nothing to lose and all to gain."

P.S.—Whether you think this foolish or say it's funny, its's a darn good way to save your money.

The advertisement is illustrated with a sketch which shows little imps being merrily "potted" off a transmission line by a genial gentleman who has a gun resembling a cartridge fuse.

From this week's "Punch":

Passenger: "I hear they're thinking of electrifying this part of the line."

Porter: "Ay; they're allus up to some daft game. They'll be electrifying *us* next!"

* * * *

Some Round Table readers may remember that some time ago I gave the definition of commission as "moneys paid not willingly, but grudgingly and of necessity." I got this from a sales engineer who spoke from the heart. His experience was probably similar to that of another sales engineer to whom I quite inadvertently mentioned "cards and cards indexing" one day last week. He told me that his commission account was in dispute, and that after three days with one of the directors he still believed that the company owed him something. The director in question referred him to Mr. Blank for confirmation. In Mr. Blank's office he stated his case, and the following remarkable thing then happened. Mr. Blank took from a drawer a number of cards, which he placed in a certain machine driven by a small electric motor. As the sales engineer put it, "there was a whirling of canvas belts, a clanking of levers and the noise of many waters." At the delivery end of the machine was a small heap of cards, which were duly fed into another machine, and this in its turn delivered a "pink form," on which was set out what the sales engineer had sold during the period of his engagement, the works cost thereof, the establishment charges and cognate details chargeable to each of the items; the profit upon the sales and the commission to which the sales engineer was entitled. "But," said the bewildered individual, "I am still convinced the result is wrong." Mr. Blank waved him away. "Our director may be wrong, and you may be wrong, but *my* system and my machines *cannot lie*!" That sales engineer went out and wept bitterly!

* * * *

OUR HOT PLATES.

No. **229**, to—

The Victoria Electric Plant Co., for their particularly recherché desk blotters. Some girls! (If you haven't had one, get it before they're all gone.—"KVA.")

* * * *

[From THE ELECTRICIAN (Second Series), Jan. 31, 1880.]

SHEFFIELD.—In a recent lecture Mr. Norham, Superintendent of the Sheffield telegraph department, stated that 40,000 telephones were in daily use in America, whilst only about 800 were in use in England.

MAGNETISM OF THE BLOWPIPE FLAME.—It has been found by Mr. W. A. Ross, of Acton, that the blue pyrocone produced by the blowpipe from an ordinary gas burner possesses magnetic polarity, for its point attracts the north pole of a compass, and repels the south gole.

With characteristic effrontery the correspondent of the "New York Herald" has interviewed M. Dumas, Chancellor of the French Academy; M. Niadet-Breguet, the able partner in the well-known firm of Breguet & Co., electrical mechanicians, Paris; Mr. W. Crookes, our distinguished chemist; and M. Fontaine, President of the newly-established Syndicat d'Electricite, in order to worm out of them their opinions of the Edison lamp, and telegraph the results to America. These reports are, rightly considered, neither for nor against the new lamp, and in giving a very reserved reception to the pushing reporter these gentlemen have done a service to true science.

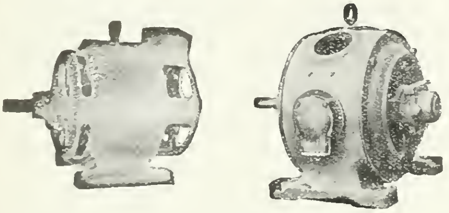
'IGRANIC' STARTERS for large motors or special duty possess unique features which give real advantages.
IGRANIC ELECTRIC Cº LTD 147, Queen Victoria St., London.

No. 30
Multiple lever type with toggle joint interlocked levers giving hand-over-hand slow motion. Heavy laminated contacts & renewable sparking tips.

No. 36
"Inching" type for setting up. No circuit making or breaking on the contacts: always on the clapper switch. Heavy duty resistance amply rated.

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: Gerrard 860. Telegrams: "Siembralos, Vic. London."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs
Sheffield—22, High St.
Southampton—46, High Street
Branches in Principal Towns Abroad.

PIRELLI-GENERAL WORKS, SOUTHAMPTON.

Few firms can claim greater experience in the manufacture of cables—from the heaviest submarine or highest tension underground cable to the smallest insulated wire—than Pirelli, whose works have been established for well over 40 years. The factories at Milan and Spezia in Italy, and Barcelona in Spain, cover a considerable area, and give constant employment to many workers. The Milan-Bicocca factory occupies some 212,000 sq. yds., and employs over 6,000 workers. Among its various departments is one specially equipped for scientific research upon cables and insulating materials and kindred processes. The Pirelli-General Cable Works, Southampton, which have recently been completed and put into full service, will benefit from the experience gained in research and manufacture. For some time past the General Electric Co. (Ltd.) have supplied every class of electric cable—the chief source during the last few years being the Pirelli factories in Italy—through the English selling organisation of Pirelli (Ltd.).

The opening of the works marks the completion of yet another link in the chain of British electrical manufacturing industries instituted by the General Electric Co. and their allied interests. The products of the Pirelli-General Cable Works, Southampton, will benefit from the great advantages which the selling organisations of the General Electric Co., Pirelli & Co., and Pirelli (Ltd.), with their world-wide ramifications, can furnish.

The Pirelli-General works are situated at Southampton on the shore between the docks and Southampton West Station. The position affords convenient access to the sea for the transport of raw materials and finished goods, proximity to a main line railway, full supplies of labour, cheap power, &c. Not many years ago the site at present covered by the works was an unprofitable mud flat, covered by the sea at high tide. When certain excavations were carried out for Southampton Docks the material excavated was used for the purpose of reclamation, and the valuable properties of the Southampton Corporation electric power house and the Pirelli-General works were built on the site.

One of the Braiding Shops.

Nearly opposite the works' gates are the old town walls and about a hundred yards further on is the famous Bargate. To the left is all that remains of the ancient Palace of King John. According to tradition, it was on a spot near at hand that King Canute was guilty of a piece of "unutterable swank." The works, at present, cover but a third of the total area owned by the company—there is, therefore, ample room for future extensions.

The entrance gates open on to a large quadrangle (partly glazed over), which is used for the receipt and despatch of goods. Material received by water is landed at the private pier, and is then lifted from the barges by means of a 10-ton electric crane on to a tramway

View of Pirelli-General Cable Works from Southampton Water.

Canadian and Indian

MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

Hopwood St. Mills,
PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union

BELLING

& CO.

We can quote you for and are regularly supplying :—

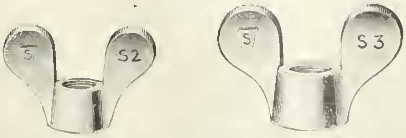
Electric Heaters for Shell Drying Ovens.
Gas and Fire-proof Heaters for Loading Rooms.
Immersion Heaters for Wax Melting.
Air Warmers for Fabric Drying Rooms.
Low Temperature Radiators for Work Rooms.
Electric Fires (Radiant type) for Offices, &c.
Electrically-heated Water Tanks to deal with any quantities.
Thermostatically controlled apparatus to keep either water or air at any desired temperature.
Electric Toasters, Water Boilers and Grillers for Mess Rooms.

We have had large experience in adapting electricity to many novel manufacturing processes, and are prepared to submit quotations and drawings to meet any given conditions.

BELLING & CO., Electric Heating Specialists, Derby Road, EDMONTON, LONDON, N.

E. SHOWELL & SONS, LTD.
STIRCHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.
Tapped Standard Whitworth and B.A. Standard.



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Simplex Interlocking Switch Plug

A type designed to meet the growing demand for an

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for use on heating, lighting and small power circuits.

This switch plug has the following special features :—

- Impossible to insert plug whilst switch is on.
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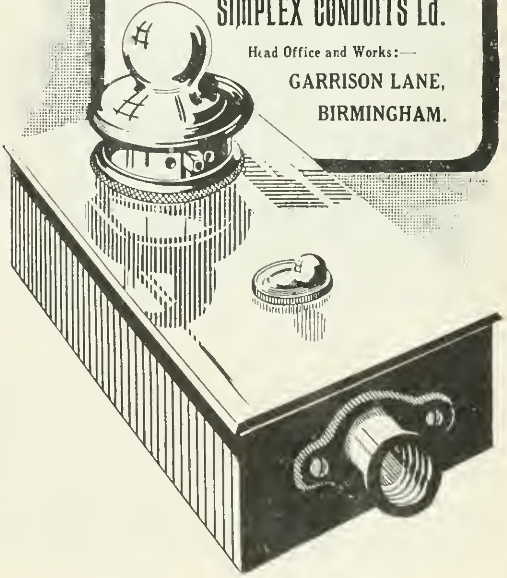

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for transportation to the department for which it is intended. In addition to this tramway there is an overhead mono-rail electrical system which forms the chief means of transport throughout the works. This mono-rail has been specially built for transporting bobbins or other weights up to 7 tons. Each of the more important avenues is provided with a runway, and there are various points and crossings linking up the main longitudinal routes.

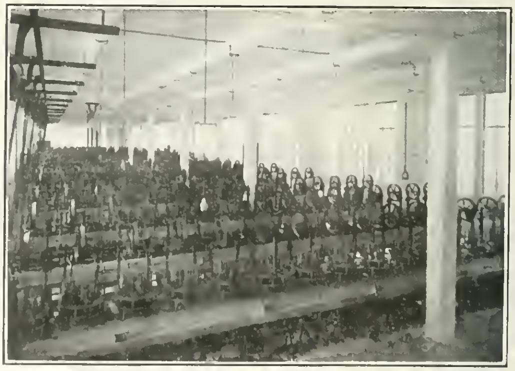
The main building is of two storeys, with provision for additional floors when necessary. The ground floor is used for the rubber departments and for the manufacture of the heavier cables, and the upper storey for flexibles and the lighter wires and cables. The

The Impregnating Tanks.

[illegible] a fact which must have a good [illegible] of the workers, and also upon the [illegible].

The [illegible] in the rubber department are driven [illegible]. On the [illegible] floor are stores with large quantities of [illegible] paper, jute and other materials. The [illegible] have been installed. Some of [illegible] stranding as many as 91 wires [illegible]. [illegible] lay up the finer wires to a [illegible] of 1,500 revs per minute. Copper wires up to 1,000 sq. mm. and 1,500 sq. mm. section can be stranded. In some of the covering machines the whole process of covering rubber, separator jacket and proofed tape is performed at one operation, and some of the longitudinal covering machines cover 12 wires at one time. Following this comes the process of vulcanising, and near at hand are the large cylinders and drums used for steam jacketing. For this latter process the cables are wound round large drums, these are covered and then passed into cylinders, where they are steamed for the necessary period and then wound off. Near the vulcanisers are the water tanks where, by means of cranes and the overhead runway, the heavier cables are immersed in water for 24 hours. Then the cores are subjected to a high pressure test of about 2 or 2½ times the working pressure according to specification.

The various processes in the making of power and high-tension paper cables are, as far as winding and stranding, similar to those used in the manufacture of rubber cables, except that they are insulated with a special cable insulating paper by means of machines which lay on the paper alternately right and left handed. If the cables are multicore, they are laid up and wound with further layers of papers so that the thickness is the same between the cores and earth or lead casing.



Small Wires and Flexibles Shop.

They are then placed in the drying chambers, and when perfectly dry the cables undergo impregnation and are then lead cased. The cables for laying direct in the ground are finished by the addition of mild iron tapes covered with impregnated jute and compound; if subjected to tensile strain they are armoured with galvanised steel wire.

The chemical laboratory and testing rooms are furnished with the

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh. See our Illustrated Advt. 19th January.

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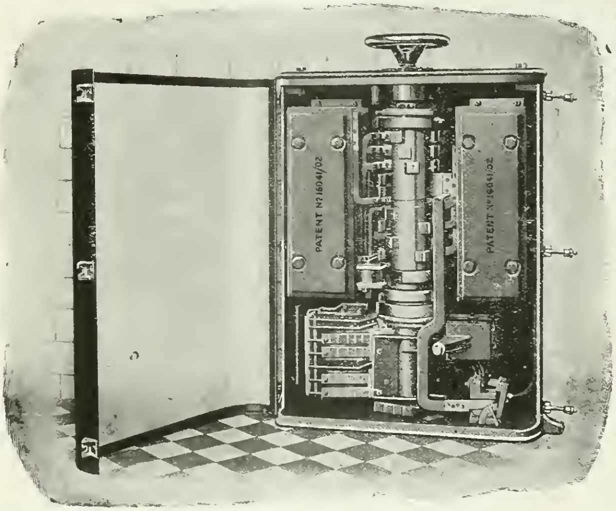

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Drum Type (free handle) as shown, also Lever Type and Flame-proof Type.

(2) **FUSES.** Porcelain Handle (with Self-aligning Contacts), and Ironclad Switch Fuses.

(3) **WALL PLUGS.** W.T., for outside use, as supplied to Admiralty, and Dustproof for Works use.

(4) **H.T. ARMOURCLAD SWITCHGEAR.**

(5) **MINING SWITCHGEAR.**

(6) **PROTECTIVE DEVICES,** to isolate faulty sections on Power Supply Systems without interruption of supply through Sound Sections.

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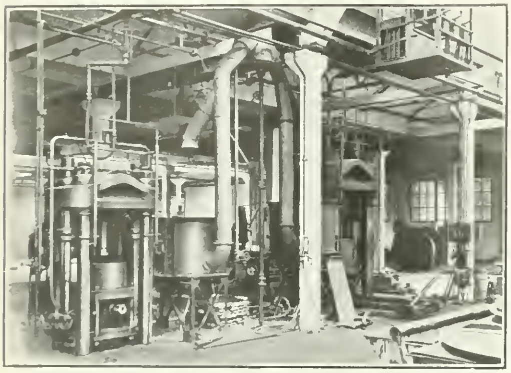
Works: Dermody Road, Lewisham, London, S.E.

most modern apparatus. All the improvements obtained from the experiments and researches in the Pirelli testing room in Milan—which has a series of instruments and transformers for tensions up to 600,000 volts—are directly utilised and applied in the methods and processes of manufacture at the Pirelli-General Cable Works, Southampton. The testing rooms in the latter, which are situated opposite the water tanks, are, we understand, among the finest in Great Britain. They form ideal rooms for their purpose, and are fully equipped with machines for testing tensile strength and torsion, as well as balances of various kinds and many other testing sets, each complete in itself. These are supplied by a 1,200 volt battery of accumulators. The chemical laboratory is equipped for the testing of oils, paper, rubber, &c., as well as for experimental purposes.



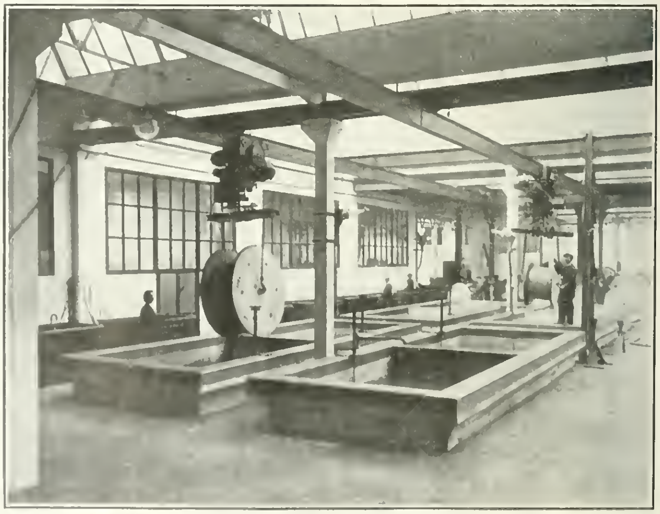
Among the Lead Presses.

The high tension testing room is supplied with current from the Corporation mains, which is then transformed into alternating current by the aid of a "Witton" alternator. The transformer gives up to 300,000 volts. There is also a [illegible] electrostatic kilo-voltmeter with a maximum range of 200,000 volts, three-phase and mono-phase transformers, the former giving up to 20,000 volts and the latter 5,000.

All the machinery devoted to the manufacture of small wires for electric lighting, telegraph and telephone, electric bells and other purposes is to be found on the upper floors. In these large, spacious workrooms are many rows of machines for the covering of wire with cotton, silk and [illegible]. The industries of Southampton in the past have afforded little scope for the [illegible]; the Pirelli General Cable Works have, however, created a new opportunity. All the processes of paper lapping—longitudinally or spirally—and braiding in all varieties of ply for flexible cords, &c., are here in full operation. The pattern and measuring rooms adjoin the departments just referred to. In the latter the flexible cords, after leaving the braiding rooms, are cut into coils of the required lengths of the multiple of a mile and are then packed and labelled for despatch. On the ground floor are the various offices, stores, repair shops, and other departments auxiliary to the manufacture of cables. All repairs to tools, machines or drums are carried out in the works' engineering shops. These are fitted with lathes, planing machines and large and small drilling machines, all of course of modern pattern. We are informed that the equipment is such that it will soon be possible to construct the new machines required for future extensions to the works. There is also a carpenter's shop for the making of swifts, drums, &c., and a large store where fittings and spare parts of all kinds, as well as other necessaries are kept.

On the west side of the works and detached from the main building is situated the boiler house, where all the steam used for general heating and for the drying chambers, and other parts of cable manufacture, is provided. The water used comes from an artesian well; in addition, there is storage capacity for 45,000 gallons of rain water. Two gas producers are used for the supply of gas to the lead furnaces; arrangements are being made for the supply of town gas also where necessary

The new enterprise represents, not so much a fusion of capital in one branch of electrical manufacture, as a joint contribution of knowledge and experience guaranteeing further progress and greater achievement in the making of cables of every kind and for every purpose. It has meant the founding of a further great British manufacturing industry, fully equipped for production on a large scale, at a time when it was most needed, and so helped to make



View of Testing Tanks.

Cork for Insulating
[illegible] similar to "Suberite"
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"THOR" High Grade Specialities
CASING and CAPPING
CONDUIT
CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
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PRESCOT DUST FUSES.

One of the most important features of a fuse is reliability, while one of its most common features is the reverse, due to a number of causes ranging from size of terminal and length of fuse, to exposure to air, the kind of air, and so on.

What is wanted is something that will protect the circuit every time and all the time.

To attain this devoutly to be wished consummation, see our

PAMPHLET No. P.121.

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Cables for Lighting, Power, Telegraphy and Telephony.
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Exploders.
Shot Firing Cables.
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Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

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FERRANTI LTD
HOLLINWOOD, Lancashire.

SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.

Britain, in a period of stress, less dependent on outside manufacturing sources. Important orders have, in fact, already been carried out for the British Admiralty, Post Office, &c. In normal times, the opening of the Pirelli-General Cable Works, Southampton, would have been heralded as an event of the first importance in the history of British manufacture. The fact that they began business quietly, and without press notice or advertisement, must be taken in itself as an evidence that their help was opportune and their importance recognised.

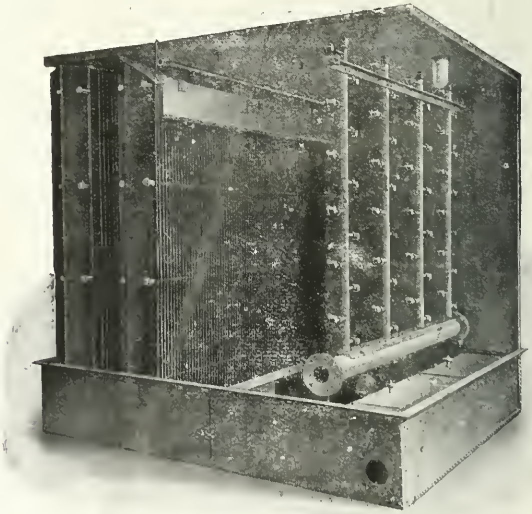
We are indebted for the above particulars to an attractive brochure just issued by Pirelli-General Cable Works, 144, Queen Victoria-street, London, E.C.

THE FILTRATION OF AIR.

Filtered air has a real commercial value in many branches of the industrial world, and there are numerous ways in which it is profitably employed. One of the most important applications is for cooling turbo-generators. These machines are small in size in proportion to their output, and have consequently a limited space wherein only comparatively small air channels can be embodied for the dispersion of the heat. Since the introduction of mechanically-ventilated generators it has been found that the use of unfiltered air has a deteriorating effect on the insulation, owing to the presence of dirt and dust particles in the atmosphere, which were gradually deposited on the windings, causing local overheating and eventual breakdown of the insulation. The hammering action also of many thousands of minute dust particles impinging on the end windings wears away the varnish and insulation fabric, with the result that when the machine in such a condition cools down in an atmosphere of ordinary humidity, the end windings rapidly absorb moisture, causing serious and unexpected "burnouts." The importance of filtration is still more evident when the large amount of air required for ventilating large turbo-generators is taken into account. For instance, a moderately large generator would use 20,000 cubic ft. of air per minute, which means a total of 28,800,000 cubic ft. per day of 24 hours. As a rough approximation, it may be assumed that one hundred millionth of the volume of the air in the vicinity of power plants consists of dust, dirt and other foreign particles. This would mean that 87 cubic ft. of dust would be blown into the machine during a year of 300 working days. While, of course, a part of this [illegible] pass directly through the machine, a portion will be deposited in the air passages, due to swirls and eddies. Such deposits of dirt [illegible] a considerable handicap to ventilation, as the quantity of air [illegible] due to the partial closing of the ventilating passages and the cooling effect of the air greatly diminished, owing to the fact that the [illegible] directly in contact with the heat radiating surfaces.

The types of air filters generally in use may be broadly divided into [illegible] and wet; the former may consist of cloth or fibre screens. [illegible] the wet type filter the purification is obtained by [illegible] methods, namely, by passing the [illegible] the water spray. The dry filter takes up more space than a wet one, and, where cloth screens are used, there is also the risk of fire, due to spontaneous combustion. In the dry type the maximum quantity of air passes through when the filter is clean, gradually lessening as the cloth becomes choked up, thereby setting up more resistance to the free flow of the air.

In the wet type of filter, as just explained, the air is thoroughly washed by passing the air current through a chamber filled with a fine mist, which causes the bulk of the solid matter suspended in the air to be precipitated down into the tank at the base of the machine. The air after leaving the spray chamber encounters a battery of scrubber plates, on which any dust or dirt remaining in the air is deposited, and then passes on to a series of eliminator plates, by means of which it is buffeted from side to side, depositing during this process any free moisture upon the plates, and leaving the washer in a thoroughly clean and cooled state with no trace of free moisture. An illustration is given herewith of a "Sirocco" air washer made by Davidson & Co. (Ltd.) of Belfast. In this detail view the side plate has been removed, in order to show clearly the spray chamber and the series of scrubber and eliminator plates. In this filter the resistance to the air current is constant, thus allowing the same volume to pass all the time, and as the resistance is low, less fan power is required to pass a given volume of air than in the case of a dry filter. It is also easily cleaned while in operation. The water consumption is very low, as it is re-circulated by means of a pump passing through two sets of filters, so as to prevent any dirt choking the spray nozzles. The makers state that this washer will remove 98 per cent. of solid matter from an impure atmosphere, and will deliver the air without any free moisture and in a cooled state.



SECTIONAL SIDE VIEW OF "SIROCCO" WET AIR FILTER.

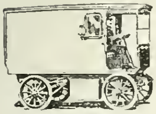
An interesting brochure has been prepared by Messrs. Davidson & Co., and it is from this that the illustrations have been taken. A copy of the publication will, we understand, be forwarded on request.

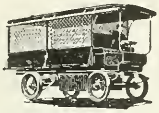
GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
[illegible] 4028 Grams: Vicmotor, Sowest, London

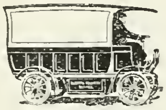
TINNING FURNACE
(Hall's Patents)
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

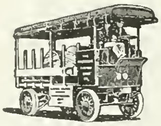
[illegible] "THE ELECTRICIAN" PRINTING AND PUBLISHING CO., LTD., at the Editorial, Printing and Publishing Offices, [illegible] FLEET STREET, in the City of LONDON, FRIDAY, FEBRUARY 2, 1917

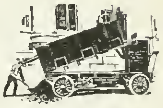
ELECTRIC VEHICLE PROGRESS











ELECTRIC TRUCKS.*

BY J. P. KEMP, A.M.I.E.E., M.I.MECH.E.

The introduction of electric trucks into the large factories and workshops of Great Britain is of such recent date that there is as yet little data available regarding their actual economic value. Sufficient experience has been obtained to show that under conditions which justify their employment they practically revolutionise the problem of internal transport from the points of view of acceleration of service, the value of labour displaced and resultant financial advantage.

This particular movement was pioneered in the United States, and the introduction of internal electric battery transport has been due principally to a desire to speed up production and to the high cost of labour in American works. The result has been that battery-propelled trucks are now regarded as a distinct acquisition, and every large undertaking having internal transport problems of any magnitude are now equipped with special facilities for dealing with these problems by means of either cranes, platform trucks, trucks with self-elevating platforms, or tractors and suitable trailers, all battery operated.

I have no exact data as to the actual number of electric trucks in use in the United States, but believe they amount to well over 50,000; in comparison with which there are not yet 500 in operation in this country.

Several enterprising English railway companies and other large British firms (notably munition factories) have experimented with battery-propelled trucks, and the fact that they continue to extend their use indicates that the trucks are achieving the purpose for which they were specially designed.

A short description of an "E" type automatic truck of 2 tons normal carrying capacity may here be of interest.

Frame.—Made of two steel channel sections extending the entire length of the platform, converging at the end into a solid casting.

Suspension.—The frame is supported by four spiral springs, each of which is encased within a malleable iron box, and transfers the load direct to the axles.

Transmission.—By Morse silent chain from pinion on motor shaft to the sprocket wheel, mounted on a jack shaft, supported under the two frame members; thence by two side roller chains from the jack shaft to the driving wheels, giving a total gear ratio of 12 to 1. The jack shaft contains a substantial and compact differential. At 4 miles per hour the motor runs at 1,000 revs. per min., and at 6 miles per hour the motor runs at 1,500 revs. per min.

Axles and Wheels.—The axles are of rigid type under the frame, and by their outer extremities carry a double set of standard annular roller bearings mounted in solid cast steel ribbed wheels, which are equipped with solid rubber band tyres of 16 in. diameter.

Steering.—Steering is done by means of a lever conveniently arranged, which moves in a vertical plane and operates the stub-axles, as in standard automobile practice.

End-Gate.—At the rear of the truck is attached a movable end-gate, which may be lowered to a horizontal position, thus increasing the length of available loading platform by 3 ft. This end-gate may also be lowered to the floor and used as a skid when loading or unloading the truck, or can easily be removed from the truck when not in use.

Power.—Power for operating the truck is derived from an Edison battery of 24 cells, type A-6, 225 ampere-hours capacity, housed in a steel compartment on the driving end of the truck.

Motor.—Specially designed electric motor, having high starting torque and exceptionally high efficiency, series wound for 24–30 volts. The armature runs on annular ball bearings, and has a capacity sufficient to propel a loaded truck up a 15 to 25 per cent. grade.

Controller.—The controller is of the drum type, specially designed for these trucks, eliminating all arcing in operation. The current cannot be applied to the controller without first releasing the brake, which automatically closes the circuit switch. The moment the current is cut off the brakes will set automatically and remain set until the circuit-breaker is again closed, at which time the band brake is automatically released. The controller is operated by a lever moving in a vertical plane, giving four speeds forward and four speeds reverse.

Speed.—Three speeds forward and three speeds on reverse, giving from 1 to 6 miles per hour.

Weight.—The complete truck with Edison battery, platform and end-gate scales 2,150 lb.

Dimensions.—

Length over all	9 ft. 9 in.
Length of platform loading space	6 ft. 6½ in.
Length of platform loading space with end-gate lowered	9 ft. 3½ in.
Width of platform	3 ft. 5 in.
Height of battery box	1 ft. 5⅛ in.
Width of battery box	1 ft. 8½ in.
Height of platform	1 ft. 8 in.
Wheel base	4 ft. 4 in.
Width of track	2 ft. 9¾ in.

Approximate cost, £400.

As these vehicles are not fitted with mileometers, it is not easy to estimate the mileage that they do per charge in and about the works, but experience shows that the battery capacity is ample to do a full day's work of from 10 to 12 hours on a normal full charge; there are some cases where trucks are employed for 20 hours' work per day, this being done on the high rate charges received only at meal times, a long charge at normal rate being given only at week-ends.

The amount of electrical energy absorbed by a truck battery per normal charge is about 15 kw.-hours, so that the total amount of energy used per truck per week while on full work would be about 90 kw.-hours. At 1d. per kilowatt-hour this would cost 7s. 6d. per week, but, as there are many works where electrical energy costs less

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* Abstract of a Paper read before the Birmingham Institution of Mechanical Engineers, Saturday, January 6, 1917.

For Motor Car Lighting.

Made at the Osram-Robertson Lamp Works, Hammersmith, London.

Osram
G·E·C
DRAWN WIRE
Lamps

"CONSULT KEMP re ELECTRICS."
ROAD VEHICLES, AUTOMATIC TRUCKS, MINERS' LAMPS.
ALL WITH EDISON ACCUMULATORS.
The Simplest and Most Economical Forms of Industrial Transport. Can be driven by UNSKILLED Men and Women at less than ONE-THIRD the cost of Petrol.
Each Factory Truck costs less than 6s. per week for Electric Power, and saves the labour of over 7 men.
J. P. KEMP, Grand Hotel, BIRMINGHAM. 'Phone: CENTRAL 7301.

than the above rate, the operating costs for electricity are also proportionately less. Practical experience in Birmingham factories shows that where such trucks are kept fairly busy the cost of electrical power is under 1s. per day per truck.

I have been frequently asked how it is that practically all the trucks on the market are built to carry 2 tons, and why smaller trucks of, say, 5 cwt. capacity are not constructed. The answer to this will, of course, be obvious to all who have had experience of the rough conditions under which all such trucks have to work. Makers of experience have found that by the time they have made their chassis, wheels and general framework sufficiently strong to survive being handled by the most unskilled labour, and to stand the bumps, vibration and collisions which they unavoidably experience in general use they are of ample strength to carry 3 tons on reasonably good surfaces and easy gradients. The normal rating of 2 tons is, therefore, a conservative one, and gives a good margin for emergency conditions; the experience so far available indicates that at this rating the trucks will last longest and render the best service.

The smallest type of truck that I have had to deal with is the "D" type automatic, rated at 30 cwt., and the only substantial difference between this and the two-tonner is that the frame is shorter, narrower and lighter, the battery capacity being about 45 per cent. less. I consider that it would not be advisable to construct trucks of smaller carrying capacity than, say, 1 ton. It is difficult to see how they could be profitably employed, and if their own strength was reduced in proportion to the weights to be carried, they would become merely scientific toys, and totally unsuitable for the rough usage to which they would sometimes be put.

Owing to the diversity of conditions under which electrically-propelled trucks are employed, it is difficult to obtain any results which are strictly comparable, and unless conditions as far as the number of tons handled, the number of trips and length of trips made are the same, any comparisons as to the cost per ton of material handled would be illusory.

I am, therefore, presenting a hypothetical case which may be of interest, and which shows the possibilities for economy in the matter of the internal transport of heavy material.

Assuming that the truck is worked for a period of 3,000 hours per annum, and that there are crane facilities for loading and unloading, so as to avoid undue delay at the termini, the average speed of the truck, including all stops, would be about 1·75 miles per hour, in which case it should cover 5,250 miles per annum. This mileage, however, would be made up of a large number of short trips, and, if for the purposes of calculation the length of a round trip is assumed to be, say, a quarter of a mile, the total possible number of round trips per annum would be about 21,000. It would seldom happen that a truck would carry a full load each way on any of the trips, so that if we estimate on a full load only one way we have 21,000 tons of material shifted a total distance of ⅛ mile, and an idle mileage of 2,625 per annum. Under these conditions the 21,000 tons of material would be transported at a total cost of £198, and this works out at a little over 2¼d. per ton handled. It may be easily gathered that any form of manual labour adopted in this connection would cost at least four times as much.

Edison Truck with End Gate Lowered to Increase Loading Space.

CAPITAL COST.

Estimated Annual Cost of Operating One 2-ton Truck.

Capital cost, say		£400 0 0
Interest on capital at 6 per cent. ...	£24 0 0	
Depreciation based on 10 years' life	40 0 0	
Annual standing charges per truck.	£64 0 0	
Operating Costs For 3,000 Hours' Service Per Annum.		
Electricity	£15 0 0	
Tyre replacements	10 0 0	
General maintenance	4 10 0	
Lubrication	0 10 0	
	£30 0 0	£94 0 0
Operators' wages at £2 per week		£104 0 0
Total Annual Operating Cost, including Interest and Wages		£198 0 0
Annual value of labour displaced, say, 8 men at £2		£832 0 0
Less cost of operating one 2-ton truck... ...		198 0 0
Annual saving effected by use of truck		£634 0 0

Types of Trucks.—In order to accommodate a large variety of different trades, numerous different types of trucks have been designed, some of which have been constructed entirely to comply with one particular purpose; others, again, have been put forward so that they can fulfil the requirements of a variety of purposes.

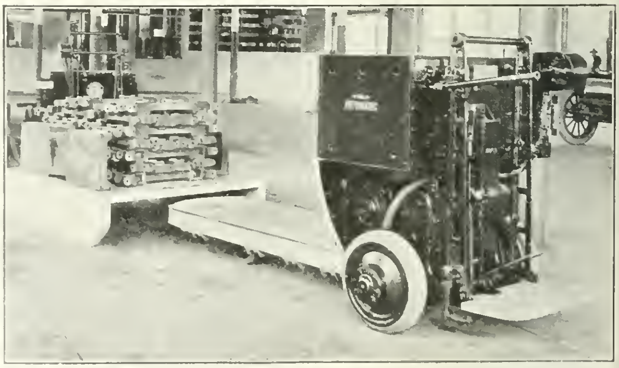
There are three systems of transport now available, one of which would be found to suit the average requirements met with in any of the large factories in Birmingham and district. These are as follows:

A. Industrial trucks, of 2 ton carrying capacity. Given good crane facilities for the loading and unloading of same (so as to eliminate standing time as much as possible), these trucks are invaluable, and they can be adapted to a large variety of useful purposes.

B. Self-Elevating Platform Trucks.—In certain works where the material to be handled is fairly well standard, it is now becoming the practice to place it on rough platforms, instead of on the floor itself, the platforms being so designed as to accommodate the deck of the truck, which can be slipped underneath. The whole of the load up to 2 tons is raised clear of the floor by about 3 in. in from 5 to 6 seconds and the material is then ready for transport. This system eliminates the dead time required for loading and unloading.

C. Tractors and Trailers.—One of the original drawbacks against having trailers running through the narrow avenues of a busy factory was that, although the tractor might clear projecting obstacles, the trailer would undoubtedly creep either in one direction or the other, and eventually foul, thus causing general delay.

Several capable minds have devoted attention to the solution of

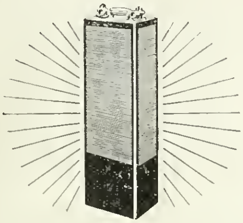


Edison Elevating Truck Backing Under Load.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte**; and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.

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DRAKE & GORHAM, Ltd.,
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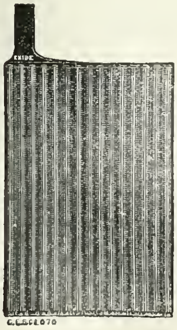
Glasgow:—
J. HALLY CRAIG,
45, Hope Street, Glasgow.

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



The number of repeat orders received is the best testimony of the results obtained. Continuous hard work with a minimum of attention day in and day out aggregating 10,000 miles per annum is the record of many sets over the past two years. Some of them have completed

25,000 MILES

on the road without a single cell having to be removed from the vehicles for any electrical defects whatever.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION,
MANCHESTER.

LONDON OFFICE:
39, VICTORIA STREET.

TUDOR
Accumulators
FOR ELECTRIC VEHICLES
AT BRIGHTON AND HOVE

About 16 Electric Omnibuses have been in regular service for the past six years, and TUDOR Accumulators have been employed exclusively.

THE TUDOR ACCUMULATOR CO., LTD.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

this difficulty, and they have evolved what might now be termed the "trackless train." This consists of a small, but powerful tractor, capable of working with equal facility in either direction, and of towing loads up to 5 or even 10 tons, depending, of course, on the condition of the road or floor surfaces. The trailers are constructed so that both their front and back axles are fixed to a central swivel, thus allowing the steering to be done from both axles. The front and back axles are cross-connected, the right-hand side of the front axle being connected to the left-hand side of the back axle and vice versa. By this system the trailers are bound to exactly follow track with the tractor which is hauling them, and no matter how many trailers are employed in one train there is no need for the driver of the vehicle to give his attention to any other matter than that of driving his own individual tractor, the trailers being obliged to follow the track of same.

The principal dimensions of these trailers are:—

Length of platform	72 in.
Width	42 in.
Height	14 in.
Wheels	10 in. diameter by 4 in. wide
Wheel base	48 in.
Steering	On all four wheels
Weight	500 lb.
Carrying capacity	2,000 lb.

The trucks which transport the load are inexpensive, so that the question of idle time during the period of loading and unloading is immaterial, but the tractor, which is the most expensive part of the whole equipment, can be kept fully employed the whole time.

Batteries.—In spite of the variety of names given to various makes there are still only two commercial types of accumulator on the market—the lead acid type and the nickel alkali type. The lead acid type is one with which many have been familiar for some time. It has many good characteristics, and many bad ones, and has also the advantage of being the lowest in first cost.

The nickel alkali battery is a distinct departure from the lead acid type, inasmuch as it is made entirely of steel, and its chemical activity is promoted by a solution of potash, which is quite harmless to the steel. It has many special advantages of its own. Either type of battery can be used for truck propulsion, but the one selected has to be particularly rugged to stand the rough usage it is bound to receive at the [illegible] hand of truck operators.

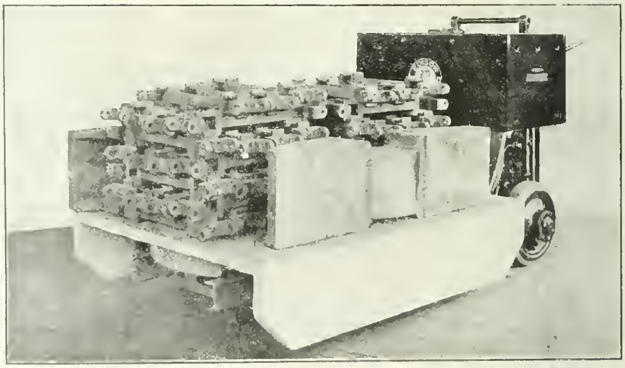
[illegible] fully stated:

1. *Rapid* [illegible] in works where the truck is in continuous use for 20 or 24 hours per day, and where it is only possible to give it occasional high rates of charge for comparatively short periods during meal times.

2. *Speed* [illegible] in many cases to complete [illegible] where the truck is negotiating [illegible] with heavy loads and where, in these cases, the [illegible] machinery with full power [illegible] experience than might be [illegible] very heavy [illegible] upon the battery.

3. [illegible] experience in driving trucks [illegible] something which has to be actually experienced to be believed, and the battery that has to survive it has necessarily to be of somewhat special mechanical construction.

We are at a point in the history of our country at which, quite apart from the question of its cost, labour is becoming exceedingly scarce, and in spite of this fact the output must be steadily maintained, if not increased. Every real labour-saving device which can be advantageously introduced into our factories should, therefore, receive fullest consideration. After a somewhat extended experience of electric trucks, I am of the opinion that there has been no greater labour-saving device introduced into the factories of this country for many years past.



Edison Elevating Truck with Load Raised Ready for Transport.

THE ODORLESS ELECTRIC FOR THE BAKER.

During an electric vehicle campaign conducted in 1915, Von Thun Brothers, bakers in Brooklyn, New York, ordered one electric truck through the Edison Electric Illuminating Co. of Brooklyn, and at the same time purchased a horse for £60. The "electric" proved to be so dependable and satisfactory in every way that they sold the horse for £20 and purchased two more "electrics," and are now contemplating buying a third.

The electric vehicle is gaining great favour in the baking industry, as it is not only more economical than the petrol car, but is devoid of the fumes of burned oil which are so undesirable, since odours are readily absorbed by pastry. The advertising value of the clean, silent "electric" is also considered an important feature, as evidenced by the stress laid by one of the largest bakers in the country on its fleet of several hundred attractive, dependable "electrics." In modern bakeries, where scientific methods are employed, electric vehicles furnish a valuable link between the consumer and the producer, and many baking companies which have eliminated the use of horses and purchased electric delivery cars credit a large percentage of their new and increased business to this new factor. The number is increasing in Great Britain, Birmingham and Glasgow being noteworthy centres.

Printed and Published by the Proprietors of "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices,
1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, February 2, 1916.

THE ROUND TABLE.

By "KVA."

This week's motto: "England expects that every man and woman will make their money fight."

* * * *

Bon Mot of the Week.—We hold the potential secret of increasing our crops by electrical means.—Thorne Baker, in the "Daily Mirror." So far it has proved only a negative potential.

* * * *

Event of the Week.—The hold-up of the electric trains and trams due to frost and snow, and the hold up of horse traction in the streets, due to the absence of "electrics." (Paradoxical, isn't it ?)

* * * *

The fire and radiator makers are having the time of their lives. Even the gas people are realising that electric fires are doing national service by saving matches!

* * * *

It is suggested that Prof. Klingenberg's magnet hand might be used by a switchboard attendant; but rather awkward if the war goes on so long that we have to use iron 'bus bars!

* * * *

Two errors crept into half the edition of the Round Table last week. In one case "wet air filter" was rendered "wet air fitter" (a new sort of plumber, I presume), and in the other the joke about the sales engineer and his commission was spoiled by the use of the word "not" instead of "still" in the sentence, which should have read: "I am still convinced that the result is wrong." Will those readers whose copies were in the wrong half of the edition please note these corrections.

* * * *

The "Observer" says:—

"In consequence of frequent tramway breakdowns the London County Council has appointed a committee to consider what alterations are necessary in connection with the operation of the system, and also questions as to fares and methods of fare collection."

In other words, "Ill fares the slot to 'ice' ning ills a prey."

* * * *

ERUDITION

1

Confucius B. Robins was a veritable mine
Of weighty information, items technical and classic,
He knew the ancient recipe for true Falernian wine,
The antidote for phosphorus, the uses of boracic.

2

Of toxodens and dinosaurs no man could teach him much,
He knew, within a mile or two, the orbits of the planets,
The area recovered from the ocean by the Dutch,
The difference 'twixt schist and quartz and whether both were granites.

3

To him a stalagmite was quite distinct from stalactite;
He knew how Venus differed from the Grecian Aphrodite,
The wave length of each tint in which the spectrum splits the light,
And told cupressus maximums from yew or abor-vitæ.

4

And yet (what deep abysses lie among the lofty peaks)
He didn't know the simple fact no wireman ever doubted,
That using Glover's cable is the antidote for leaks,
And all other kinds of trouble are inevitably routed.

—P. Blagg, in "Glover's Almanac."

I cannot refrain from awarding a Hot Plate this week to the lady member of the Marylebone electricity supply staff who ran out for a policeman when there was trouble on the switchboard. A correspondent who signs himself "Exciter," in the "Electrical Review," naively suggests that the Council should include in its instructions to sub-station attendants the following:—

"If you want to right a short, ask a policeman.
Little Miss Lovebird, the other day
Had a short circuit down Marylebone way.
Her assistant and she also had fits,
They thought the sub-station was going to bits,
So they went and fetched a policeman."

In other words, in case of "shorts," call a "copper."

* * * *

Upon which I might versify thus:—

Mary had a nasty "short,"
It really was a whopper,
She blew like smoke,
But it was no joke,
So she *had* to call a "copper."

* * * *

I must again apologise to Hot Plate awardees for non-delivery; I hope a consignment will come through soon. The Hot Place idea is, I find, regarded as a good joke, but it is considered a better joke when I write and ask the prospective recipient for his correct voltage. In some cases I have had a difficulty in getting this voltage, because the Hot Plate is not considered to be a real one. In one instance the Hot Platist thought the joke was well on him when on connecting it up it blew his main fuse!

* * * *

OUR HOT PLATES.

No. 230 to—

The lady sub-station attendant at Marylebone who called in a policeman to "arrest" a short on the switchboard.

No. 231 to—

My old friend Mr. A. W. Blake, electrical engineer, Willesden U.D.C., upon the increase of his salary by £100 per annum.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Feb. 7, 1880.]

Carbons for Electric Lights.—The great importance of getting good carbons for electric lamps is practically demonstrated in a triumphant manner by the Brush light. There the regulating mechanism of the lamp is the simplest in vogue, yet the light is the steadiest and whitest, all because the carbons are excellent.

The Electric Light and Shipbuilding.—Messrs. Robert Napier & Sons, Glasgow, have adopted the electric light in early morning and late evening to the new building of the new steel mail steamer, "Parisian," and the new Admiralty store ship. We may add here that the new rival of the "Great Eastern," now being built by the Inman Line, will be fitted up with electric light.

A German Electrical Society.—France has now its Syndicate d'Electricité, and Germany has just achieved the formation of a technical electrical corporation, which has for its object the development of pure electrical science, the promotion of its application to the arts, and, lastly, the establishment of a place of meeting for German electricians. There are now at least six electrical societies in existence, including the above, our Society of Telegraph Engineers, the Melbourne Electrical Society, the Chicago Electrical Society and one in New York.

Maidstone.—In order to compare the light of gas and that of electricity a gentleman has offered to provide the apparatus necessary to illumine the bridge. It is hoped the light will shortly be exhibited.

L. P. S.
CLIPS, TIPS & TERMINALS
of all descriptions.
Write for Booklet, with Illustrations, of 75 types to:—
THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

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Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
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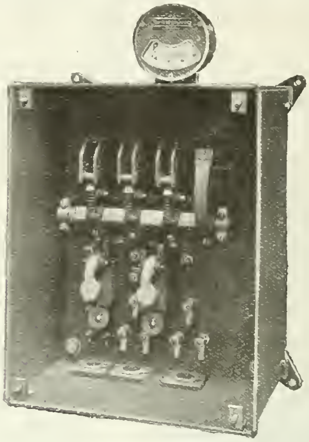
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood [Bldgs
Sheffield—22, High St.
Southampton—46, High Street
Branches in Principal Towns Abroad.

SINGLE-HANDLE REVERSING CONTROLLERS.

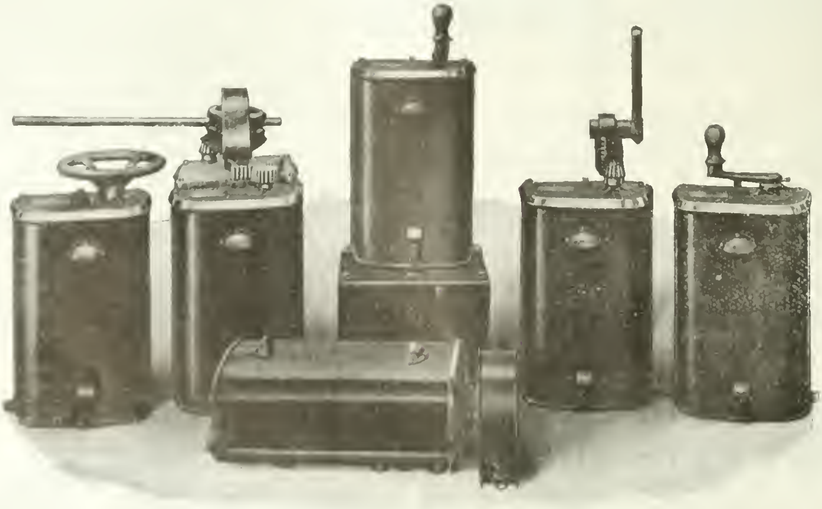
These controllers are all of the single-handle type, built on the metal and mica principle. Each part is standardised in a detachable unit, so that replacements and repairs may be easily effected. The contact drum is built of hard drawn copper strips, which are screwed on to cast iron spiders clamped on to the insulated steel shaft. Renewable arcing tips, which can be quickly replaced, are provided at the ends of the contact strips. The contact fingers are mounted on a stout fixed insulated steel bar. The phosphor-bronze pressure springs are shunted by copper strips, which prevent heating and loss of temper of the springs. Each finger is fitted with a large renewable contact piece, which provides cooling surface for the disrupted arc and takes up spark wear. This contact can easily and quickly be renewed, no matter how low the contact is worn. All controllers are reversing, but a device is provided by which only one half of the drum can be used, thus converting to non-reversing. In such cases the second half of the drum is always available as a stand by.

All live parts are enclosed in a weatherproof sheet steel cover lined with insulating material. This cover is easily removed by lifting a latch. Special cast-iron watertight cases can also be supplied for the smaller sizes as an extra. The terminals are of the pinch screw type, and ample space is provided for the cables. This feature will be appreciated by those who have had difficulty in making connections inside a controller where space is limited. The usual cable outlets are plain bushed holes, but screwed glands for pipe or various cable fittings for multi-core and armoured cables can be supplied at an extra cost. Such arrangements are necessary where the controllers have to comply with the Board of Trade Electricity in Mines Regulations.



Three-Pole Current Breaker with Instrument Attached.

The usual operating device for the controllers is the ordinary crank handle, but they can be fitted with handwheels, lever handles, rope or chain wheels, if so desired; or two controllers may be mounted together and arranged for operation from a single universal lever



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Our Manufactures include:

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- Phosphor Bronze Wires.
- Brass Rod.
- Brass Forgings.
- Enamelled Wires.
- Cotton Covered Wires.
- Aerial Cables.
- Joint Boxes and Pillars.
- Jointing Compounds.
- Primary Batteries.
- Exploders.
- Shot Firing Cables.
- Window Lead.
- Cable Racks.
- Static Condensers.
- Pole Line Steelwork.
- Paper Pinions.
- Fuses and Fuse Wire.
- Electric Welders.
- Telephone Cords.
- Annealing Furnaces.
- Tramway Insulation.
- Overhead Equipment.
- Electricity Meters.
- Knife Switches.

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The Helsby Leclanché Cell is not a product of the war, it has been made at Helsby in the same way for many years past except for such minor modifications as have been suggested by our wide experience. Peace, perfect peace, reigns where it is installed.

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PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh.

See our Illustrated Advt. next week.

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HOLLINWOOD, Lancashire.
SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.

GUARANTEED SECOND HAND
MOTORS
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Phone: Victoria 4026 Grams: Vicminster, Sowest London.

handle. The drums on the smaller sizes can also be fitted with a spring return. The controllers can be arranged for use with limit switches on certain sizes; they are only so arranged when specified, and at an extra charge. Brake solenoids can be used with any controller provided they are connected across the motor leads. The resistances are either of the cast grid or of the company's patent unit type. Three different ratings are standardised as follows: Two-minute Rating.—This allows a total of two minutes out of any period of 15 being occupied in starting the motor, no matter how many times it may be started. During this period the handle may be on the first notch for a total of 30 seconds, the remaining 90 seconds being occupied in passing over the other notches between the first and “full on” notch. Five-minute Rating.—This is the same as the foregoing with the exception that the time is five minutes out of every 15, two minutes being allowed on the first notch and three minutes divided over the other notches. Continuous Rating.—This will allow of continuous running on all notches of the controller with full load torque, provided the speed is not reduced to less than half normal. On the earlier notches, where the speed of the motor is less than half normal, the resistances are designed to carry full-load current throughout for a total period not exceeding five minutes out of 15.

It is often of advantage to combine the controller and resistance in a single unit, and this can be done in the smaller sizes. When this arrangement is adopted the floor space occupied by the control gear is reduced to a minimum. The control unit can stand close to the machine it operates, and all wiring between controllers and resistance is completed by the company, so that only the motor and line connections have to be made on site. No-volt and overload releases can be supplied with these controllers. They take the form of magnetically operated contactors with overload trips mounted on a slate base with sheet steel protecting cover, suitable for mounting on a wall. The contactor is so interlocked with the controller that the action of returning the latter to the “off” position re-sets the overload release device.

Ammeters of the company's own standard SB moving iron type can be mounted on brackets attached to either the controller or overload release device. These instruments comply with the British Engineering Standards Committee specification for grade 1. instruments. The table gives details of dimensions, &c.

Max. B.H.P. of motor. 100 125 volt.	Max. B.H.P. of motor. 200 250 volt.	Max. B.H.P. of motor. 400 600 volt.	No. of notches. Power.	No. of notches. Off.	No. of notches. Power.	Approx. dimensions. Total height, floor to top of handle. ft.	Total height in.	Floor space. Depth. ft.	Depth in.	Floor space. Width. ft.	Width in.
10	20	30	5	1	5	2	1	0	7½	1	1½
						2	3½	0	7½	1	1½
20	40	80	6	1	6	3	2	0	8	1	4
						3	5½	0	8	1	4
50	100	250	9	1	9	4	0	1	3	1	7½

The above details are taken from Descriptive Leaflet 65/1, issued by the British Westinghouse Electric & Mfg. Co. (Ltd.), Trafford Park, Manchester.

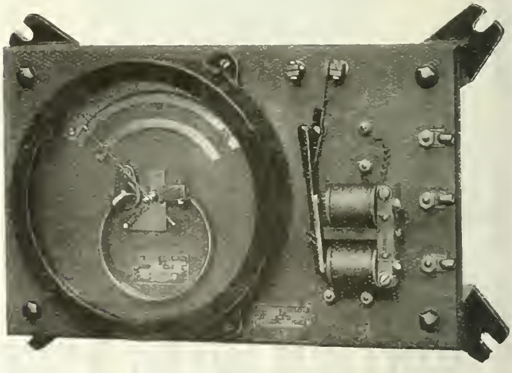
PRESSURE GOVERNOR PANELS.

The pressure governor panel illustrated herewith is designed for use with automatic starters controlling motor-driven pumps or air compressors for maintaining a constant pressure of air or water. They will automatically start and stop the motor between two predetermined limits of pressure.

The governor panel consists chiefly of a “Bourdon” gauge mounted on a slate base and provided with a glass-fronted case. In addition, there is mounted a relay which makes and breaks the operating circuit of the automatic starter. The pipe connection between the governor and the air receiver or tank is made on the back of the governor base. The electrical connections can be made on either back or front. Suitable feet are provided for mounting the complete governor panel on the wall.

The pressure gauge is a “Bourdon” tube or gauge spring, designed for a definite maximum pressure. The movement of this gauge spring is transmitted to a pointer by means of a lever mechanism. The pointer is provided with silver contacts, and moves between two adjustable brass riders which are mounted on segments attached to the slate base. The connections from the segments are brought out at the back of the base. A graduated scale is fixed above the upper segment; this scale serves to indicate the pressure in the tank or reservoir, and also serves as a guide for adjusting the governor for the proper cutting in and cutting out pressures. As the silver contacts on the gauge are only designed to carry a very small current, it is necessary to provide a relay between the gauge and the automatic starter to operate the solenoids on the latter apparatus. The connections are so arranged that no circuit is actually broken on the gauge contacts.

The relay, which will operate on either alternating or direct-current circuits, is made up of two coils. The armature is pivoted through the centre to the middle leg of the magnet frame, and is connected by a spring to a contact arm, which is likewise pivoted in the centre of the casting. When moving the armature between the “on” and “off” positions, the spring is moved over the centre point of the contact arm, giving the latter a quick movement to either position; thus the operating circuit of the automatic starter is quickly made or broken on the upper contacts of the relay. Simultaneously the operating circuit of the relay is broken, so that the coils of the relay are only energised momentarily, and are automatically open-circuited by the contact arm. As the relay coils are only energised momentarily it is not necessary to place resistances in series with them. Normally, with no pressure on the “Bourdon” gauge, the silver contact on the pointer rests on the rider shown on the left of the gauge. When the line is made alive one coil of the relay is energised through this contact, and immediately moves the contact arm over to the right-hand contact of the relay, thus closing the operating circuit of the automatic starter, which brings the motor up to speed. When the pressure has reached the maximum for which the gauge is set—*i.e.*, when the pointer moves over to the right far enough to make contact with the right-hand rider—the second coil of the relay is energised and moves the contact arm over to the left again, thus opening the control circuit of the solenoid on the starter. The motor is then automatically disconnected from the line.


General View of Governor Panel.

The panels are made for pressures up to 1,500 lb. per square inch. In order to obtain the best results it is recommended that the gauges be used on pressures not exceeding 80 per cent. and not less than 20 per cent. of the maximum rating.

Descriptive price list No. 5,521 gives additional particulars, and may be obtained from the British Thomson-Houston Co. (Ltd.), Rugby.

C.A.V.

On War Work

ALTHOUGH our works are exclusively engaged upon National and Imperial Service, our extensive stock will enable us to give prompt delivery of most of our Electrical Specialities.

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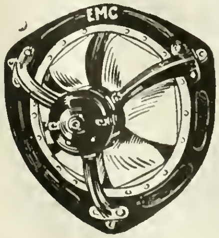

Enterprise Manufacturing Co.
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PHONE US: AVENUE 5366.
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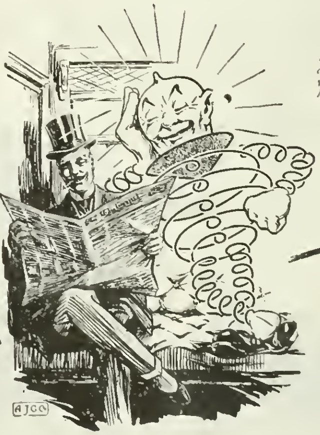

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WIRE LAMPS.

Made with a special strong filament that withstands vibration. Impervious to jolts and jars. Strong, Brilliant, Economical.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Rd., Willesden, N.W.

·INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
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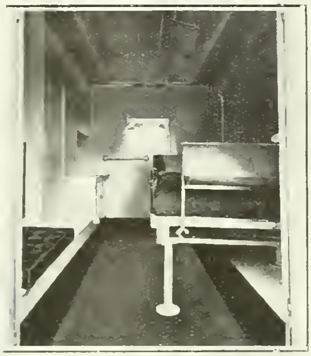
ELECTRICALLY-HEATED AMBULANCE

The modern petrol motor car is now fitted with dynamo and battery equipment of considerable capacity, and this fact is being turned to good account in connection with ambulances. A vehicle of this class has to ply in all weathers, and it may be kept for hours standing in the open. The comfort of the brave occupants needs to be considered as much as possible, and it is contributed to considerably by the provision of suitable heating arrangements.



End View of Ambulance showing end of Stretcher with Curved Heater-Reflector at the Foot.

We understand that it is not unusual to employ the ambulance for operating purposes in extreme cases, and the lives of many of our brave fellows have been saved by this promptitude. Obviously, the temperature of the ambulance itself will contribute towards the success or otherwise of such measures.

General View of Electrically Heated Ambulance.

The adjoining illustrations show a vehicle which has been fitted by the Dowsing Radiant Heat Co. with heaters which derive their energy from the dynamo or the ignition and lighting batteries. In the smaller illustration the interior of the ambulance is shown, and at the foot of the stretcher will be noticed the convector heater, which is suitably fixed at the foot. The Prometheus type of element is employed in this convector, because it is of light construction and is easily renewable. The convector is controlled by a three-heat switch, and the maximum energy consumption is 250 watts. The three-heat switch is placed conveniently handy, so that the nurse in charge can regulate the temperature as desired. The heating unit itself is attached to the front of a curved metal reflector, and both these parts can be removed for cleaning or repair.

The vehicle illustrated is one of a fleet of motor ambulances attached to the Belgian Field Service, which has been supplied by Messrs. Whitlock Bros. (Ltd.)

Upon these vehicles a battery of 13 cells is provided which will keep the heater working for several hours, in addition to lighting two lamps inside the car. We understand that a spare battery is kept on charge at the base hospital and is put on board the ambulance in place of the discharged battery. Where there are no battery charging facilities, a small dynamo driven by the car engines will furnish the necessary charging current.

We understand that the procedure in cases where operations have to be performed is to place the patient on the stretcher and draw the bedclothes over the convector at the foot. In such cases the feet are generally very cold, and the effect of warming them is to give the patient a feeling of comfort and the sensation of heat throughout the body. There is no risk of the clothes being scorched or burnt, because an asbestos-lined metal sheet is placed over the convector.

It is stated that the addition of this extremely simple appliance has been instrumental in saving many lives. It furnishes yet another example of the convenience, adaptability and economy of electric heating. Incidentally it illustrates that electricity is the only heating agent which can be employed in such circumstances.

PLEXSIM ELECTRIC HEATING AND COOKING LIST.

Simplex Conduits, Ltd., have just issued a new catalogue of electric heating and cooking apparatus, in which is shown a good range of their now well-known "Plexsim" goods. Many of the articles are specially designed for industrial use, and we understand there has been a particular large demand from many of the national and other factories recently built; a fact which tends to show that electric heating is taking its share in the "factory efficiency" campaign now in progress. Among the articles illustrated are large electric kettles and urns for messrooms, staff tearooms, &c. Also industrial hot plates, glue, wax and solder pots, and stills for distilled water, in various sizes.

The company have specialised in this branch of electric heating, and the appliances shown in the catalogue are made throughout at their factory in Birmingham. The appliances are supplied suitable for the following voltages: 100-110, 200-220, 230-250; all apparatus for special voltages is charged 25 per cent. extra.

All Plexsim electric cooking apparatus is guaranteed for a period of 12 months from the date of invoice. The company will repair, free of charge, apparatus in which any electrical defect due to faulty material or workmanship is discovered, but do not hold themselves responsible for any consequential loss arising out of such defects. They cannot, of course, repair free any apparatus that has been opened or taken to pieces, used for a different purpose than that for which it was intended, or worked at a higher voltage than that for which it was constructed and marked. This guarantee does not apply to defects caused by fair wear and tear, accident, misuse or neglect.

Plexsim Hot Plate.

The heating elements consist of special section high specific resistance wire of special manufacture, wound upon thin strips of mica. This resistance wire is practically indestructible and is not subject to oxidation. The construction of the elements gives considerable emissive surface, and the elements are run at a comparatively low temperature, which gives them long life. The method of assembling the elements in the various appliances is so arranged as to give considerable pressure of the elements upon the surface to be heated,

The best test of all.

The length of time "Z" Drawn Wire Lamps last has had as much to do with the ever increasing demand for them on the part of users who reckon their annual purchases in thousands of lamps, as their strength.

Are you including All-British "Z"s in your 1917 programme?

"Z" drawn wire Lamps
Licensed under British Patents 23,1S/06 · 27,1S/33 & others

SOLE MAKERS: THE "Z" ELECTRIC LAMP MFG. CO., LTD. OFFICES AND WORKS: SOUTHFIELDS, LONDON, S.W.
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ensuring maximum efficiency of the appliance. In kettles, &c., the air space between the bottom of the kettle, upon which the body rests, and the heating elements themselves, ensure the bottom of the kettle always being kept cool, and there is no risk of burning or scorching the table upon which it may be standing. All apparatus is constructed to give easy access to the heating elements for renewal or replacement. Certain appliances illustrated in the catalogue are arranged for temperature regulation by means of fitting three connectors. Any variation from one-third to full heat may be obtained by means of these three terminals.

Plexsim Large Size Electric Kettle.

Plexsim Electric Still.

The catalogue referred to can be obtained on application to Simplex Conduits, Ltd., Garrison-lane, Birmingham; or branches in London and the chief provincial centres.

NEW WESTINGHOUSE LEAFLETS.

We have received advance copies of a number of leaflets which are just off the Westinghouse press. No. 413/3 deals with water wheel alternators and contains illustrations of the interior and exterior of the power station of the Tyssefaldene hydro-electric scheme. For this installation the company supplied three 1,200 k.v.a. water turbo-alternator sets, which generate three-phase 25 cycle current at 12,500 volts. The machines are totally enclosed and of the revolving field type, and operate at 250 revs. per min. Each set has an outside chamber of 19 ft. 6 in. and a stator bore of 12 ft. 6 in.

Leaflet No. 305/12A describes Westinghouse low equivalent lightning arresters and multi-gap surge dischargers. An illustration of the apparatus and a diagram of the connections are shown. The arresters are designed to protect any system from potential rises due to lightning discharges in the neighbourhood of overhead lines or due to switching in or out of lengthy feeders.

Leaflet No. 52/6-1 deals with the company's "V" rotor starters for A.C. slip-ring motors having two-phase three-wire or three-phase rotors. Illustrations of these starters are given on a separate sheet.

Leaflet No. 91/4 illustrates steel clad motor control pillars, type "P." One of the illustrations show a group of 10 special weather-proof and dust-tight pillars manufactured for an explosive factory, and each pillar contains a D.P. main switch, two fuses and motor starter. These pillars are fitted with glazed fronts.

Leaflet No. 65/1-3 illustrates single handle air-break drum type reversing controllers, type "F," for polyphase slip-ring motors.

CONTINUOUSLY TESTING FEED WATER.

A device has recently been patented which is adapted to continuously and automatically testing liquids. It is being employed to good advantage for testing feed waters for boilers and for indicating the presence of sugar in boiler feed waters. This testing device has an improved form of time-controlled mechanism, so that it will test successively and automatically at predetermined intervals without attention other than to set the time-controlling mechanism at the desired time intervals. A glass liquid receiving tube with graduated marks forms a mixing chamber. The larger pipe at the top of the tube is an inlet pipe, the smaller, a vent pipe. The tube is extended downwardly to form an outlet conduit controllable by a turning plug valve arranged therein. The two containers on either side of the tube are formed of glass or other transparent material, these containers having outlet pipes connecting with the outlet pipe of the tube. The containers are intended to hold the re-agents, the one on the left receiving a chemical indicator and the one on the right receiving the acid which is to be combined with the chemical indicator and the liquid to be tested. A pair of turning plug valves is interposed in the outlet pipes of the containers.

The time-controlled mechanism of this tester includes a plurality of electromagnets, these magnets being of the solenoid type and having movable cores. The cables are connected with the cores and trained over a plurality of sets of guide pulleys, the cables being convoluted about the valve stems of their respective valves, the grooves in the valve stems serving to accommodate the cables. The free ends of the cables are connected to coiled retractile springs for returning the valves to closed position after an actuation. The time-control mechanism includes an ordinary clock having the usual minute and hour hands, being specially modified to close the re-

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KINGSWAY LONDON

spective circuits of the electromagnets to energise the latter. The circuit-closing mechanism referred to includes an insulating ring member provided with a plurality of circumferentially arranged threaded openings spaced at intervals conforming to minutes or any desired intervals of time.

In operation the liquid to be tested is supplied to the mixing tube. At a predetermined moment the minute hand will make contact with the first screw. This energises the right-hand electromagnet, exerting a pull on the cable and the opening valve of the container on the left. This permits some of the chemical indicator to flow from the container to the mixing chamber. After a predetermined interval of time has elapsed the hand reaches the next contact screw, where the foregoing operation is repeated and the container on the right opens. When the hand reaches the third contact screw the operation is again repeated, the bottom valve opening. It is pointed out that the valves only remain open while the minute hand is in contact with the screws, the valves immediately closing by virtue of their respective retractile springs. However, the bottom valve remains open a sufficient time to permit all of the contents of the tube to flow through the outlet and permitting some of the incoming liquid to wash the tube before the valve closes.

SHORT-CIRCUIT TESTS ON OIL CIRCUIT-BREAKERS.

Recent tests of circuit-breakers installed in a plant of large capacity, while not subjecting the breakers to the guaranteed limit of rupturing capacity, furnish an interesting demonstration of the ability of breakers to withstand successively severe operation without damage to the contacts. Sixteen short-circuit tests were made through the same breaker without the breaker being opened for change of arcing tips or examination of the state of the contacts. At the end of the test the breaker was opened for inspection and there was no evidence on the arcing tips of excessive burning such as might be expected. The test was conducted by short-circuiting a 25,000 k.v.a. 23,000-volt turbo-generator, five of them being made without external reactance in the test circuit. Five were made with 5 per cent. 500 ampere reactance coils between the breaker and the short-circuit. The remaining tests were made by short-circuiting the circuit at a sub-station 7 or 8 miles distant, their circuit including about 3 miles of cable. In these latter tests the power stored in the combination of underground cable and overhead line probably represented a considerable increase in the kilovolt-ampere broken at the breaker contacts.

A series of tests were also conducted on another type of breaker rated at 25,000 volts 600 amperes, in which short circuits having a root-mean-square value of 175,000 k.v.a. at 21,500 volts were repeatedly successfully interrupted, representing the largest amount of power which has ever been used under such a test. The generating apparatus was rated at 142,620 k.v.a. The generator voltage was stepped up through a total transformer capacity of 90,500 k.v.a., and oscillograph records were made of each test. The record of the most severe test showed that the short-circuit continued for six cycles on a 60-cycle circuit before the breaker contacts parted, and continued for three cycles through the arc. This short-circuit, as well as the others, was opened by the breaker without difficulty, the same arcing contacts and oil being used in all the tests. There was no damage to the circuit-breaker other than slight burning of the contacts and tank lining, which did not affect its continued successive operation. In the first series of tests Westinghouse type E-6 circuit-breakers were used, and in the second series Westinghouse type O-1 oil breakers.—"Electrical World."

THE MAGNET HAND.

The testing of artificial limbs, especially such as would enable men to do mechanical work, was taken up early in the war by the Verein Deutscher Ingenieure, and in February, 1916, a special testing station for these appliances was opened in Charlottenburg.

In the magnet hand (not patented) of Prof. Klingenberg, the attachment to the arm or shoulder ends in a cup which encloses an electromagnet; the cup is fitted with a ball bearing and can be clamped in any position; the electric circuit is closed or opened by the aid of the other arm or the chin. It is said that the magnet hand helps a man to do filing and planing, to put metal sheets under a punch, and even to manipulate shears or pincers; tools not of iron are provided with an iron ring or plate, so as to become manageable. It is also suggested that the magnet hand might attend to an electric switchboard; the introduction of magnets sufficiently strong for mechanical pull might there and elsewhere lead to unpleasant magnetic effects, however, we should think. The hand can also be provided with fingers and a thumb, to be opened or closed separately. Of other apparatus, praiseworthy mention is especially made of the American Carnes arm. Limbs submitted for tests should enable the man to do six or seven hours' work daily. In tests recently performed at a marine hospital in Hamburg very satisfactory results were obtained in workshops for instrument making, with ordinary labourers, formerly dock hands and men engaged in cement and glass works, and not at all trained to skilled work.—"Engineering."

CUTTING TOOLS MADE BY ELECTRIC WELDING.

At the present time the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is using a number of welded cutting tools in its planing machines and lathes. They were made by welding high-speed steel tips to shanks of machinery steel by means of the arc welding process. This process, says the "Iron Age," has been found cheaper than either oxy-acetylene welding or forging and enables worn-out high-speed tools to be cut to tips of the proper size, thus effecting a considerable saving. The high-speed tip is first tacked to the machinery steel shank, and after applying borax as a flux, the welding is completed. The tool is laid in mica dust to cool gradually. The tool is then given an initial grinding after which it is tempered and the grinding operation completed. This makes the tool ready for use. The machinery steel shank used may be of either hot or cold rolled or carbon steel and of any desired length, while the steel tip should be short. The metal of the shank, which is relied upon to reinforce the tip, is built out and around the latter. In this way, it is explained, a larger radiating surface is provided, as well as a conducting path of greater area back to the butt of the tool, which keeps down the temperature at the cutting end.

An ordinary Westinghouse electric arc welding equipment, such as is employed for the welding or repair of castings, is used, a Norway iron electrode $\frac{5}{32}$ in. in diameter being utilised. To secure the best results a current of approximately 100 amperes is recommended and a voltage of from 60 to 70 volts. The work, it is stated, should not be hurried, although a good operator should be able to weld from 25 to 30 tools having a cross-section of 1½ sq. in. in a 9½ hours day.

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1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, February 9, 1917.

THE ROUND TABLE.

By "KVA."

LAST DAY to roll up in your thousands, and PAY! PAY!! PAY!!! into the Great War Loan.

* * * *

The "Morning Advertiser" (London) explains the stoppage of the L.C.C. cars during the recent hard weather thus: "I understand that the salted snow got into the conduit and short circuited the juice, destroying the fuses, and so stopping the service." Another case of "the fusing of electric wires!"

* * * *

According to the "Contractor," "the Electricity Committee recommend the Salford Corporation to afford an additional supply of electrical energy to certain works on condition that the firm provide the cost of the transformer and switchgear required, and that the existing agreement be extended for a further period of five years."

* * *

Here surely is to be seen the effect of co-operation in the electrical industry. Not so many years ago electric power supply engineers would give their souls, let alone transformers and switchgear, to have "landed" an industrial power consumer!

* * * *

A correspondent in "Engineering," writing on the subject of "Electron Quanta and Relativity Theories," remarks, among other things, "Sinning in good company is too often looked upon as justification for sin, even among engineers"; which suggests that the writer has a remarkably good knowledge of engineering.

* * * *

A correspondent calls my attention to an advertisement of Leclanché cells, in which it is stated that "peace, perfect peace reigns where it is installed." He suggests that this cannot be intended to apply to its use in connection with bells, alarms and telephones, for one would expect quite the opposite of peace, perfect peace in such circumstances.

* * * *

"The total cost of extending the electric lighting system and repairing boilers at Vladivostock is estimated at 105,000 roubles, which it is proposed to pay off by increasing the price of current." Quite right: "make the consumer pay, what is he there for?" must be the motto of this far Eastern electric supply concern.

* * * *

A correspondent asks if Chester's plucky little hydro-electric station got "the frozen eye-ball" during the recent severe weather. I have seen photographs of the public sliding unceremoniously upon the stuff that ought to have been going through the fore-bay for conversion into electrical energy, but, perhaps, Mr. Britton will answer the query?

* * * *

A lay contemporary complains that the price of electrical energy in the State of Washington, U.S.A., is only a farthing per unit, "a rate which is much appreciated by local smelters," and that electric smelting over here is handicapped by the absence of cheap "juice." What else can be expected when in the localities interested there is regular opposition to the building of power stations large enough to produce energy at even better rates than the great Yanks.

The saying, "a square peg in a round hole" has, in the light of the genius of Bairnsfather, assumed a new aspect, for the round hole will assuredly say to the square peg, "If yer knows of a better 'ole, go to it."

* * * *

"Motor Cycling" asks, "What is carburation?" One answer is the art of creating a scientific atmosphere around an extremely simple article, and persuading the public to pay a high price for the article and the halo!

* * * *

The Americans have reduced abbreviation in speech to a fine art, but it is doubtful if anything can be more foreshortened and yet mean so much as the code words used by manufacturers of all classes. "W. R. M." hits the idea off in verse in "Glover's Almanac," thus:—

> Suppose you want some point two five, of type called single core,
> This core made up of copper wires,
> Whose conductivity inspires
>   Your admiration, AND
> Suppose you want it waterproof, its strands completely filled,
> With compound rare, whose presence there
> Will guarantee that water dare
>   Not penetrate the strand.
> Suppose you want this perfect strand with insulation served,
> Our special type which we devised
> Of Bitumen, that's vulcanised
>   (It is, sans doubt, the best).
> Suppose you want then double tapes, with jute and compound too,
> Send straight to us a telegram
> One word will do—'tis CIBIWAM
>   We'll gladly do the rest.
> Suppose you want to know the price delivered where you like,
> With statement, too, of earliest date
> We can despatch as sure as fate
>   This cable CIBIWAM.
> Consult again our private code, See Mains List No. 4,
> You'll find a word—just one—HEMOT
> That will express the blooming lot
>   Stick it on telegram.

* * * *

OUR HOT PLATES.

No. 232 to—

Mr. James Dalrymple, upon the occasion of the repayment of the whole of the capital expenditure upon the Glasgow Municipal Tramways of nearly four millions and having £120,000 available for renewals and depreciation. Some achievement!

No. 233 to

The Cantie Switch Co., for their new "squat" fuse.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Feb. 7, 1880.]

TRANSMISSION OF MOTIVE POWER BY ELECTRICITY.—At Shaw's Water Chemical Works, Greenwich, a neighbouring waterfall furnishes the power to drive a circular saw, a turning lathe, and a vertical boring machine. Two Siemens machines and a water turbine are employed. The turbine is driven by the fall, and one machine is driven by the turbine. The current from the latter is conveyed to a second machine in the workshop 150 yds. distant, and keeps the latter going. From this machine the tools above mentioned are driven by means of belting.

ELECTRIFICATION OF MACHINE MADE PAPER.—This phenomenon was first described by Hankel in "Pogg. Ann.," lv., 477. On leaving the last pair of pressing rollers the paper is highly negative. The paper on the reel is electrified, and notably so when the reel is large. When the paper is cut off from the reel, and the sheets pulled apart, it is stated that frequently brilliant sparks pass. This electricity arises merely from the heating of the paper and its compression, as no friction takes place while the velocity of revolution of the rollers is the same. In "Pogg. Ann.," lxviii., 159, mention is made of Schönbein's electrical paper, employed by him in the construction of an electrical machine. Can any reader give a description of this paper?

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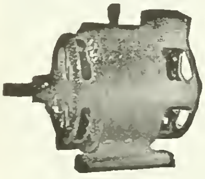
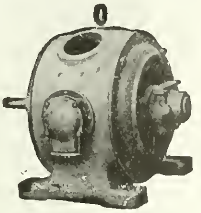

For Direct Current.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"CANTIE" FUSES AND FUSE BOARDS.

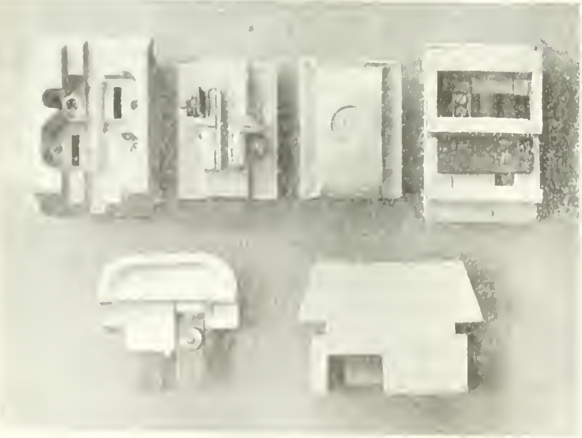

Fig. 1.—[illegible] Fuse Bases [illegible]

There does not seem to be any limit to the variety of designs and shapes which can be introduced into fuses and fuse bases. In the early days the fuse maker was virtually in the hands of the potter so far as the shape of the porcelain handle of the fuse was concerned [illegible]

During the past 5 years there have been many notable examples of fuses and fuse gear which illustrate this point. The fuse itself would not have come into being but for the potter, and his ingenuity and perseverance have furnished the fuse maker with a shape of fuse which corresponds exactly with his electrical requirements. Our readers must be familiar with many such fuses and we will not, therefore, take occasion to itemise any of them.

The "Cantie" fuse and fuse gear, of which illustrations are given herewith, is another recent addition to the already growing list of special fuses which depend for their success upon the art of the potter. The makers, who are among the oldest switch builders in the country, claim as the distinctive feature of the fuse the extreme shortness of the fuse-wire itself. They had this primary object in view in designing the fuse and have been able to achieve it with the help of the porcelain maker. In a pamphlet which they have just issued the importance of the short fuse is emphasised, and reference is made to a report of the National Physical Laboratory on the subject; an interesting calculation of the energy loss in long fuses is also made. According to this report the energy loss on two 8-way, triple pole 50 amp. distribution boards having fuses 6 in. long and running with full load during a working week of 60 hours is 38·08 kilowatt hours during 12 months, and taking energy at 1d. per unit this would mean an expenditure of £7 7s. If the length of the fuse is reduced to 2 in. only the energy loss falls to 12·7 kw. hours and an annual cash saving of £4 12s. would result. Obviously this is an important consideration and one which would appear to be an unanswerable argument for the short fuse. The Cantie Switch Co. claim that although on their new fuse there is only a length of 2 in. of fuse-wire, the fuse does not overheat even when it is made up with other fuses in an iron case; they also state that the porcelain shape which they employ is free from excessive heat stresses and is unlikely to break.

The illustrations serve to show that the new Cantie gear is essentially compact, and in its completed distribution board form it occupies the minimum of wall space; this in itself is a valuable feature where industrial power installations are concerned. It means that circuits of considerable horse-power capacity can be safely and satisfactorily fused in a comparatively small space. It is not an uncommon occurrence for motors to be put down in inaccessible positions, and that there is a minimum amount of wall surface upon which to mount the fuses and control gear. With certain types of fuses some difficulty would be experienced in finding the requisite space. The makers have kindly submitted a 50-ampere sample fuse for our inspection, and this measures 3¼ in. wide by 5 in. deep. The fuse base has a projection of 3½ in., and the fuse handle of a further 1½ in., the width of the latter being 3 in. It will, therefore, be seen that for its carrying capacity the fuse is one of the "squattest" on the market.

Referring to the illustrations, Fig. 1 shows the fuse-base and fuse handle in a variety of positions. It will be noticed that the fuse handle is rectangular in shape, and is provided with a heavy bridge, having in the centre a deep channel which is thickly lined with asbestos webbing. At diagonally opposite points on this bridge are fixed the main knife contacts, with large diameter heavy milled nuts for pinching down the fuse wire. The fuse is threaded across from one contact to the other and laid in the asbestos-lined channel. The shape of the front of the fuse base is clearly shown in Fig. 1, and it will be noticed that the spring clip contacts into which the fuse

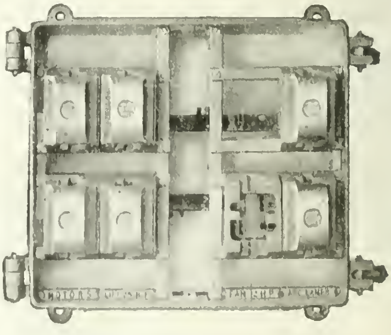

Fig. 2.—New "Cantie" Distribution Fuse Board.

— THE —

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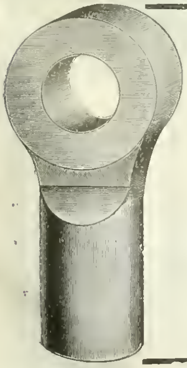

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Thermostatically controlled apparatus to keep either water or air at any desired temperature.
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We have had large experience in adapting electricity to many novel manufacturing processes, and are prepared to submit quotations and drawings to meet any given conditions.

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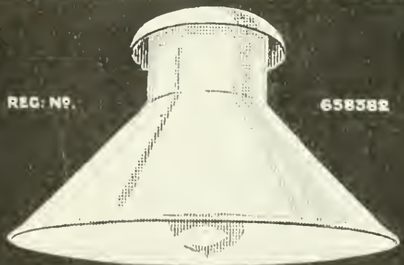

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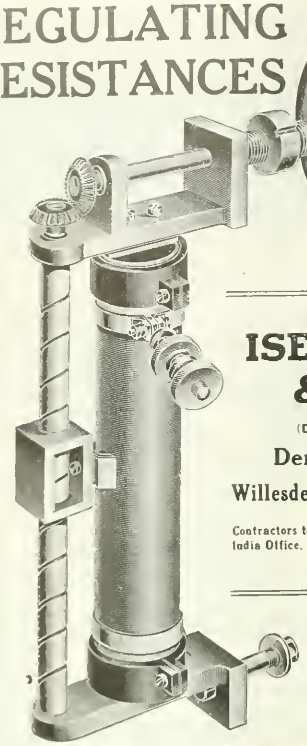


REGULATING
RESISTANCES

"BACK OF BOARD" TYPE—FOR FIELD REGULATION.

ISENTHAL
& CO.
(Department 4)
Denzil Works,
Willesden, London, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

LIST ON
REQUEST.

handle is plugged are well shielded within the mass of the porcelain base; it is not possible to thrust the fingers into the slots at the bottom of which are the clip contacts. The fuse handle fits either way into a recess in the fuse base. When in position the channel in the fuse handle forms a vertical tube, three sides of which are the asbestos-lined channel, and the fourth side a short length of heavy asbestos cord, which is secured in the centre of the recess in the fuse-base. By means of this ingenious construction the fuse wire is always in free air, and when the fuse is blown there is a clear vertical passage of considerable area through which the air blast can pass. This channel is also completely shut off from both the knife contacts on the fuse handle and the clip contacts on the fuse base. It would be difficult to imagine a more ingenious method of so shrouding the electrical connections in a large block of porcelain as to ensure the cooling of the arc and the complete safeguarding from "blow backs" of the connections. The mass of cold material available for cooling purposes may be gathered from the fact that the 30-ampere fuse base and fuse handle weigh 1½ lb.

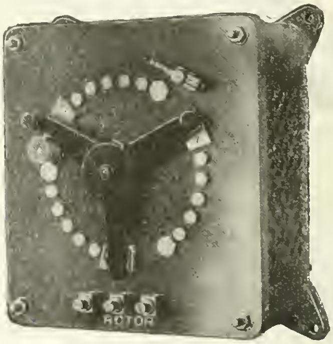
Regarding the performance of the fuse, we have no facilities for testing it ourselves, but understand that the company has carried out extensive trials over a period of two years. In one of the tests a colliery engineer who has charge of a 12,000 kw. plant, put a single-pole fuse in a five-way fuse-base on a 500 volt rotary converter circuit, with a short length of cable and a circuit breaker also in circuit, set at very short time lag. The fuse [illegible] on every trial without the circuit breaker coming into action, also there was no discolouring of the fuse contacts or porcelain base. The company [illegible] that they have made many tests on the blowing of the fuse [illegible] and have themselves been surprised at the [illegible] with which the circuit is broken. In this respect they [illegible] attention to the fact that the asbestos-lined channel in which the fuse wire [illegible] being open at one side, can be wiped out with the finger [illegible] small globules of copper and metal dust which are deposited as the result of the arc.

Reference to Fig. 2 will explain the method of mounting this ingenious fuse in distribution board form. The makers claim that there is a minimum of bending of the feeder and main cables with this construction, and the illustration certainly bears this out. The fuse-bases are designed to engage with the 'bus bars by spring clip contacts, so that it is an extremely simple matter to remove both the fuse handle and the base from the distribution board. According to a descriptive price list which the company is issuing, the fuse-boards are made in two groups, one in which the capacities range from 10 to 50 amperes per way, and the other in which the capacities range from 51 to 150 amperes per way. It will be noticed that the main cables occupy a central channel on the board, and that this is covered with an enamelled iron plate upon which are printed the instructions for removal of the fuse bases. Provision is made for naming each of the feeder circuits in large legible letters.

Copies of this interesting price list can be obtained on application to the company at 67, Mount-street, Nottingham.

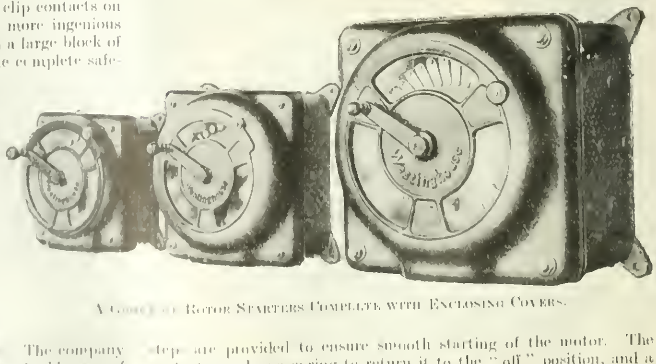
ROTOR STARTERS FOR A.-C. SLIP-RING MOTORS, HAVING 2-PHASE (3-WIRE) OR 3-PHASE ROTORS.

The starters illustrated are for use in the rotor circuit of slip-ring motors, having three slip-rings. They are built in sizes up to 200 H.P., and are made to suit various rotor current values up to 300 amperes, as listed in price leaflets issued by the British Westinghouse Co. They are designed to start motors at their rated horse power on full-load torque, the time taken in starting not to exceed half minute out of 15 minutes up to and including 20 H.P.; three-quarter minute out of 15 minutes from 21 H.P. to 70 H.P. inclusive; one minute out of 15 minutes from 71 H.P. to 200 H.P. inclusive.



Rotor Starter with Front Cover Removed.

The contact lever is of the three-arm type, mounted on a slate base. The contacts are renewable on all sizes, and a sufficient number of steps are provided to ensure smooth starting of the motor. The contact arm has a spring to return it to the "off" position, and a catch to hold it in the "full-on" position. The terminals are of the pinch screw pattern on the smaller sizes, and consist of studs with cable terminals on the larger sizes. The starters can be supplied either open or fitted with a protecting cover over the starting switch front. The front covers are of cast iron with glass inspection windows, and they completely enclose the face plate and prevent accidental contact with live parts. Provision is made to release



A Group of Rotor Starters Complete with Enclosing Covers.

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
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Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
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Telephone Cords.
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Tramway Insulation.
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Knife Switches.

HELSBY
LECLANCHÉ CELLS

The Helsby Leclanché Cell is not a product of the war, it has been made at Helsby in the same way for many years past except for such minor modifications as have been suggested by our wide experience. Peace, perfect peace, reigns where it is installed.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

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MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
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LEAD MELTING FURNACES

(Hall's Patents)

For Cable and Pipe Presses, Accumulator Grids, etc.,
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
ENORMOUS SAVING IN RESIDUE.
MONOMETER Mfg. Co., Ltd., Aston, BIRMINGHAM.

Electrical Engineers and Manufacturers
The House for Electric Heating.
Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.
Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.
Telephone: Gerrard 7601 (2 lines)
Petrol Engine Sets.
Manufactured in sizes from 2 kw. to 20 kw.
Quotations for larger sizes on application.
F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

the starter arm by means of a suitable push-button fitted to the cover.

The resistances are of the company's patent unit or grid types, according to the size of starter and the rotor current. The resistance boxes are of cast iron, with removable top and bottom plates, making inspection and renewal of resistances an easy operation. When the no-voltage release attachment is fitted, the starter arm is held in the "full-on" position by the usual retaining catch. The no-volt release magnet is connected in one phase of the supply circuit, and on removal of pressure from the coil terminals it releases the catch by the weight of its armature. When this attachment is required on starters for circuits above 600 volts and not exceeding 3,000 volts, a separate instrument transformer (65 watts, 100 volts secondary) must be provided; the extra price for this will be furnished on application. Slow motion step-by-step operating gear can be fitted at an extra cost, and provides a quick step-to-step action from contact to contact, reducing the burning of the contacts, such as results from careless operation of the starter when this gear is not fitted.

Insulating bushes, through which the cables pass, are fitted in the cover, and when required a screwed gland can be fitted to take the pipe carrying the three rotor leads at an extra price. When this is fitted the cover of the starter is modified. Auxiliary contacts are supplied separately when required for electrically interlocking the starter with the no-volt coil of a circuit-breaker.

Descriptive leaflet No. 52 6, issued by the British Westinghouse Electric & Mfg. Co. (Ltd.), Trafford Park, Manchester, gives fuller details.

PORTABLE AUGERS IN SHIPBUILDING AND OTHER CONSTRUCTION WORK.

Only the man who has been reared within sight and sound of a shipyard who has watched the development of a boat from the drafting board until she slid off the ways, can appreciate the vast saving of time and labour which has been accomplished in marine construction by portable electric tools. The first portable auger consisted of a series of sections which could be manipulated like a folding rule with belt driven pulleys on each joint, the auger or other tool at one end and power furnished at the other end by a donkey engine. This unique device had a working radius of about 30 ft., and would bore about 20 holes to the old hand auger's one.

The development of small electric motors made possible the application of the portable idea to the operation of drilling, reaming and grinding, but a wealth of experimenting was necessary to develop anything like a reliable tool which would stay on the job. The principal difficulty to be overcome was that of producing a tool sturdy enough to withstand the rough usage to which this type of tool would be subjected and yet have it electrically and mechanically effective. A brief reflection on the type of workman to be found in marine construction yards shows that they are not of the pink tea variety; their work demands that they are more or less strenuous in their [illegible] up, and he who makes their tools must keep this fact in mind.

After having evolved a motor housing which would withstand rough usage without being unnecessarily heavy, we turned our attention to the motor, and finally decided that a general purpose stock motor was not suitable for our purpose. We installed a motor department, and worked out several motors all of a distinctive type, but wound for the different speeds which experimental and field work had established as being the most suitable for different kinds of work. In common with other manufacturers in this field, we had been working to produce a tool which would not overheat and burn out the motor or fuse the switch contacts—the two commonest forms of trouble in portable electric tools. We eventually developed a quick-acting make-and-break switch which operates as quickly when breaking as when making contact, and requires but a very slight touch on the control. This switch practically eliminates the sticking and using of switch contacts. Realising the considerable degree of protection given to the motor by this switch, workmen would occasionally work a tool beyond its capacity for extended periods, which overload had a tendency to overheat the motor and endanger the windings. To offset this so far as was consistent with good working practice, we increased the load capacity of the motor so that it would stand up under reasonable overloads. The motor temperature is kept down by a fan on the armature shaft. By thus producing a dependable tool we greatly enlarged its field of practical usefulness, and gave the shipbuilder and shopman a reasonable assurance that his men would not be subjected to frequent lay-offs due to the failure of tools.

During the period of improvement in design of motor and switch other improvements were made, one, a most important one, being in the design of the switch receptacle and housing. Formerly, when it was desired to renew or change a cable or conductor cord on electric tools it practically was necessary to dissemble the tool. With our present form of connection in the switch box the removal of a cover exposes the connections and likewise renders it an easy matter to renew fuses. Gears were given a new ratio and cut, heat-treated and hardened, and the present design permits them to run in grease, so that one application of grease for every 300 hours of duty is sufficient. The simple and efficient lubricating system and ball bearings assist materially in prolonging the life of the tools under severe heavy duty.

It is unnecessary to tell the man interested in ship construction and maintenance of the various ways whereby portable electric tools have become standard equipment in the yard and shop and aboard ship. It is sufficient to say that where there are holes up to 2 in. in diameter to be drilled or reamed or light grinding to be done a type and size of portable electric tool adapted to the economical disposition of the work is indispensable. These tools can be had to work on any standard current—direct, alternating and universal—and their power efficiency remains practically the same irrespective of the working distance from the source of power. Unlike any other power-driven tool, their efficiency is the same, after being repaired properly, as it was when new, due to the fact that an electric appliance either works right or does not work at all. In our latest type of portable electric marine tool we have combined a drill, reamer and grinder which will work on direct current, and when used with a bench stand and a post or wall stand practically constitutes a portable machine which can be taken to any part of the shop or ship when occasion requires it. What this means to shipbuilders and owners, especially during a breakdown when at sea, will best be appreciated by those who have been through this experience under old time conditions. Dependable portable electric tools aboard ship often spell the difference between a profitable and a disastrous voyage. "Take heed ye men who go down to the sea in ships."—C. H. Blackstone in "Canadian Electrical News."

FOR EFFECTIVE IMPREGNATION
USE
"LACWATT"
Black or Golden Brown
JENSON & NICHOLSON Ltd *Insulating Varnish Dept*
GOSWELL WORKS, STRATFORD, E.

"THOR" High Grade Specialities
CASING and CAPPING
CONDUIT
CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
WRITE FOR PRICES & DISCOUNTS.
HASLAM & STRETTON, Ltd., Windsor Place, CARDIFF & Bristol Bridge, BRISTOL.

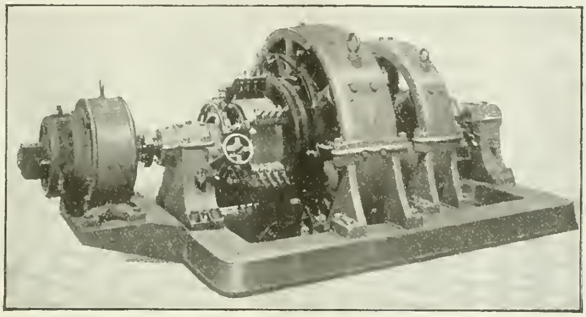
Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

VICKERS LIMITED.

Motors and Generators of all types.

Rotary Converters.

Complete equipment for the electrical lighting and driving of Machine Shops, Factories, Mills, etc



250 K.V.A. Rotary Converter. 6 phase, 50 periods, 480/560 Volts. 1,000 r.p.m. Inverted type.

Patent Automatic Reversing Drive for Machine Tools.

River Don Works, SHEFFIELD.

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TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

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TELEPHONE: 6323 HOLBORN.
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CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

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Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

Hopwood St. Mills,
PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union.

THE ESSEX Accumulator and Dry Battery.
HAND LAMPS, INSPECTION SETS, TORCHES, POCKET LAMPS, ACCUMULATORS, ETC.
List on Application.
THE ESSEX ACCUMULATOR CO.,
497, GROVE GREEN ROAD, LEYTONSTONE, LONDON, N.E.
Telegrams: "Essaccula London." 'Phone: Wanstead 749.

THE NEW SWITCHGEAR CONSTRUCTION CO. (LTD.)

Manufacturing and trading interest attaches to the recent registration of the New Switchgear Construction Co., which has established works and offices at Sutton, Surrey, on a site immediately adjoining the L.B & S.C. Railway, and close to Sutton station. The premises are ideal for workshop purposes and especially for the erection of large power switchboards which require ample floor and head room for their assembly. The machine tool equipment is essentially modern and the capacity of the buildings, and also the site of the works, will admit of considerable extensions.

The Directors of the new Company are well known business men and engineers and are Mr. Charles E. Cleeves, a prominent South Wales colliery owner and chairman of the Western Section of the South Wales Colliery Owners' Association; Mr. James Hall, for a number of years manager of the Switchgear Department of the Union Electric Co., and lately general manager of the Switchgear Construction Co., and Mr W. Walter Hughes, a well-known consulting engineer of wide experience of British colliery practice, who will act as consulting engineer to the company. The newly formed company has acquired the business of the Switchgear Construction Co., Ltd., of Park Street, Southwark, London, S.E. It will specialise in the production of high, medium and low pressure alternating current and direct current switchgear. The high-tension gear and the iron-clad steel plate type, of a design which has been standardised and is already well known, it having been given considerable usage by the Union Electric Co., by whose organisation it has been developed to its present form some ten years ago. It has a good reputation among both large and small industrial electric power engineers, who in most cases have given repeat orders for extensions both to main and subsidiary boards. The gear complies in detail with the Official Regulations as to the use of electrical energy in mines, factories and textile mills, and is held in high esteem by engineers in charge of electric power plants on account of its safety, compactness, robust construction and freedom from breakdown under severe circuit conditions.

The new company is entirely British in its capital, directorate and staff. The heads of the firm have had a long and valuable experience of switchgear practice, which they will bring to bear upon the operations of the company. Their object is in every way to enhance the already high reputation of British switchgear in the markets of the world and especially in that competition with German manufacturers and German methods which will be inevitable after the war; in respect of the export business the company is making arrangements which will enable it to bring the products of its Sutton works into the hands of all overseas buyers, and in this department it expects to be exceptionally active in ousting the German trader.

The prospects of the company appear to be exceptionally good, and doubtless it will be welcomed as a valuable addition to the ranks of British electrical manufacturing firms.

HENLEY'S EMPLOYES' WAR CONCERT.

In aid of the Henley War Relief Fund a successful concert was held on Friday, the 9th inst., at the Cripplegate Institute, where members of the staff and other volunteers delighted a large and appreciative audience. Some of the turns by members of the staff came as a surprise to the audience, revealing considerable ability both from the musical and humorous point of view. In addition to the staff the following friends were good enough to give their services: Mr. Bernard Flanders, A.R.A.M., acted as accompanist; Miss Jessie Fisher, with her monologues "That Peccadillo"; Mr. Wilfred Alderton, with his silver bell solos; and Mr. Grant Molene and his company of the Warwick Repertory Club, with a dramatic sketch, entitled "A Question of Identity."

In the unavoidable absence of the managing director of the company (Mr. George Sutton), Mr. W. J. Potter took the chair, and in the course of the proceedings referred to the good work done by the fund, the contributions to which since the inauguration have amounted to over £2,300. The parcels of luxuries sent once a month to the Henley men at the front—and to those who were unfortunate enough to be prisoners in Germany—have almost without exception reached the men and have been much appreciated. At the start of the war the fund was more than sufficient to cover expenses, and various contributions were made to the Red Cross Fund and other war charities, but the number of Henley employés in khaki has now increased to a total of nearly 800, and although the fund has so far been able to keep pace with the demand, the gradual increase has depleted it, so that some assistance was necessary. The proceeds of the concert cleared £25, and other contributions of £40 raised the total to £65. Attention was also drawn by Mr. Potter to the facilities offered by the company to its employés who wished to contribute to the War Loan—*i.e.*, that the company would advance money to any of its employés free of interest for two years, to enable them to do so.

Cork for Insulating
Compressed similar to "Suberite."
Having the agency from cork manufacturers in Spain, we solicit inquiries.
JULES LANG & SON, Charlton Works, Charlton Place Islington, London, N

One, Two & Three Phase MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices, 1, 2 and 3 Salisbury Court, Fleet Street, in the City of LONDON. Friday, February 16, 1917.

THE ROUND TABLE.

By "KVA."

Event of the Week.—Edison (according to the "Daily Chronicle") *is inventing* a device for detecting and catching submarines.

* * * *

The writer of the advertisement in which Leclanché cells are associated with the idea of peace, perfect peace sends me the following note :—

Dear KVA.: Does your gentle correspondent wish to imply that, on the declaration of peace the ringing of joy bells will constitute an act of war ?

The writer, who as part of his earthly penance, has, ex officio, to say something weekly (and *pace* your correspondent sometimes does it weakly) about our manufactures, has hitherto been lured on by hope of that diviner drink in the land where the patients (or whatever you call 'em) warble eternally, and the harp is a constant feature of the landscape, there to "requiescat in pace."

Alas, his illusions have now been shattered—first by the ominous remarks of Raymond respecting the unpopularity of the local whisky, and now by your correspondent's suggestion that sound is the antithesis of peace.

Must the writer then hie him to that "other place" which they say is so greatly improved since the extraordinary influx of his electrical colleagues who have gone ahead ?

Yours faithfully,
W. A. W.

* * * *

If you know any R.F.C. man (and who doesn't) you will have often heard him speak of "Archie." In the "Daily Chronicle," under the title of "Letters of An Airman," there appeared recently, from the facile pen of "Contact," some notes on "Archie," his origin, habits and propensities. His birth is described thus :—

One day a pilot noticed some far-away bursts, presumably meant for him. He was old enough not to have forgotten the good old days, when the music halls produced hearty if vulgar humour, and he murmured "Archibald, certainly not." The name clung, and as Archibald the A.A. gun will go down to posterity.

"Contact" then goes on to describe certain pronounced changes in "Archie's" habits :—

"Archie" has since grown up, and become sober, calculating, accurate, relentless, cunning and deadly mathematical. John or Ernest would now fit him better as being more serious, or Wilhelm, as being more frightful. For "Archie" is a true apostle of frightfulness. To anyone who has seen a machine broken up by a direct hit at some height between 8,000 ft. and 12,000 ft. "Archie" becomes a prince among the demons of destruction.

An instance given of "Archie's" deadly accuracy is thrillingly described :—

"Archie" wounded a pilot from our aerodrome in the head and leg, and an opening the size of a duck's egg was ripped out of the petrol tank facing him. The pilot was growing weak from loss of blood, but it occurred to him that if he stuck his knee into the hole he might be able to pump up pressure.. He tried this, and the engine came back to life 50 ft. from the ground. At this height he flew in a semi-unconscious condition 16 miles over enemy country, and crossed the lines with his 'bus scarcely touched by the machine guns trained on it.

"Contact" winds up by saying that his aerial experiences have given him "a fellow feeling" for the birds in the air, and though he is very fond of pigeon pie he vows, after months of "Archie," he will never again fire at anything on the wing.

The female barely gowned is not often the subject of engineering advertisements, however much she may be discussed among engineers. A correspondent has drawn my attention to an announcement in a recent issue of the "Electrical World," inserted by the Morgan Crucible Co. It forms one of a most attractive and humorous series in which Eastern customs are utilised for purposes of illustration and worked in to point a moral for the use of Morganite brushes. The specimen loses somewhat by reproduction in line and not half-tone, and also the little lady depicted is dusky and not white. I have reproduced that part of the wording which relates to the sketch; the rest is about brushes :—

KIKO WUSTI.

In parts of Southern India the native women wear ultra-abbreviated costumes.

Kiko wusti ?—you ask, which, reduced to its full English translation, means—*why ?*

Our custom collector states that the reason is not because of the intense heat, as one might suppose, but rather because of the advertising value.

Some years ago this information would have been received by the American woman as a distinct shock.

To-day, however, she smiles her nod of approval, indicating the American trend toward the conservation of cloth.

How customs change !

* * * *

Lent is now in season and already I hear of self-denying resolutions, even among engineers. One of the most grotesque is that decided upon by an engineer I met on Tuesday last. He is at present marooned in the only hotel of a Yorkshire town with a number of kindred engineering spirits, among whom billiards is the only evening game. The subject of Lent was solemnly discussed last week and after all the rest had vowed to give up something, the abstemious engineer in question said he would "give up beating the others at billiards"!

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), Feb. 21, 1880.]

Edisonia.—The "Operator" says, "The opinions of scientific men in Europe as to the ultimate success of Edison's light seem much divided." We thought otherwise ; and it still seems to us that the scientific opinion of Europe is practically unanimous, and is that Edison has failed. In fact, we have not heard of one solitary individual possessing any scientific standing in Europe who has expressed the opinion that Edison has succeeded.

Utilising Waste Rubber.—The following method of utilising old and waste rubbers has just been patented in Germany. The rubber waste is subjected to dry distillation in an iron vessel over a free fire with the aid of superheated steam. The product, when thickened and vulcanised in the usual manner, is declared to possess all the good quality of first-class natural rubber. It is recommended that the lighter oils which come over should be separated from the heavier products.

L. P. S.
CLIPS, TIPS & TERMINALS
of all descriptions.
Write for Booklet, with Illustrations, of 75 types to:—
THE L.P.S. ELECTRICAL CO., 14, Howick Place, Westminster, London, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
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Write for particulars to—

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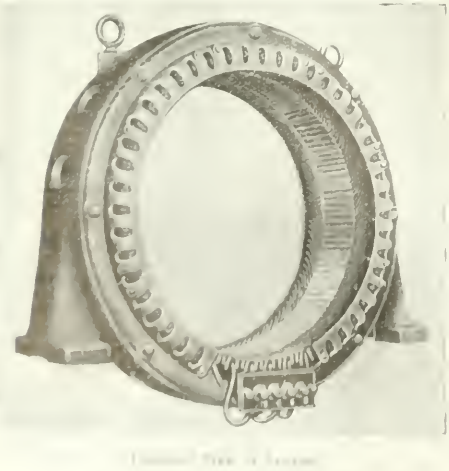
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 535[illegible]. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St.
BRISTOL—[illegible], Bridge Street
CARDIFF—[illegible], St. Mary Street.
GLASGOW—[illegible] Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood [Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

ALTERNATORS WITH LARGE EXCITERS.

So simple an expedient as the building of an exciter, on the same shaft as the alternator, large enough to supply current for lighting and small power purposes does not seem to have been generally adopted as standard in the production of certain types of generating plant. In many industrial installations, particularly textile mills,

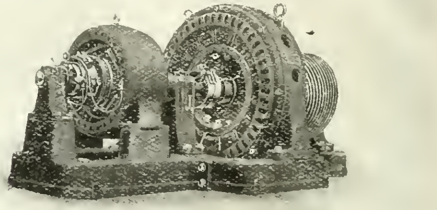


[illegible] View of Stator.

[illegible] power [illegible]. In such cases the exciter will be built on the alternator shaft and by increasing its capacity by a few per cent. there is available, for low capital outlay, energy for lighting and the driving of a few small direct current motors.

Messrs. T. W. Broadbent, Huddersfield, send us a catalogue in which they describe their T type alternators which have extra large exciters attached to them as a standard thing.

The alternator is designed specially for the purpose of motor driving, and is of robust construction. Although standardised as a three-phase generator, it may be wound either one or two phase if desired. Its E.M.F. curve approximates closely to the sine wave form; and the generator is therefore suitable for parallel working. A feature of the alternator is that the continuous-current generator supplied as its exciter is large enough to provide, in addition, for the lighting of an average electrically-driven works, factory or mill. This system of combining an alternator and a dynamo for the respective purposes of motor driving and lighting is one which offers many practical advantages. By this means are combined the simplicity and reliability of the three-phase current for power transmission, and the good pressure regulation of continuous current for lighting.

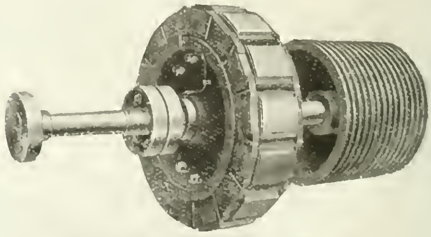


Complete Alternator and Large Exciter.

As a matter of practice, the ratio of the electric energy required for lighting to that required for power, in such cases, does not vary greatly; and the relative proportions of the machines listed will, the makers believe, be acceptable in most cases. The continuous-current generator can, without difficulty, be made relatively larger or smaller, as may be necessary to suit special requirements.

The standard alternator winding is for 460 volts, and a frequency of 50 cycles per second. Unless otherwise ordered, every generator is arranged to run in a clockwise direction, looking at the pulley end. The exciter is compound-wound for a standard pressure of either 115 volts or 230 volts, its output for each size being specified in the list. The exciter is included in the price of the alternator and is an integral part of it.

The rotor is of massive construction, being essentially a rotating field magnet. The cores and poles are of laminated iron; and are securely clamped to the cast-iron hub which forms the magnetic yoke. The hub of the rotor forms a flywheel which tends to minimise any cyclic irregularity in the driving of the alternator. The



Rotor Complete with Coupling for Exciter Armature.

rotor coils are former wound. They are treated with solid compounding; after which they are insulated; and they are then treated with insulating varnish in the ordinary way. Bronze flanges support the coils at both ends; and the outer flanges are securely held in position by the laminated iron pole pieces.

The stator core consists of iron laminations assembled in a cast-iron frame having a number of inwardly projecting radial ribs, the laminations being clamped up between strong cast iron plates. The feet of the stator are large and widely spaced, so as to ensure a rigid fixing on the bedplate. The coils are former wound, and are thoroughly impregnated with insulating varnish before being assembled on the core. They are held in position in the slots by means of keys or wedges of hard insulating material. The insulation of the stator is carried out throughout with specially selected materials; and the winding is almost indestructible in ordinary service.

Pedestal bearings of the ring oiling type are used; there are three

By Appointment
Ironfounders to
H.M. the King.

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ELECTRIC FIRES

are the result of practical experience, coupled with the finest materials and the most modern ideas.

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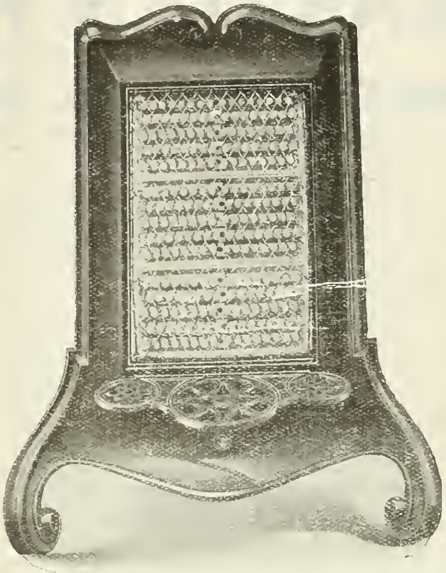

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Rods, Wire, and

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MOTORS (A.C. & D.C.),
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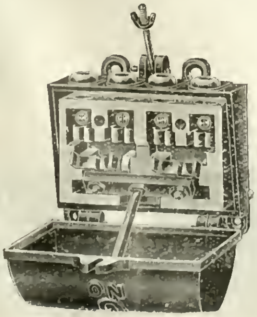

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FOR

Hotel Lighting

POPE

ELASTA

WIRE LAMPS

Made by
POPE'S ELECTRIC
LAMP CO., LTD.,
HYTHE ROAD,
WILLESDEN, N.W.

BASTIAN METERS FOR DIRECT CURRENT ONLY.
Made in ENGLAND with
BRITISH CAPITAL and BRITISH LABOUR.
THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

for the alternator and an additional one for the exciter. The bearing bushes are of phosphor bronze; they are of large diameter; and have a length of from two-and-a-half to three diameters. The bearing bushes and oiling rings for the alternator are split, the bottom half bushes being provided with slots for convenience in barring them round when desired. Each bearing is provided with an oil gauge and drain tap.

Terminals suitable for the current specified are provided; and are mounted on a slate panel, conveniently fixed to the lower portion of the stator frame. A rope pulley of the diameter specified, and grooved for the specified number of ropes, is supplied with each machine. Each generator is self-contained on a bedplate, which is of substantial proportions and ribbed internally wherever necessary.

The exciter is mounted on an extension of the alternator bedplate and is coupled direct to the alternator through a flanged coupling. Each alternator before despatch is, we understand, subjected to the usual load test; it is flash tested with four times its working pressure, between the windings and frame; and its insulation resistance is measured.

The alternator is designed to work at its specified output continuously without undue heating; and for a period of one hour with a non-inductive overload of 25 per cent. without injurious heating. The rise of pressure in root mean square volts from full load to no-load, with constant excitation, will not (except in the two smallest sizes) exceed 7 per cent. on a non-inductive load, nor 20 per cent. on an inductive load having a power factor of 80 per cent.

The machines are listed in eight sizes ranging from 60 kw. alternator with 10 kw. exciter to 400 kw. alternator with 68 kw. exciter.

Copies of the list can be obtained from the makers, T. W. Broadbent, Ltd., at Victoria Electrical Works, Huddersfield.

"EFFICIENT EQUIPMENT FOR SUCCESSFUL INDUSTRIES."

The above is the title given to a 61 page catalogue which has reached us from that long-established and highly reputable overseas engineering house, Messrs. Noyes Bros., Ltd. The brochure is carefully laid out, artistically printed and copiously illustrated. It furnishes pictorial and textual evidence of the work which this enterprising house has carried out on the Australian continent. It is a magnificent record of British engineering effort with British mechanical and electrical and allied plant and machinery. It is also a valuable missionary document for the employment of electric power for all industrial purposes. In this regard it affords better proof than all the speeches and articles on the expansion of British overseas trade of the merit of British production and their ability to compete with those of the highly organised German trader.

In the foreword to the brochure it is pointed out that Messrs. Noyes Bros. have [illegible] complete electric tramway systems, power plants, industrial electrical installations for factories, mills, and mines, complete lighting installations for buildings or towns, [illegible] manufacturing machinery, including cement making plants, hoisting and conveying gear, power transmission de[illegible], [illegible] and road making plants, heating and [illegible] equipment, and crushing and ore dressing machinery, a range of [illegible] effort which it would probably be [illegible] in that part of the world. It is also stated that the [illegible] plant, cost of installation and operation, and [illegible] in modern plants. At its various depots in Melbourne, Sydney, Brisbane, Adelaide and Perth it carries large stocks of machinery, motors, portable tools and engineering and electrical supplies. The letterpress of the brochure is opened with a phrase which seems to us to be particularly apt. It reads as follows:—"Machinery and efficient power production and distribution are vital factors in all modern industries." It is then pointed out that the object of the publication is to give the friends of the firm some idea of the nature and extent of the engineering work which it has carried out, and the illustrations are reproduced from photographs which illustrate installations typical of many put down.

The pictures of generating plant are extremely interesting and show that the company makes no idle boast in claiming that it will put down complete installations. There is an excellent view of a spray cooler for cooling condensing water in the plant installed for the South Australian Portland Cement Co. It is interesting to note that the company has supplied approximately 3,000 H.P. in generating sets driven by gas engines.

The views of switchboards, several of which were supplied by Ferranti Ltd., show that the company has a preference for the British product.

The section dealing with electric motor installations is one of the most instructive that we have seen in book form. The photographs have been taken from the point of view which clearly explains the advantages of the electric drive and the convenient manner in which the motor can be fixed immediately adjacent to its work. The largest motor shown is a 250 H.P. direct-current machine designed for rope driving the rolling mills of the Victoria Iron Rolling Co., Melbourne. Another interesting picture is that of a direct-current motor which rope drives on to an exceptionally large flywheel attached to a compressor at the Geelong Freezing Works of the Geelong Harbour Trust.

Quite one of the best photographs is that which shows the laying of a Callender submarine cable across Sydney Harbour. In the crane section are views of a motor-operated Priestman grab at work in Sydney Harbour, and a 30-ton overhead electric traveller is another show picture. The company has evidently done some big work in cement making plants, a class of industry in which the electric drive proves very valuable for the driving of the large diameter rotary kilns, which are a feature of these works.

The concluding page shows illustrations of the company's Melbourne offices and also their large premises at Sydney. On the same page are two Rolls of Honour, which include the names of the staff at both these places who have joined the Colours. In every way the catalogue is a most creditable production and one upon which we take the opportunity of extending our congratulations to the company.

ELECTRIC SELF-STARTERS.

In the issue of the "Car Illustrated," dated Jan. 17, there appeared on page 211 an article by Miss Ethel A. Southam, entitled "Self-starters: Their Defects and Advantages." The views put forward were those of a purely private car owner who has no direct or indirect interest either with car manufacturers or makers of electric starting sets. In the opinion of Mr. William Holt, a director of Brolt, Ltd., the makers of the well known electric lighting and starting sets, the contributor makes rather sweeping assertions which require modification. He says:

Prior to the spring of 1914 British car manufacturers were very

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MOTORS
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Phone: Victoria [illegible] Grams: [illegible] Sowest, London.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
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Phosphor Bronze Wires.
Brass Rod.
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Joint Boxes and Pillars.
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Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT DUST FUSES.

To obviate the destructive effect of open fuses when blown on short circuit under modern generating conditions, use Prescot Enclosed Fuses.

See Pamphlet p. 121.

Made at Prescot by

BRITISH INSULATED & HELSBY CABLES. LTD.,

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PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

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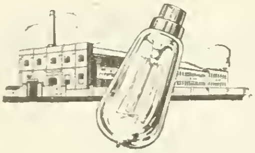

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[illegible] ELECTRIC [illegible] LTD. OFFICES AND WORKS: SOUTHFIELDS, LONDON, S.W.
Depots in Principal Cities.

conservative on the starter question, and it was almost impossible to find a manufacturer who would seriously consider the provision of a self starter at all.

It should be borne in mind, moreover, that the starting of a British or Continental high-efficiency engine using plain magneto ignition was quite a different proposition to starting the "woolly" engines using battery ignition as fitted to American cars at that period, with carburetters adjusted for easy starting regardless of petrol consumption.

A direct positive drive was essential for British engines, and early in 1914 the first British self-starter was marketed having this feature, viz., the "Brolt," which has a direct gear action on the flywheel. This was immediately taken up by the British car manufacturers, and many had already standardised it when war broke out.

The remarks in the article on the deficiencies of the British self-starters are altogether too sweeping and appear to refer to the earlier types of starters embodying other methods. The troubles mentioned were due to [illegible] difficulty in keeping the batteries charged and slip in rubber friction drive.

Now these two matters are closely related, inasmuch as the amount of discharge required for starting purposes directly determines the amount of charge required. With a starter such as the "Brolt" the power applied to the engine is instantly and automatically and the full power directly applied in the most highly efficient manner, while the moment the engine starts the load is removed from the starter and consequently from the battery. It will be readily seen that it only demands from the accumulator a fraction of the energy required when the connection of the power to the engine has to be made [illegible] when the losses in transmission are heavy and the time taken to make connection is often quite considerable.

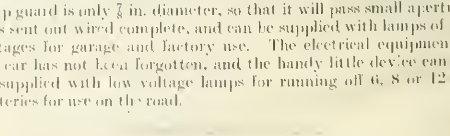
I quite agree that the size of dynamo installed requires consideration of the conditions under which the car is used as a town carriage with frequent stopping and starting and no straight away runs is [illegible] from the conditions to a car used almost exclusively for touring. At the same time the provision of a highly efficient directly applied automatic starter removes a large proportion of the [illegible] so that the battery will be kept charged without adding to the cost and [illegible] of the installation.

[illegible] their [illegible] to the cars and attention which should periodically be given, and which ensure the absence of trouble and satisfactory working of the outfit. I might say that [illegible] have not been at quite such a standstill during the past terrible two and a half years as assumed, and that after the war the full benefit of their experience will be available.

In view of these remarks, I do think that the rather sweeping assertions as to self-starters in general should be modified a little in justice to some of the makers, as the present-day British self-starter is as reliable as any other part of the car, and will do full justice to the British car on which it is fitted.

MOTOR CAR INSPECTION LAMP.

An interesting product of the war is the shell inspection lamp, one of those exclusively electrical accessories which has made electric lighting "do its bit" in the output of munitions. We are not surprised that that enterprising firm of manufacturers, Messrs. Simplex Conduits (Ltd.), of Garrison-lane, Birmingham, have adapted this into a useful electric inspection lamp for the rapid examination of the inaccessible parts of the chassis of engine of petrol and other motor cars. The lamp is strongly made in two patterns, one 26 in. long, with the lamp guard 1¼ in. diameter, fitted with a switch in the handle; the other is only 15 in. long, and the lamp guard is only ⅞ in. diameter, so that it will pass small apertures. It is sent out wired complete, and can be supplied with lamps of high voltages for garage and factory use. The electrical equipment on the car has not been forgotten, and the handy little device can also be supplied with low voltage lamps for running off 6, 8 or 12 volt batteries for use on the road.



Long and Short Types of Inspection Lamp.

FERODO FRICTION SURFACES.

Owing to the continually increasing cost of raw materials, the manufacturers of Ferodo fabrics have been compelled to advance the prices of these fabrics 15 per cent., so that list prices are now plus 25 per cent. instead of plus 10 per cent. as hitherto. This increase came into operation on Jan. 1 last, and it is only due to the fact that the makers held large stocks of raw materials, of which they determined to give their customers the advantage, that prices have been maintained at their previous level for so long a period. The well-known quality of Ferodo fabrics is fully maintained, and engineers, motorists, and other users will find that there are no friction surfaces so efficient, reliable and economical as Ferodo linings. Should any difficulty be experienced in obtaining supplies a postcard should be addressed to the makers, the Herbert Frood Co. (Ltd.), Chapel-en-le-Frith, Derbyshire.

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.

Telephone: Gerrard 7601 (2 lines).

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

THE ROUND TABLE.

By "KVA."

I have had quite a budget of correspondence this week, and two letters are from opposite sides of the earth. The first is an appreciation from Brooklyn, N.Y. :—

DEAR KVA : I've been enjoying your "Round Table" for a good many years now—and these days, when "Neutrality" is no longer an excuse for pro-Germanism on the part of some individuals, I feel a closer bond than ever. All good wishes!

JOHN L. HOGAN,
National Electric Signalling Co.

* * * *

But friend Hogan is not satisfied with that ; he sends me a poem, which a note on "telephone sympathy" in this column on January 19, has inspired :

To KVA, London :—

That "Telesympathics," I like as a name ;
I'm writing to outline a case of the same . . . .
F. Jensen and pardner have drawn down Hot Plates . .
I wonder if you'd care to hear, from the States,
A story concerning a pair sympathetic—
A man and a girl with sensations magnetic ?

My line from the office goes straight to the 'change
And, lifting the telephone off, I arrange
To get a Fair Damsel, or some busy man
By talking to "Central" directly. She can
Call me at my desk in the very same way . . .
In fact, people do it some 'steen times each day.

Now, this is the instance I think rather queer,
Although its mechanics are prefectly clear :
I grabbed the receiver, cut in on the line,
And started to call Mary's number, "Three nine . . . ."
When, lo and behold ! In a voice that I knew,
I heard "This is Mary and *I'm* calling *you* !"

Some call it coincidence—maybe 'twas luck,
Or else Telesympathy ! Truly, we've struck
A topic of interest, subtle and deep . . . .
The sort of a problem to solve in one's sleep !
Perhaps in ten years or a dozen we'll sell
A self-calling telephone, *minus* the bell !

JACK HOGAN.

The last line caps the lot, and is worth a Hot Plate, only goodness knows when I shall be able to deliver it !

* * * *

The other letter is from Mr. P. S. Jackson (general manager in India for Siemens), who writes me from Madras :—

DEAR KVA : Here is a story which is quite original and which strikes me as suitable for your "Round Table" :

A certain electrical man on the "qui vive" for business got the tip that an armature of one of the generators in the wireless station at Madras required renewal, and he therefore rose up very early in the morning so as to be there "on time." Our wireless station here is most jealously guarded by Territorials of the 4th Devonshire Regiment, and he therefore very soon found himself face to face with a tough customer in the shape of one of the sentries stationed at the gate. "Where is your pass," was the first thing he was asked, and in reply he said that he was on his way to see the Military Mechanic, as he heard that another armature was required. I do not know that my friend looks like a "spy," but anyhow he seems to have roused the suspicions of the worthy sentinel, who retorted ferociously, "No armatures (amateurs) wanted here—Jao." (Hindustani for "go" ; or perhaps it could better be translated colloquially "clear off.")

* * * *

Some pin their faith to C.T.S.,
With which we quite agree ;
But think in time they'll also need
The Pamphlet T.S.C.,
Which deals with Tumbler Switch Controls
For incandescent lamps,
And will be sent quite free to them,
Or with "Booklet," seven stamps.

* * * *

In another column we print the more serious items in Hill's talk on the Engineers' Club. One of the less serious but none the less apt items I reproduce here :—"I may, perhaps, be allowed to treat it—to begin with—as a Biblical lesson. From its beginning, Genesis—through Levicitus—the settlement of its constitution and laws (which, by the way, should be re-drafted when the War is over) ; the Book of Job (when the Club was being prepared and furnished and the committee might have been likened to Job, save for the fact that they had no friends left) ; the Apocrypha (that weird and beautiful collection of hopes, thirsts and aspirations, embodied in the Suggestion Book, about what Tennyson called 'The Crossing of the Bar') ; and, finally—if you have patience to hear it—'The Book of Revelations,' our Chairman to-night proving its authenticity by exhibiting in his own person every well-known 'Mark of the Beast.'"

The last reference is to our dear old friend Seaton, who afterwards said from the chair that engineers had notoriously thick skins.

* * * *

Even the makers of switch and fuse gear are influenced by war terms, for I read that a new fuse is a desirable thing because its connections are made "at the front."

* * * *

OUR HOT PLATES.

No. 234 to—

Mr. John L. Hogan (National Electric Signalling Co., Brooklyn, N.Y.) for his idea of a self-calling telephone minus a bell.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Feb. 28, 1880.]

RISE IN TELEGRAPH WIRE.—The price of best drawn telegraph wire in long lengths has gone up 30s. per ton, and we hear on good authority that it is likely still to rise.

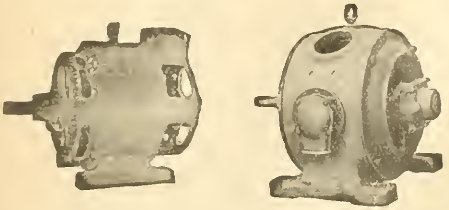
TELEPHONE EXCHANGE FOR GLOUCESTER.—A meeting was held last week to discuss the question of establishing a telephonic exchange at Gloucester. The sum mentioned as necessary to connect Gloucester with Sharpness, viz., £7 per mile of wire and £10 per instrument, or a total of from £100 to £120 per annum, seems to us exorbitant, and out of all proportion to the benefit to be obtained.

AN IMPRACTICABLE SCHEME.—The Duplex Polytechnic "Journal" notices a proposal which has seriously been put forward for heating steam boilers by means of platinum rendered incandescent by the passage of a current. We think that our contemporary's estimate of the cost of so doing, viz., a cost of 30 times greater than that of heating directly by coal, is certainly not exaggerated if voltaic batteries are to be used for the purpose. In any case the scheme deserves mention only by way of warning to a certain class of "inventors."

No. 350·3. Rear-of-Board Pattern.
'IGRANIC'
CONVERTIBLE PLATE FIELD REGULATORS for MOTORS and DYNAMOS.
No. 350·1. Front-of-Board—Open Type.
OVER 160 CAPACITIES, NUMBER OF STEPS, 26 to 130.
LARGE STOCK FOR QUICK DESPATCH.
IGRANIC ELECTRIC Co LTD 147, Queen Victoria St., London.

SIEMENS

STANDARD
ELECTRIC MOTORS


For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

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Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: City [illegible]. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—[illegible], Bridge Street.
Cardiff—[illegible], St. Mary Street.
Glasgow—[illegible] Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs.
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

P.P. TURBO-PUMPS.

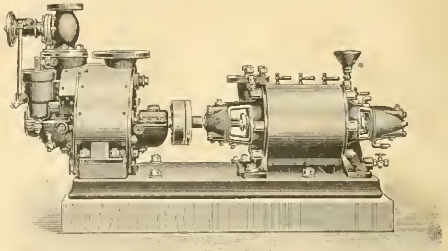
According to their new catalogue the essential feature in which the P.P. turbo pumps made by the Power Plant Co. differ from other designs is the patent diffuser. This part is so arranged that the water enters and passes it with hardly any change of direction. The diffuser passages, which start almost tangentially where they adjoin the outer surface of the impeller, are gradually widened axially towards the next stage and at the same time smoothly curved spirally towards the inlet of the next impeller. As the direction of the water flow does not change from the tangential into the radial direction, the number of guiding passages can be reduced to a minimum. The pumps with patent diffusers, in combination with scientifically designed impellers and up-to-date mechanical construction, [illegible] losses due to friction or eddies, and give the [illegible] of great suction lift, high efficiencies, [illegible], low [illegible] moderate prices.

[illegible] regard to the [illegible] to capacity of pumps, to the pressure, [illegible] less than [illegible] and the further [illegible] it is essential to use motors with a fair margin of power. The following table contains the margins recommended for a range of power consumptions:—Motors up to 2 H.P., 25–30 per cent. more than horse-power required by the pump; motors up to 10 H.P., 20–25 per cent. more than horse-power required by the pump; motors up to 50 H.P., 10–20 per cent. more than horse-power required by the pump: motors over 50 H.P., 10–15 per cent. more than horse-power required by the pump.

Should the pump be driven by a belt, 5–10 per cent. are to be added to the horse-power to cover friction loss. For spur-gear driven pumps 2–5 per cent.

The casing of the P.P. pump is normally made of cast-iron, but will be built for special purposes in special cast-iron, bronze, cast-steel or for small lifts in hard lead.

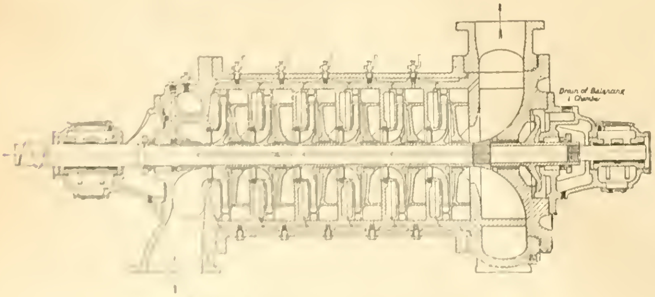
High-pressure pumps are built in sections. In the smaller sizes (up to 3 in.) these sections are held together by through bolts. In larger sizes, however, the various stages are assembled in a cylindrical outer casing. As the whole water pressure is taken by the inner stage casings, this outer casing can be very light and merely serves to hold together the suction and delivery end and to centre the various stage casings. This patented design renders it possible to dismantle the entire pump from the delivery side without breaking either suction or delivery pipe-joint.


Steam Turbo-driven "P.P." Pump.

Low-pressure pumps have casings made in one piece. They can be dismantled from the suction side. Suction and delivery branches are placed either in the vertical or horizontal plane through the pump axis.

The impellers are made of phosphor-bronze or cast-iron. They are specially constructed for any particular capacity, carefully balanced and fitted with renewable sealing rings which are designed in a special way on the labyrinth-sealing principle. The diffusers are made in cast-iron or phosphor-bronze and are carefully machined. The stuffing box is water-sealed on the suction side and fitted with metallic packing which is held in position by soft packing rings. By applying this metallic packing the stuffing box cannot get hot and friction losses are reduced. The bearings are either of the ring-lubricated type or ball bearings. They are of ample dimensions.

The shaft is made of Siemens Martin steel or nickel steel. The impellers are fixed by leather keys or Patent Woodruff keys and nuts and can easily be removed. The balancing of the axial thrust in high pressure pumps is effected by means of a hydraulic balancing device which automatically adjusts itself for any variation of head and capacity, or for any wear that may take place. Our balancing



Section through "P.P." Turbo Pump.

Impeller for Axial Pump for 20,000 gallons per minute.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

Hopwood St. Mills,
PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union.

BELLING

FIRES
GRILLERS
BOILERS
OVENS

ALSO ALL KINDS OF SPECIAL ELECTRICAL APPARATUS FOR MUNITION WORKS & MANUFACTURING PURPOSES

BELLING & CO.,

ELECTRIC COOKING & HEATING SPECIALISTS,
Derby Road Works, Montague Road,
UPPER EDMONTON, LONDON, N.

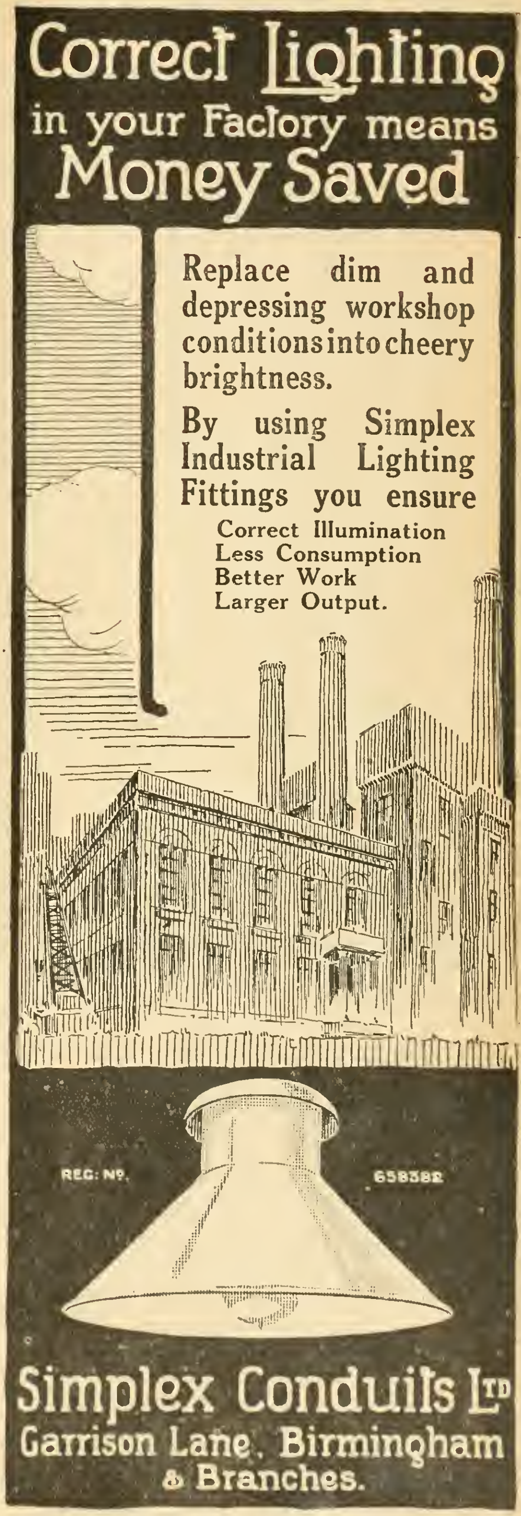
. SHOWELL & SONS, LTD
STIRCHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.

Tapped Standard Whitworth and B.A. Standard.

Made from No. 1 tapped ⅛" to No. 9 tapped [illegible]".

Sole Agent for the Electrical Trade:
LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.
TELEPHONE: *Holborn* 6323.



Correct Lighting in your Factory means Money Saved

Replace dim and depressing workshop conditions into cheery brightness.

By using Simplex Industrial Lighting Fittings you ensure

Correct Illumination
Less Consumption
Better Work
Larger Output.

Simplex Conduits Ltd
Garrison Lane, Birmingham
& Branches.

LOAD AND EXPERIMENTAL
RESISTANCES
MADE TO ANY SPECIFICATION.

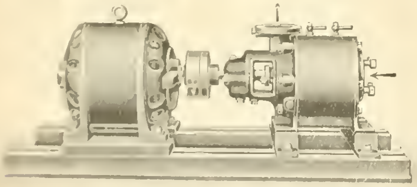
Particulars of Standard Types will be found in our List, to be had on application.

RAPID DELIVERIES GUARANTEED.

ISENTHAL & CO.,
(DEPARTMENT 4)
Denzil Works, Willesden, London, N.W.

Contractors to the Admiralty, War Office, India Office
Colonial Office, Postmaster General, etc.

[illegible] extremely sensitive and a perfect balance is maintained without the use of any thrust bearing. The couplings are P.P.



Motor Driven "P.P." Pump.

[illegible] taper [illegible] The direction of rotation is marked by an arrow on the [illegible] It is clockwise as viewed from the [illegible] end of the pump.

"TRICITY" ON THE UNDERGROUND.

With [illegible] as freely available, one would expect that the [illegible] Electric [illegible] of London would not only think [illegible] so far as the travelling public is concerned, but also in [illegible] the staff and [illegible]. Evidently some step is being [illegible] possible to record that a complete [illegible] staff of the Under-ground [illegible] in premises adjoining Earl's Court Station. [illegible] house within hail of [illegible] road. It is made [illegible] which leads into the [illegible] told the "fair" ladies [illegible] Circus, to enjoy an [illegible]. Presumably the [illegible] sufficiently [illegible] 20 minutes for the [illegible] been provided on the first [illegible] in connection with the reading [illegible].

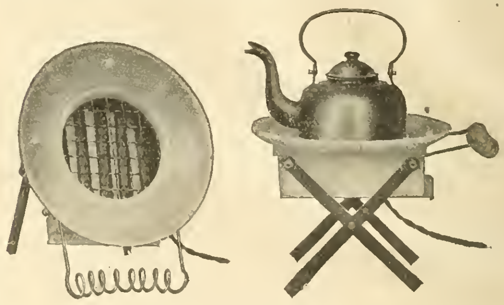
The apparatus upon which the principal burden of the cooking is imposed for about 200 meals daily is all of "Tricity" manufacture and comprises four single ovens, each fitted with two ribbed hot-plates loaded to 1,800 watts on "high" and 500 watts on "low." There are also five plain extension boiling rings with the usual utensils, fish kettle, ham boiler, saucepans, irons, &c. Each of these boiling rings has a loading of 850 on "high" and 250 on "low." The total loading for the entire "Tricity" installation is approximately 12 kw. This apparatus has all been manufactured by the British Electric Transformer Co., and supplied through their sole selling agents, Messrs. Gillespie & Beales.

In addition there are two hot-water boilers, one steamer and several hot water cupboards supplied by the Jackson Electric Stove Co.

"BEAM" ELECTRIC FIRES.

The mornings and evenings are still "snappy," although the spell of wintry weather is broken. The fire makers and dealers, of course, would like to see the good old-fashioned winters again, but, after all, they cannot complain this year that Jack Frost has not done them a good turn.

Enterprise Mfg. Co. (Messrs. Ashdown & Roberts), of Gun-street Electrical Works, Bishopsgate, London, E.C., send us their list of electric heating and cooking devices, among which are the "Beam" fires illustrated herewith. The style shown is No. 1 of a series of four fires, Nos. 1A, 2 and 3 being rather more expensive. The heating element is designed for 1 and 1½ unit loading and the finish is either plain black or vitreous enamelled. The fire is of simple construction, and, as the illustrations show, can be tilted to act as a fire, throwing its heat forward, or placed horizontally to act as a boiling ring for a small kettle. Such a heater should be most useful in small offices in which it is now becoming more and more necessary (let alone patriotic) to make one's own tea. The fires are inexpensive and are made under Patent No. 2,250/15. Copies of the list can be had from the company on application.



"Beam" Convertible Fire.

INDUSTRIAL HEATING FOR SHOE FACTORIES.*

BY DAVIS M. DEBARD.

Electricity has replaced the high-pressure steam boiler for industrial heating purposes in many shoe factories. After three years of continuous effort the Brockton Edison Co. succeeded in substituting electrically heated machines for all machines requiring steam heat in one of the shoe factories in Brockton, and the results have been most gratifying. The factory referred to has an output of 700 pairs per day and the shoes manufactured are men's Goodyear welt shoes, retailing from 16s. to 24s. per pair.

The machines electrically heated, with their connected loads, are as follows:—

No.	Machines.	Kw. each.	Total kw.
2	Goodyear Stitchers	0·62	1·24
2	Goodyear welters	0·48	0·96
1	Bobbin winder	—	0·40
2	Pulling over machines	1·47	2·94
4	Box toe steamers	0·75	3·00
1	Bottom drier	—	2·28
1	Bottom filler	—	0·55
1	Gem insole machine	—	2·86
	Total connected load		13·93

A watt meter has been installed on each group of machines, and

---

* In "Canadian Electrical News."

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

"Greatly begin! Though thou hast time
But for a line, be that sublime—
Not failure, but low aim, is crime."
LOWELL.

Well Lowell, we have used our time
On many lines, mostly sublime;
And ever up the ladder climb.

If, rarely, we have gone awry,
'Twas not because we failed to try,
But only that we aimed too high.

Yes, we are human enough to err at times, but our customers don't have to pay for the misfires; indeed they profit by our experience.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phones: Victoria 4026 Grams: Vicminster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. Feb. 16.*

Cork for Insulating
(Compressed similar to "Suberite").
Having the agency from cork manufacturers
in Spain, we solicit inquiries.
JULES LANG & SON, Charlton Works, Charlton Place
Islington, London, N.

WE SPECIALIZE *in Electrical*
Varnishes, Compositions,
Enamels etc.
Write for List :—
JENSON & NICHOLSON LTD INSULATING VARNISH DEPT
GOSWELL WORKS, STRATFORD, E.

below is given a record for July, August and September of shoes made and kilowatt hours for each operation:—

JULY.

Shoes manufactured .... 14,821 pairs.
Total kilowatt-hours for heating machines .... 2,570 kw.h.

No.	Machines.	Kw.h.		Kw.h. per 100 pairs.
2	Goodyear stitchers	312	......	2·1
2	Goodyear welters	217	......	1·5
2	Pulling over machines	534	......	3·6
4	Box toe steamers	620	......	4·2
1	Bottom drier	640	......	4·3
1	Bottom filler	171	......	1·2
1	Gem insole machine	76	......	0·5
				17·4

AUGUST.

Shoes manufactured .... 16,998 pairs.
Total kilowatt-hours for heating machines .... 2,965 kw.h.

No.	Machines.	Kw.h.		Kw.h. per 100 pairs.
2	Goodyear stitchers	369	......	2·1
2	Goodyear welters	232	......	1·4
2	Pulling over machines	616	......	3·6
4	Box toe steamers	724	......	4·2
1	Bottom dryer	610	......	3·7
1	Bottom drier	741	......	4·3
1	Bottom filler	211	......	1·2
1	Gem insole machine	72	......	0·4
				17·2

SEPTEMBER.

Shoes manufactured .... 16,468 pairs.
Total kilowatt-hours for heating machines .... 2,841 kw.h.

No.	Machines.	Kw.h.		Kw.h. per 100 pairs.
2	Goodyear stitchers	341	......	2·1
2	Goodyear welters	240	......	1·4
2	Pulling over machines	615	......	3·7
4	Box toe steamers	707	......	4·3
1	Bottom dryer	610	......	3·7
1	Bottom filler	179	......	1·1
1	Gem insole machine	149	......	0·9
				17·2

No boiler in operation for steam.

There are also a few other machines in this factory, as in every factory, heated by gas. It is fair to assume that these machines, if electrified, would require 2·8 kw. hours per 100 pairs, making the total for industrial heating 20 kw.h. per 100 pairs. It is unnecessary, however, to devote our efforts at present to electrifying these machines, because we believe that after the steam machines are [illegible] these will surely follow. With current at 1d. per kw.h. the cost for industrial heat per 100 pairs would be 1s. 8d.

In going over the kilowatt hours consumed, given above, it is interesting to note how uniform the current consumption has been and how other conditions have affected the consumption of the bottom driers—July and August having been rainy and damp, the consumption was higher than in September, when the weather was dry and clear, with practically the same output.

Heretofore one of our greatest problems in interesting the shoe manufacturer in electric service for power, has been the machine heating problem. But now being able to tell him that electrically heated machines can be substituted for the steam heated machines, he becomes interested because:—

First. He is relieved of the trouble and large expense in operating a high-pressure boiler, requiring a licensed operator, who in Massachusetts is not permitted to leave the boiler-room for more than 15 minutes at a time.

Second, he can apply heat to any one or more machines when and where needed.

Third, he has perfect control of heat.

Fourth, his costs are proportional to his output.

Fifth, his costs are less than by the high-pressure steam method.

In collecting data from a number of shoe manufacturers purchasing light and power from us, but operating high-pressure boilers for industrial heating, we find that during the months of June, July and August, when no factory heating was required, the coal used 100 pairs of shoes made, runs between 90 lb. and 191 lb., the average being about 125 lb. per 100 pairs made.

Take the factory using 90 lb. per 100 pairs for industrial purposes and analyse costs for one year:—

Shoes manufactured one year	pairs	304,000
Coal for industrial heating and factory heating, 307 tons	pounds	687,000
Water evaporated	cubic ft.	76,400
Engineer, at £4 16s. per week		£249 12 0
Coal, per ton		1 2 0
Water, per 100 cubic ft.		4 0

a basis of 90 lb. per 100 pairs for industrial heat, 273,600 lb. of coal would be required, while 414,080 lb. or 185 tons would remain for factory heating.

COMPARATIVE HEATING COSTS.

Operating Costs—High-Pressure Boiler and Steam for Industrial purposes.

Coal, 307 tons at 22s.	£337 14 0
Water, 76,400 cubic ft. at 4s. per m.	15 6 0
Engineer, £4 16s. a week	249 12 0
	£602 12 0

Operating Costs—Low-Pressure Boiler and Electricity for Industrial Heating Purposes.

Coal, 185 tons at 22s.	£203 9 0
Water, 46,000 cubic ft. at 4s. per m.	9 4 0
Labour for heating 30 weeks at £2	60 0 0
52,288 kw.h. at 1d. per kw.h.	209 3 0
	£481 16 0
Makes saving to shoe factory per year	£120 16 0
Per cent. saving—25 per cent.	

In 1907 the company started a power campaign and by establis a fair power rate and continually soliciting this class of busi particularly the shoe business, which is Brockton's greatest indu it can now safely say that 70 per cent. of the shoes made in the trict by the company are made on electric power, and now tha heating problem has been eliminated, we hope to make it 90 per In the district served by the company's lines, 25,000,000 pai shoes were made during the year 1915.

We find that the owner of the shoe factory is like the man f Missouri; he wants to be shown that electrical industrial heating success. We have demonstrated that it is, that the operators of t machines like it, that the cost is less and that the very best resul are obtained.

If the central stations having shoe factories in their district ca get one factory equipped, give it newspaper publicity, and do as w have done in personally conducting a number of shoe factory super intendents and owners through the electrified factory, it will do mor to secure the majority of this excellent business within the next five years than any other method.

"THOR" High Grade Specialities
CASING and CAPPING
CONDUIT
CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
WRITE FOR PRICES & DISCOUNTS
HASLAM & STRETTON, Ltd., Windsor Place, CARDIFF & Bristol Bridge, BRISTOL.

One, Two & Three Phase
MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

REYROLLE'S

SIX SPECIAL LINES

(1) 500-v. IRONCLAD **SWITCH FUSES.**

(As Illustration.)

50 and 100 amps. capacities.

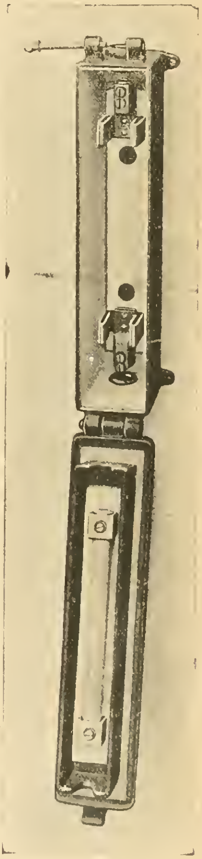
Deals satisfactorily with short circuits.

Fireproof Linings.

Easy and safe for re-wiring.

No costly refills required.

Ordinary fuse wire used.



(2) **MOTOR STARTERS.**

Drum Type with Free Handle Circuit Breaker (interlocked), also Lever Type.

(3) **WALL PLUGS.** W.T., for outside use, as supplied to Admiralty, and Dustproof for Works use.

(4) **H.T. ARMOURCLAD SWITCHGEAR.**

(5) **MINING SWITCHGEAR.**

(6) **PROTECTIVE DEVICES,** to isolate faulty sections on Power Supply Systems without interruption of supply through Sound Sections.

A. REYROLLE & CO., LTD.

HEBBURN-ON-TYNE, England.

On War Office, Admiralty and India Office Lists.

ON MANY MACHINES

quick starting and stopping is of the utmost importance. Line your clutches and brakes with Ferodo fabrics and you secure the maximum acceleration and deceleration, for Ferodo fabrics engage sweetly and without jerk providing perfect transmission, whilst they absorb more foot-lbs. of energy per square inch than any other material known. The adoption of Ferodo lined brakes on the Underground Railways of London resulted in a four-minute service being converted into a minute and a quarter service owing to the rapid deceleration. In addition Ferodo fabrics prevent fire and short-circuit caused by metal dust resulting from the metal to metal brakes, and they have proved to be three times as durable as the chilled cast-iron shoes previously used.

FERODO

CLUTCH AND BRAKE LININGS.

Contractors to the War Office and Admiralty, London General Omnibus Co. and Underground Electric Railways of London and Paris. List "X" from

The Herbert Frood Company, Ltd.

Works: CHAPEL-EN-LE-FRITH.

'Phone: 19 and 20 Chapel. Wires: "Friction, Chapel."

We hold stocks at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester and Newcastle.

BRITISH INDUSTRIES FAIR, 1917.

The third British Industries Fair opened on Monday last in the Victoria and Albert Museum and the Imperial Institute, and, in spite of the restrictions imposed by the war, it is larger, both from the point of view of the number of exhibitors and from the area covered, than it was last year. In order to obtain the increased accommodation, it has been found necessary to house the toy section in the Imperial Institute. The pottery and glass section, the fancy goods section and the printing and stationery sections remain, however, in the Victoria and Albert Museum. From the point of view of the number of exhibitors, the toy section is the strongest section in the Fair, a fact which is interesting when it is remembered that prior to the war the toy trade was practically non-existent in this country. Several toy exhibitions have been held in past years, but the toy section of this year's British Industries Fair is a far stronger exhibition of toys than any of the fairs devoted exclusively to that industry. And this too, in spite of the fact that only manufacturers are entitled to exhibit, and that there will be no foreign firms and no wholesale firms, as there have been at the privately organised toy fairs in the past.

In the glass section there is an interesting exhibit showing the success which has been made in the manufacture of chemical glass; no less than six firms are showing chemical glassware, which was before the war almost entirely manufactured abroad. The china section, too, contains specimens of laboratory porcelain, an almost exclusively German product previous to the outbreak of war. There is not the same demand for high priced luxuries that there was at the [illegible] of the last Fair, but manufacturers are making attractive exhibits, for they realise that the demand from abroad for English goods, now that German competition has practically stopped, is as high if not higher than ever. Many manufacturers have stated that they will make no effort to supply the home demand until they have satisfied that of the shippers and exporters, as by so doing they will be bringing new money into the country.

The Fair, which will be open from 10 a.m. to 6 p.m. each day, will close on March 9th, and by that time it is expected that a considerable proportion of the 20,000 British buyers to whom invitations have been sent will have visited the Fair. Invitations have been issued to about 1,000 firms in neutral countries and the Dominions, but it is, of course, uncertain how many will be able to come.

NEW BENJAMIN CATALOGUE.

The attention of light users in commercial and industrial concerns is being called by Benjamin Electric, Ltd., to their new catalogue of scientifically-designed reflectors. These are intended for service in connection with half-watt lamps and lamp clusters of various sizes. The half-watt fittings listed are of the distributing, the concentrating and the 45° angle parabolic types. We illustrate the open or hooded pattern herewith, and this is suitable for indoor or outdoor use; in the latter case a suitably shaped canopy is placed over the holders. The reflector is supplied 12 in., 15 in., 18 in. and 21 in. diameter; the height varying from $4\frac{3}{4}$ in. for the smallest diameter reflector to $12\frac{1}{2}$ in. for the largest.

Half-watt Reflector Fitting.

The cluster reflector fittings are of the wireless type and are designed to meet the demand for substantially made lighting units for foundries, factories, textile mills and engineering works generally. They are listed in 15 in. and 18 in. diameter sizes for pear and spherical lamps.

Extensive and Focussing Type Vitreous Enamelled Steel Reflectors.

Benjamin steel reflectors are now well known in lighting circles and in the list referred to are put forward in styles A, C and D; the two first being "Ezekleen" reflecting surfaces and the latter being vitreous enamelled. Illustrations of the latter are given herewith.

A variety of other Benjamin lighting accessories and specialities are described and priced in the list.

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

THE ROUND TABLE.

By "KVA."

Event of the Week. Glasgow invites tenders for a 15,000 kw. turbo-set (and Mr. S. L. Pearce probably thinks that his Manchester sets of the same size are now a bit on the small side).

* * * *

C. T. S. Brooking is nothing if he is not humorous in his advertisements. A Ponders End correspondent sends me a cutting from a contemporary, which shows the St. Helens Cable corrosion proof fittings attached to a half-*wall* lamp. You may always count on "C. T. S. B." making people read his ads.

* * * *

The restricted import of apples will, I am afraid, put an end to that delicately flavoured dish "Tricity Apples and Cream." This is a pity, for many of the gas advocates have, I believe, always fancied this altogether exclusive item in the *cuisine électrique* at The Tricity House.

* * * *

I hope that Mr. H. E. Blain will extend his staff dining rooms, with electric cooking, to other parts of the "Underground." It is deplorable to think that gas is employed for any purpose on so popular and so exemplary an electrical institution as our beloved "Underground."

* * * *

"The Electrical Contractor" in the midst of a tirade against fuses, fuse boxes and fuse makers generally, works itself into a splutter of misprints and decides in a frenzy that the contractor "will have no alternative but to bridge the *contracts* with a dangerously short length of bare wire." Our contemporary seems within dangerously short distance of becoming "The Electrical Contactor" if the "r's" get out of place like this!

* * * *

From this week's "Punch"; sketch of lady before gas fire :—

Old Lady (ruminating): "What a poor supply of gas there is. Ah! well, I mustn't grumble. Perhaps we are attacking with gas at the front to-day."

By the irony of fate this delightful quip is faced with an advertisement of the British Commercial Gas Association working off the T.N.T. stunt!

* * * *

Thus does the "Gas Journal" confuse issues, and take a delight in so doing :—

As a little corrective for the "Lest we Forget" organ of the electrical industry, we reproduce the following paragraph from a daily newspaper: "An electric train from Waterloo to Shepperton caught fire yesterday just beyond Earlsfield Station. It was taken back to Earlsfield, where all the passengers alighted, and were later transferred to another train. The damaged coaches, in which the fire was soon extinguished, were subsequently removed from the line."

* * * *

A Newport correspondent sends me an advertisement from a London weekly illustrated paper, which extols the merits of a certain electric torch light. Great stress is laid on the fact that "the strongest wind will not blow it out"!!! The announcement is headed with the line from the well-known hymn, "Let there be light," and probably this explains the need for the reference to the light being immune from risk of dowsing. In the early days of the industry it is on record that in quite a number of electrically lighted churches the singing of this hymn has been interrupted by the blowing of the main fuse or a breakdown at the station! Verb. sap.!

Levitation is one of those delightful states into which it was possible to get oneself before the war. The price and availability of the raw material made it possible. But a correspondent sends me a printed circular letter, from which I gather that it will, after the satisfactory conclusion of the initial experiments, be possible to achieve levitation by electrical means. I cannot find room for the whole document, but here are a few extracts :—

> With the object we hope of interesting you, we have pleasure in enclosing particulars concerning Levitation.
>
> It has been established from previous laboratory tests that a weight of more than 100 lb. can be held suspended in the air by means of magnetic repulsion for an indefinite period and at inconsiderable expenditure of electric power. The company's task is to prove that a heavy weight, say, 10,000 lb., can be similarly levitated. It is very generally conceded that if you multiply the number of magnetic repulsive coils, each supporting, say, 20 lb., you can multiply in the same ratio the total weight that can be levitated; present experiments will settle this beyond the possibility of controversy.
>
> We have strong reasons to believe that the power required to hold levitated a heavy weight for a considerable period will be found after full trial to be surprisingly below general expectations; but even in the event that the results from first experiments show that a much greater volume of electricity is required than is at present anticipated, this need not necessarily be looked upon as a discouraging factor. We do not pretend that finality will be obtained in the early tests. Further improvements will follow to a certainty in the construction of repulsive coils, and fresh inventions made from time to time for economising electric power in various ways, so that gradually the consumption will be reduced to lower and still lower limits.
>
> When the force of magnetic repulsion is applied in actual practice to the levitation of heavy weights, it is just possible that the views of engineers and other technical people by whom we are advised may prove to be founded on erroneous data; we do not consider this likely, but it is just possible.
>
> In these circumstances we wish to emphasise the point that, should you care to consider an investment in the company now being formed, it must be on the clear understanding that if Levitation as a commercial proposition proves to be an impossibility, the shares of the company may possibly become valueless. On the other hand, should this wonderful natural force, concerning which so comparatively little is known at present, be demonstrated as applicable to commercial purposes, as we hope and believe to be the case, then those who associated with us in the undertaking from the commencement will realise enormous profits.

The letter is addressed Dear Madam; I suppose, because it is presumed that all the men are at the front.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), March 6, 1880.]

Electricity v. Gas.—At the tenth annual meeting of the Manchester District of Gas Engineers, held last week, Mr. Chew, of Blackpool, read a paper on "Three Months' Experience of the Working of the Electric Light." He described the experience with, and the result of the practical trial of, the new illuminating power as a means of lighting up the Blackpool promenade and piers, then entered at some length into the question of cost, and stated "that the capital expended in the case of Blackpool was £2,800. The working expenses were £3 6s. 10d. per night of five hours. With respect to the question of electric lighting in general, he entertained no fear that it would ever supersede gas, pointing among other things to the difficulty which must inevitably be occasioned if gas were used as a general illuminating power, by the fact that electricity could not be stored, but must be produced as required; so that the apparatus would have to be continuously at work for the benefit of consumers who might require light during the day or night. He also referred to the difficulty of increasing the number of lights beyond a certain number in one circuit, so that the small lights could not be produced as economically as large ones. He saw no cause for alarm, for he was sure that electricity, with its delicate automatic cut-off arrangements, which would soon get out of order, would never be used for the illumination of dwelling-houses and such-like purposes, though for lighting public squares, large halls, &c., it might enter into competition with gas. In the discussion which followed, the ex-president (Mr. Newbiggin) expressed his opinion that electricity was simply an expensive luxury in lighting.

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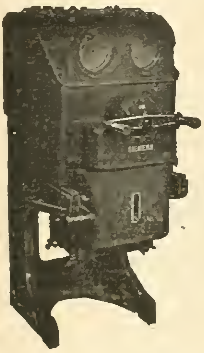

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IGRANIC CONTROLLING DEVICES.

We feel sure that electric power engineers, particularly those having charge of industrial motor installations, will be interested in the new file of leaflets which the Igranic Electric Co., Queen Victoria-street, London, E.C., have just published. We understand that it is not a complete catalogue of the company's products, but may be considered as representative of the wide range of controlling apparatus which they manufacture.

In a foreword the company describes its business in four words, "makers of electric controllers." In this preface a number of interesting "opposites" are cited. The company makes controllers for governing the revolutions of a washing machine, and the raising and lowering of the ponderous bastule of a movable bridge: they also produce little 5-contact starting switches for the organ motor in the village church and remote-control systems for iron and steel mills, or docks and mines. It is pointed out that the company has made controllers for 20 years, and that much that they did not know in the beginning they have since learned by experience, and that experience is placed at the disposal of those who are confronted with problems involved in electric control.

Turning now to the arrangement of the leaflets, these are grouped into four parts: (1) direct-current controllers, (2) alternating-current controllers, (3) controlling devices for alternating and direct-current circuits, and (4) magnets. Following the index is a table which gives the average normal full load current of motors, both direct and alternating current, at different voltages. It is pointed out that the resistance in Igranic rheostats is calculated to carry at starting a current [illegible] in excess of the normal full load current of the motor. Following this are notes on installing rheostats and [illegible] abnormal starting currents. We reproduce these [illegible] of general interest.

Installing Rheostats.—"A rheostat is a device for controlling or limiting the current in an electrical circuit by the insertion of resistance. This resistance transforms a portion of the electric energy into heat, which heat must be carried away. The most practical way to dissipate heat is to supply proper ventilation. Therefore every rheostat must be so installed that the air will have free access to it on all sides. This means that a rheostat is not a thing that can be installed in some out of the way place and boxed up, or surrounded by other objects which would obstruct the free ventilation. The best place to install a rheostat is on a wall or a post. When placed on the floor or on the ceiling, space should always be provided under and over the rheostat to allow of a free circulation of air through the resistance."

Abnormal Starting Currents.—"It frequently happens that motors are called upon to start under a load which requires a starting current much greater than the continuous carrying capacity of the motor, even though the motor may operate within its rated capacity after it has been brought up to normal speed. In order successfully to sell starting rheostats we have to make them in different sizes and guarantee what each size will do and agree to sell it for so much money. When a customer sends us an order for a starter without any information we send him one which will withstand a starting current 50 per cent. greater than the normal rating of the motor, for a limited time, and stamp this starting current on the name plate. This 50 per cent. excess is the momentary surge of current which may occur on cutting out a section of the starting resistance when accelerating a loaded motor. A well constructed motor, however, will withstand a starting current temporarily, two or three times as great as its normal rating, and when such starting current as this is necessary it simply means that a larger starting rheostat should be used. If we built all our starting rheostats capable of standing these excessive starting currents they would cease to be starting rheostats and become speed regulators, costing from two to three times as much."

There is a useful table occupying leaflet No. 7, which gives the numbers in the new leaflets which correspond with the numerical indexing of the old catalogue.

The various parts of the file of leaflets are further subdivided and the classification should materially assist the work of reference, more particularly as there are now so many specialised forms of starters, controllers and regulators. In the case of direct current, which occupies part 1, there are seven sections which deal respectively with motor starting switches, motor starting and controlling panels, starting switches with speed regulation, field rheostats, main switches, accessories, and controllers for special duties. Part 2, which deals with alternating-current apparatus, is divided into four sections, which deal with motor starting switches, oil switches, accessories and controllers for special duties. In part 3 are to be found particulars of controlling devices for lighting circuits, and these are sub-grouped under three headings of dimmers, switches and accessories. In the section dealing with magnets will be found particulars of lifting magnets and such magnetic specialities as separator pulleys, disc brakes and magnetic couplings and clutches.

The ubiquity of the machine tool at the present time and its influence upon the conduct of the war is probably responsible for the developments in connection with the control of machine tool motors and the provision of automatic and semi-automatic machine tool controllers. We notice that there are several leaflets which deal very fully with this feature of the Igranic company's business, and it is interesting to note that systems have been standardised for equipment from 1 H.P. to 50 H.P. There is a special leaflet which is devoted exclusively to push-button control for motor driven planers and vertical slotters.

We shall hope to return to the subject of this catalogue in a future issue; meantime we recommend those installation engineers who have not yet had copies to make early application to the company at the address given above.

ELECTRICALLY-OPERATED SCRUBBING MACHINE.

An electrically operated scrubbing machine is being placed on the market by the Dale-Rey Corporation. This machine wets, sweeps, scrubs and dries the floor at a single operation. It requires only one attendant, who merely pushes the machine forward and guides it. The amount of water distributed on the floor is controlled from the handle. This water is immediately swept up by a cylindrical brush 16 inches wide and 20 inches in circumference. This brush is driven by a [illegible] H.P. motor, chain connected, and revolving at the rate of 600 revs. per min. The brush scrubs and carries the dirt and soiled water over an apron into a separate receiving pan so that clean water is being continually used. The tank has a capacity for eight gallons. An upright, with cord reel attachment, keeps the wire away from the floor and the operator. Current may be taken from an ordinary lighting socket. The weight of the outfit is 100 lb. and it is claimed an attendant pushing it forward at a rate of one mile per hour can scrub an area of nearly 5,000 sq. ft. per hour, or about five times the area that could be covered by hand in the same time.

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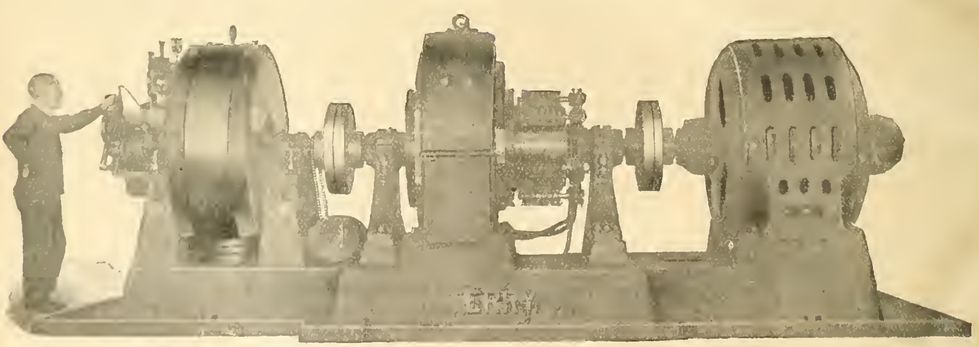
LARGE EXCITER UNITS.

The three large exciter units which are now being installed in the new power plant of the Buffalo General Electric Co. have a number of instructive features. Probably the most interesting point is that the plant is insured against loss of excitation by providing two independent sources of power for driving each exciter. Each unit consists of a 300 kw. exciter direct-connected to an induction motor at one end and to a steam turbine at the other end. The governing mechanism of the turbine is so arranged that if the power for the induction motor should fail, the turbine would automatically pick up the load. In case of trouble on the main circuits, the exciters can be depended upon to take care of themselves without attention, and the operators can give all their attention to clearing up the trouble on the main circuits, while with ordinary motor-driven exciters the exciter units shut down as soon as the voltage of the main circuit fails, and it is necessary to start up an independent unit before voltage can be restored to the main circuits.



TURBO-DRIVEN DOUBLE EXCITER.

Another advantage of the duplex exciter drive is that it gives the exciter unit a higher all-day efficiency than either a motor-driven or a steam-driven exciter. This maximum efficiency is secured by driving the unit from the turbine end when the station is operating at full load and the turbine exhaust can be used efficiently in the heaters, and by shifting the drive to the motor end when the station load is light, and the main generators can easily carry the exciter load.

The large capacity of the units (300 kw. normal) and the high pressure and temperature of the steam supplied to the turbine (275 lb., 275 deg. superheat), as well as the duplex drive feature, make these units worthy of note. The turbines were manufactured and the units assembled by the Terry Steam Turbine Co., Hartford, Conn.

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NEW TRADE PUBLICATIONS.

EDISWAN BATTERIES.—The Edison-Swan Electric Co. is issuing to the trade an attractive card printed in several colours and it should help to encourage sales of "O.K." "E.C.C.," ESCO" and "H_2O" primary batteries. Needless to say these are entirely British and the card calls attention to this fact and also that the batteries are "on sale within." Traders who are able to do business in these useful articles should take in a stock of batteries and put the Ediswan show-card in the window to sell them.

POWER CIRCUIT BELLS.—The General Electric Co. has just sent out pamphlet L. 2092, which describes and prices a series of bells designed for use on power circuits. Among these are weather-proof and gas-tight and water-tight bells with bell-metal gongs.

SMALL MOTORS.—A new list of small alternating and direct current motors is now available from the General Electric Co.

Z LAMPS.—A variety of folders dealing with Z Lamps in all their sizes and styles is being sent out by the Z Electric Lamp Mfg. Co., Southfields, London, S.W. They call attention to traction, flashlight, motor-car, candle and sign and illumination type lamps. One folder is devoted to emphasizing that Z Lamps can be obtained from stock in Manchester, at the company's depot, 60, Long Millgate.

SIMPLEX LONDON EXTENSIONS.

There will be no need for us to introduce to London and district electrical contractors the Simplex electrical rendezvous in Charing Cross-road, which has been there for a number of years, and thinking of Simplex one thinks of Charing Cross-road and vice versa. For some time past the company has had to subdivide its London accommodation owing to the bulk of the premises over its spacious showroom on the ground floor being occupied by other tenants. We now understand that this disability has been removed and the arrangements will shortly be completed whereby Simplex in London will be housed in one building. From the point of view of the trade this will be an advantage: those who require conduit, fittings, lamps, glassware and general accessories will all enter by the same door, although they will get what they want on different floors.

Under the guidance of Mr. E. P. Bennett, the genial manager of the company's London branch, we have this week been shown over the new premises, or rather that portion of them with which we have not previously been familiar. The arrangement with respect to the showroom will be as before, and we do not need to say that this has always been an attractive feature of the London house. The heavier items in the company's business, such as conduit, conduit accessories, iron boxes for switches, distribution boards, &c., will, as formerly, be found in the basement. On the first floor the company has set out commodious offices for the administrative and clerical staff, and these are furnished in modern style and lighted in accordance with the best accepted Simplex illumination ideas: in this respect we may make special reference to the enamelled steel industrial reflectors and the indirect fittings which have been utilised in combination with ½ watt lamps. The net result is an effective, pleasing and restful system of artificial lighting. On this floor is the office of the general manager, Mr. L. M. Waterhouse, and Mr. Bennett and the London staff.

The second floor has been fitted out as a stores for certain classes

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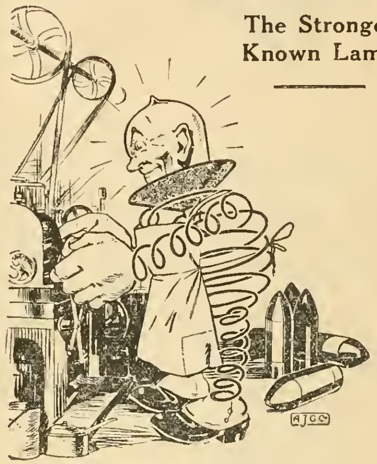

"I am indispensable to War Workers."

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W.

of fittings, glassware, shades and cooking and heating utensils. On the top floor is the stores accommodating a variety of wiring accessories. In future the premises will be known officially as Simplex House, though they have, as we have already said, been the headquarters of Simplexities for many a long year.

The exigencies of the war has compelled the company to employ a large female staff and in this regard we may refer to a particularly cosy rest room, which is fitted with a variety of cooking utensils, which we are sure will be extensively used and prove very helpful.

We feel sure that the many friends of Simplex Conduits will take an early opportunity of paying a call at the new-old premises.

THE FIRE HAZARD OF ELECTRIC IRONS.

The National Fire Protection Association recently sent out an illustrated bulletin drawing attention to the fire hazard necessarily associated with the careless use of electric irons. Unfortunately, the electric is not yet as foolproof as it is convenient, and it is well that users of all electrical equipment should be advised of the necessity of using a certain amount of caution, which in no way detracts from the convenience or usefulness of the articles themselves. The following extracts covering the situation, particularly with regard to electric irons, are taken from the above-mentioned bulletin:—

The Augusta, Georgia, conflagration of March, 1916, involving a property loss of over £100,000, is believed to have been caused by an electric pressing iron left in circuit in the dry goods store in which the fire broke out less than 30 minutes after closing. Whether or not this surmise is correct, it is obvious that small fires easily become conflagrations when conditions are right, and that among the innumerable fires occurring from pressing irons, both gas and electric, there may at any time be one productive of a fire of great magnitude.

In New York City alone 16 fires, involving property losses of from £1 to £100, occurred in 1914 from electric pressing irons which had been left in circuit; and 27 in 1915. The 1916 budget of reports is already large, indicating a further increase. The appeal of the electric pressing iron is its convenience; it can be attached to any lamp socket in any part of the house or shop; but in this fact lies a large element of its hazard. These irons are found not only in the home, but also in many manufacturing or mercantile establishments, and the fires usually start from irons which have carelessly been left with the current on. Sometimes where irons are left connected, the current is turned on the circuit unknowingly by some person. Usually any combustible material in contact with the iron ignites. Following is a typical form of fire report:—

This fire was caused by an electric pressing iron being left unattended and connected to the circuit. Fire communicated to the wooden table on which the iron was used, then to the building. The loss amounted to £20 on the building and £4 10s. on the contents. The fire was extinguished by the fire department with chemical fire extinguishers.

Manufacturers, electricians and fire inspectors have long been aware of this hazard and have tried several ineffective means for safeguarding the use of electric irons. The first method was that of special stands so arranged that if the iron were allowed to remain with the current on, the amount of heat transmitted through the stand could not cause a fire. This safeguard was not satisfactory. Many of the stands were poorly designed, others became broken or were inconvenient to use, and there still remained the many instances where the careless person went away leaving the iron on the table instead of on the stand, or with inflammable material over it or against it.

The next step was an attempt to find some way to prevent a person leaving the current on without knowing it. A great deal of skill and ingenuity has been used in this direction with the result that many ideas have been brought forth. The first idea was to place a pilot light in series with the iron so that the current could not be used unless the pilot light was burning. This plan did not prove practicable for two reasons: first, the cost of the special lamp to carry the heavy current (3·7 amperes) used in electric irons; and secondly, the amount of energy consumed by such a lamp. Users often adopted the plan of inserting a short-circuiting plug in place of the lamp, to save consumption of current.

The next step was to connect a small pilot lamp in parallel with the flat-iron or other heating device. This plan has received a great deal of attention by the electric fittings manufacturers, with the result that many attractive fittings called "heater control combinations," are on the market. They may be obtained in several

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capacities and in a wide variety of designs, from the plain switch and socket combination base for use in factories, to the ornamental combination with the bull's-eye ruby glass pilot lamp mounted on a face plate for use in the home. This device, though developed to a high degree, as a remedy for the hazard is not all that could be desired. Such fittings are open to two sources of weakness: first, the little candelabra lamp burns out and need not be renewed since the lamp is wired in multiple with the flat-iron and consequently is not necessary for its operation; the second and more important weakness is that people will so readily go off and leave the iron with the current on despite the burning pilot light danger signal. A third consideration is that the use of such a device confines the user of the iron to one particular electrical connection in a certain spot. This is all right for mercantile establishments, but not for the housewife whose inclination is to plug the iron into any lamp socket in kitchen, nursery or summer piazza. However, this arrangement has undoubtedly prevented a great many fires, at least in shops, by offering a reminder to those who are not indifferent to the hazard, that the current is on the iron.

It is obvious that the problem must be attacked from another angle—that of the iron itself. It should be made "fool-proof." The temperature of a flat-iron for safe and satisfactory use is from 400° F. to 600° F. This temperature is not dangerous, but when the irons as now designed are allowed to remain with the current on continuously, their temperature rapidly increases to 1,200° F., 1,400° F. or even 1,800° F. in some instances, and the iron may reach a red heat. Needless to say, under such conditions any combustible material in contact with it will ignite. A more serviceable arson "plant" could hardly be devised!

It has long been known that it is perfectly possible to safeguard the electric pressing iron within itself. As in the case of the nitro-cellulose motion picture film, cheapness has been the determining factor. It is the American habit of mind to run any fire danger to save a dollar.

It is astonishing that in this interesting field of invention and manufacture there has been so little attention paid to the development of a satisfactory and commercially practicable safety device for electric pressing irons. While this line of invention has not been followed as actively as might have been expected, nevertheless some fairly successful attempts have been made. Certain members of the National Fire Protection Association have used for many years an electric pressing iron once produced by a manufacturer whose ideas of safety were in advance of his time. This device was driven off the market by the cheaper devices which are now causing daily fires. Its heater contained a pool of metal, which when a required temperature was reached, liquified sufficiently to release a spring which ejected the cord plug at the heel of the iron. Another attempt included an automatic switch in the handle cutting off the current when the handle was released. There has recently come upon the market, however, a device in which a thermostatic switch placed in the iron automatically cuts off the current whenever the temperature exceeds a pre-determined range, usually 400°F. to 600°F. This device not only greatly modifies the hazard, but offers many advantages in its practical use. A number of tests of it were made by Underwriters' Laboratories to determine the probability of fire starting from such an iron when left in contact with various combustible materials. The thermostat was set at the maximum of 600 F. and the current turned on. Photographs taken contrasted the result of these tests with similar tests made at the same time with an unguarded electric flat-iron. Apparently with the iron upon a wood surface a maximum temperature of 600°F. will cause a charring or "dry distillation" of the wood, but the tests seem to indicate that the danger of actual fire is not great.

It is to be hoped that in recognition of the undoubted hazard of the ordinary unprotected electric pressing iron, a more extensive development along these and similar lines will be stimulated by the co-operation of manufacturers, central station companies, inspection departments and others, to the end that this very convenient and now almost necessary household and factory appliance may be cleared of its present bad and probably increasingly bad reputation.

The pressing iron at its best is for its intended function, a source of heat. Any source of heat should be carefully safeguarded, and even such types of pressing irons as the one favourably described should be used only in a specific place, with an indicating device for the guidance of the user.—"Canadian Electrical News."

A KISS OF DEATH.

Contrary to expectation, this is not the title of a new film thriller, but the story of a short-circuit on one of our 13,800-volt lines. On a recent Sunday trouble showed on the Fayville line between Hopkinton and the Sudbury dam. On patrolling the line through the woods Charlie Marshall, Hopkinton trouble man, found one of the lines on the ground with a squirrel lying dead beside the wire. Another squirrel was wedged in the cross-arm brace on the pole, and was also dead. On examination it was found that the bodies and noses of both animals were burned. The nature of the burns disclosed the fact that one squirrel was on the line and the other was on the brace, which is rounded. When the little animals touched noses a flash over from line to arm was caused, which burned off the wire and resulted fatally for the unfortunate lovers. Which goes to show that the top of a pole carrying 13,800 volts is a bad place for spooning.—"Edison Life."

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THE ROUND TABLE.

By "KVA."

Bon Mot of the Moment.—"We are within measurable distance of the time when the country will produce all the food we need," says Mr. W. T. Kerr, Borough Electrical Engineer, Hereford, "by a combination of sunshine and electric suasion."

* * * *

One of the best Army stories that I have heard recently is told as an actual fact. An employé of a small firm, engineers, I understand, joined the forces in 1914, and as a good servant was paid his full wages just as in peace time, and was so being regularly paid. In due course his military career developed, and brought him within reach of marriage and happiness. In announcing to his "employers" his intention of taking unto himself a wife he took the opportunity of suggesting that "perhaps they would think fit to give him a rise."

* * * *

George Bernard Shaw has been writing in the "Daily Chronicle" on "The Technique of the War," and his comments on experts in general and science in particular are worth reproducing :—

> But if you ask the technical experts a question on a point of simple fact concerning their weapons or any other part of their technical material, you get answers of startling discrepancy. When the answer to a question is a figure, one authority says 100 and another 20,000. Every playwright is familiar with this phenomenon. He has to consult experts on technical points when his play touches on technical matters (often military, and sometimes medical); and every expert gives him a different answer, and, when he pleads the previous answer, declares that the other expert is an ignoramus. Finally the playwright is driven to conclude that science is a matter of the taste and fancy of the scientist, whilst the conduct of a husband when he discovers his innocent wife concealed in the bedroom of another gentleman is as immutable as the orbits of the spheres are supposed to be—probably erroneously.

* * * *

In his recent remarks on "The Engineer's Club" at Manchester, Mr. Edmund Hill brought in a reference to the "Institutions" and the tendency of the engineer to become a member thereof. Hill's remarks aptly describe London procedure :—

> They will join anything that puts mystic letters after their name, or will, once a fortnight or so during the winter months, let them listen to Papers that are usually excellent under conditions that are always damnable. Imagine, for instance, the case of a man whom fate has made an electrical engineer. He has listened in London to a most interesting Paper and part of a discussion on some hydro-electric scheme. He wants to take part in the debate, but he keeps half an eye on the president, who he hopes will ask him to speak, and the other eye and a half on his watch, anxious to know if he can get to the Waldorf or "The Coal Hole" before closing time.

ELECTRO-HARMONIC SOCIETY.

Last Concert, 31st Season, 1916-17.
Holborn Restaurant (Venetian Chamber), London, To-night, 8 p.m.

Unofficial Programme.

In the Chair, Mr. A. M. Sillar.

Solid Drawn Chorus	"Let's NOT go down the Strand"	*N.S-*
	The Cable Makers' Association.	
Spirit Solo	"Ora Pro Nobis" ...	"*Hyfee*"
	Mr. F. L. Rawson.	
Vulgar Fractionette	"Out, Damned Spot"	*Compounded*
	The Anti-Decimalists.	
Point Naught Glee	"Just a Wee DOT and doris"	*Re-Kurring*
	The Pro Decimalists.	
Splutter Chorus	"If you want to stop a short, fetch a policeman"	*Kopt*
	Lady Sub-station Attendants.	
¼-Watt Choir	"Let the Lower Lights be Burning" (We don't think)	*Winot*
	Tungsten Lamp Association.	
"N.S." Plaint	"They all play the same old game" ...	*Forde*
	Mr. Neville Chamberlain.	
Moonless Solo	"There's a light that's burning in the window"	*Payne*
	Any Special Constable.	
Grizzlette ...	"I'm a devil when I'm annoyed" ...	*Fay*
	"Gas Journal" Memorandist.	
Suspense-ophone	"I h(f)ear you Calling Me"	(*Field*) *Marshall*
	The Conditionally Exempted.	
Hia-Pricesque ...	"Shall Us? Lets!"	*Collins*
	All The Publishers.	

GOD SAVE THE KING!

* * * *

One of the new revues is called "On and Off." We wonder if the title has been inspired by those switching competitions we so frequently read about. Perhaps the author of the revue is a Lektrik certificate holder. The ladies are sure to be very be(s)witching.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), March 13, 1880.]

Screening Magnetism.—M. Jamin finds that a concentric tube of iron 6 mm. thick will screen almost completely an interior core from the effects of an exterior spiral current.

Electrical Proof of Death.—In a recent note we described the use of electricity as the only known means of diagnosing the presence of life in a body apparently dead. This is not a new application for electricity, for electro-bioscopy, as it was called, was known as early as 1792, and was treated exhaustively by Dr. Crimotel, in a work published in 1866 at Paris, under the title of "De l'Epreuve Galvanique." This test may safely be taken as the only reliable one for determining a true corpse.

The Almighty Dollar.—Our cousins are not always so keen as regards business as not to make mistakes. It seems that one Simpson had a patent for insulating wire. This patent was sold to Mr. C. G. Colgate, who requires, according to the ideas of some of the companies, a little too much in the way of royalty. He has obtained from the Western Union and other associated companies 10,000 dollars as a compromise, having claimed 1,000,000 dollars. "Persons wanting cables must send to England for them, and an enormous prohibitionary duty on imported cables is threatened." So much the better for English manufacturers.

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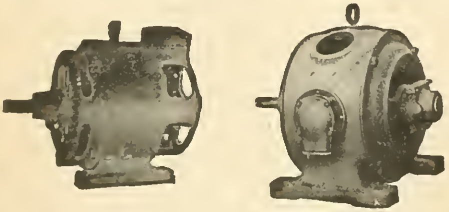

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ELECTRIC MOTOR DRIVE IN PAPER MILLS.

The following article on the use of electric power in paper mills will be of interest at the present time in view of the impending shortage of pulp and paper supplies in this country. The article is reproduced from "Electrical World."

Electric-motor drive for paper mills has many advantages, and often, to quote the opinion of the manager of a large eastern mill, the possible increased production alone will warrant the expense of the change from mechanical to electric drive. Both individual and group drive are used, but individual drive is especially desirable where variable speeds are required, as in the case of the paper machine.

Woods used for paper manufacture include poplar, fir, pine and hemlock. Mills manufacturing wood-pulp paper may be divided into two general classes, those which make the pulp required and those which purchase the pulp. The manufacture of wood-pulp, especially mechanical pulp, involves the use of large amounts of power, and where water power is available it is customary to use it for the grinders and chippers, although electric drive is well adapted to the requirements of these machines and is rapidly displacing water power.

Cotton and linen rags can be converted into paper of different grades, depending upon the colour and quality of the material. The rags are carefully sorted and all foreign material removed, and then again sorted according to quality and cut up into pieces, and later cut to a finer degree by mechanical cutters and the dust removed by machines. The rags are then boiled with suitable chemicals and are ready for the beginning of the machine processes.

In making wood pulp paper, fresh green wood is used for mechanical pulp, as it is more easily ground and produces better fibre. Blocks of wood about 18 in. in length are placed in the grinders and held against a grindstone revolving at from 200 to 260 revs. per min. by hydraulic pressure ranging from 30 lb. to 75 lb. By this process the wood is reduced to a pulpy mass, and, during the grinding, the stone is sprayed with a stream of water to prevent burning of the wood. The pulp is then screened and is transferred to the beaters, where it is mixed with other stock that may be desirable, and is then rolled into sheets by wet machines, ready for storage or shipment, or it is transferred to the paper machine direct. Pulp grinders with a 27 in. by 54 in. stone require from 300 H.P. to 600 H.P., depending upon the pressure and the size of the pockets. Chemical pulp is made somewhat differently, as the wood is chipped in chippers and treated with chemicals in digesters, where different combinations are employed to secure different grades of pulp.

From this stage the preparation of the raw material and the manufacture of the paper from rags and wood-pulp, is in general, similar. The beaters which are used for refining the pulp consist of an oval-shaped tub with a partition half-way across the centre corresponding with the rectangular section. A heavy roll with knives in the periphery, parallel to the shaft, is rotated between one side of the tub and the partition. This roll is adjusted with reference to a bed plate, which consists of a number of steel plates standing on edge. The adjustment of the roll has to do with the ultimate condition of the fibre, as all of the stock passes between the roll and the bed plate. Clean water is constantly added to the stock while the dirty water is removed. The bleaching process sometimes takes place in the beater by means of adding the required bleaching solutions. From the beater the stock is generally run through a "Jordan engine," which consists of a cone-shaped plug made of hardwood and steel bars, fitted into a hollow concentric cone lined with a filling similar to that of the plug. By regulating the space between the plug and the outer cone the stock is finally reduced to the proper condition for the paper machine.

Sometimes it is desirable to drive the Jordans and beaters by different motors, as in some mills the entire stock is not subjected to the last refining process. Both the Jordan and the beater are operated at constant speed, but the power for operation depends upon the condition of the stock and the adjustment of the machine. When, however, all of the beaters supplying one paper machine are driven by a single motor the load will be practically uniform. Motors with high torque and constant speed characteristics should be used for beaters, and shunt-wound, direct-current motors, squirrel-cage and slip-ring induction motors are all operated on this service.

The power required to drive beaters is a variable quantity, but from tests it has been determined that a good rule to follow is to allow 1 H.P. for each inch of width of the beater roll. For work on light stock, such as ground wood, sulphite fibre, old papers, &c., with a moderate peripheral speed not exceeding 1,600 ft. or 1,700 ft., three-fourths of a horse-power for each inch of roll face will generally be found ample. The starting torque for beaters varies considerably, depending upon the methods of operation. If a beater is shut down full of stock, and started again shortly afterward, with the roll down in its running position, the starting torque will be about the same as the normal running torque. If the roll is lifted before starting, the necessary torque will be reduced and the beater will start comparatively easily. If, however, the stock is allowed to stand for some time with the rolls stationary, as on Sundays, the fibre settles to the bottom, clogging the roll, and requiring more than normal torque to start it, even if the roll has been lifted above its running position. For this reason, slip-ring motors are often recommended for beaters, as they give a better starting torque. Beaters lend themselves to either group or individual drive.

For newspapers and other kinds of paper, as well as rag paper, the Fourdrinier paper machine is in general use. The machine can be conveniently divided into two parts, the constant speed part consisting of the pump, felt beater, shaker and screen, and the variable-speed part, which includes the wire press rolls, dryers, and calenders. The constant speed requirements are from 25 to 30 per cent. of the total machine power requirements. A considerable range of speed variation with fine increments is essential for the variable-speed portion of the machine and the common method is to employ a shunt-wound, variable-speed, direct-current motor or a constant-speed induction motor in connection with some form of mechanical speed-changing device. Satisfactory results are obtained by the combination of an adjustable-speed interpole motor, the motor having a field rheostat with from 60 to 90 points. The power requirements of a Fourdrinier machine vary with the width of the paper and the speed of production. For example, in a test of the variable-speed part of a 152-in. machine, the motor input varied from 87 H.P. to 92 H.P., depending upon the quality of the paper.

On account of the great variety of paper, the method to be adopted for driving the machines must be studied for each installation. One

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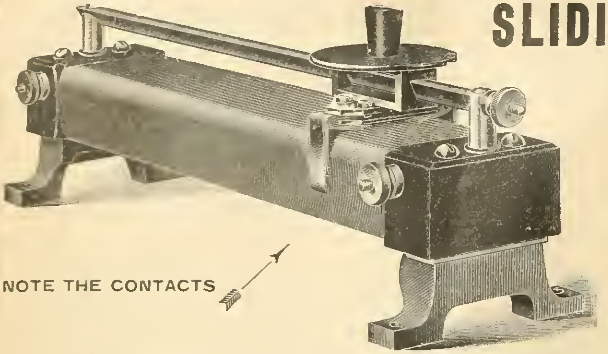

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method is to use a constant-speed motor for driving both the constant and the variable-speed ends of the machine with a mechanical speed changer between the motor and the variable-speed shaft.

Still another method is to use a constant-speed motor for the constant-speed end of the paper machine and an adjustable-speed, direct-current motor with field control on the variable-speed end. Since most paper mills use alternating current for their principal drives, this scheme involves the use of a motor-generator set for supplying the necessary direct current for the adjustable-speed motors. The range of speed which can be obtained by this method is limited by the economical range for which it is possible to obtain adjustable-speed motors. This limiting range is about 4:1, and it is preferable to confine it to 3:1.

In some instances a method that is used consists of installing a constant-speed motor for the constant-speed end of the machines, with the speed variation of the motor driving the variable-speed end of the machine obtained by voltage control. By this method it is possible to obtain speed ranges of 5:1 or 6:1 and greater, by purely electrical methods. The generator for supplying the direct current for the variable-speed motor is usually driven by an induction motor. It is also possible to omit the motor driving the constant-speed end of the paper machine and drive this from a pulley on the motor-generator-set. Another arrangement which has been considered is to use an engine belted to the constant-speed shaft and belted or direct-connected to a generator and exciter, which would furnish power for the motor driving the variable-speed end of the machine.

There is a modification of the voltage-control system which has certain features of superiority, consisting of a combination of a certain amount of field control of the motor driving the variable-speed shaft with voltage control. With this method of voltage and field control, 10:1 speed variation may be obtained.

For driving the calenders a slow and uniform threading speed is essential, and there must be a gradual acceleration from low to high speed, with ability to slow down and accelerate again. Simplicity of control and operation is also important. Electric drive, for these reasons, is especially adapted to this work, as each weight of paper can be run at the highest operating speed and the operation of the machine is always under instant control. Two-motor drive is well adapted to calenders, one a small squirrel-cage motor with gear reduction for threading the paper through the rolls, and gradually accelerating the speed by means of the larger motor. In a large Eastern mill the 66-in., 72-in. and the 86-in. calenders are equipped with 75 H.P. and 15 H.P. motors, the former for driving and the latter for threading in.

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Power required for presses and trimmers varies from almost nothing to the maximum and properly proportioned flywheels should be included in the machine equipment. The power requirements of some additional machines used in paper mills are as follows:—Water pumps, 10 H.P. to 20 H.P.; saws and barkers, 10 H.P. to 15 H.P.; stuff pumps, 5 H.P. to 10 H.P.; elevators, 3 H.P. to 10 H.P.; cutters, 5 H.P. to 10 H.P.; exhaust fans, 5 H.P. to 15 H.P.

A NEW PATENT ELECTROLYSER.

Construction.—The patent electrolyser, described and illustrated in a new pamphlet issued by Vincent Roberts & Co., Leeds, consists of a rectangular box of porcelain, divided by the electrodes into a number of compartments, so arranged that the brine entering at the highest point at one end flows by gravity under and over the electrodes until it passes out at the lowest end, changed into hypochlorite, running finally into a carboy, where it is stored for use. The electrolyser is designed for use on board ship, for hospitals, for water sterilising, laundry work, &c. To ensure that the liquor has at the outlet the requisite strength intended the rate of flow is carefully regulated to allow time for the electric current to do its work. If the flow be too slow the electric current would overheat the brine, producing *chlorates*, valueless for the purpose intended, and the heat developed would ruin the apparatus.

The passage of a current of electricity through water decomposes it, setting free hydrogen and oxygen; if, now, common salt be added to the water the process becomes complicated, as, in addition to the liberation of hydrogen and oxygen, chlorine and sodium are set free, but they instantaneously make fresh combinations, one being the combination of the chlorine with the oxygen, to form hydrochlorous acid. It is this hypochlorous acid in the liquor which the bleachers and the launderers employ, suitably diluted, for whitening linen and cotton goods, and this electrolytic compound is a perfect substitute for grass bleaching. The salt and water mixed to a density of 4 per cent., stored in a vat at a higher level than the electrolyser, passes on its way to it through an automatic feed tank, provided with a float valve and an adjustable feed valve, which latter is set to deliver 12 gallons of brine an hour. *Continuous* current is employed, 110 volts 8 to 10 amperes. The electrolytic sodium hypochlorite as made contains 3 grammes of available chlorine per litre (= 0·3 per cent.), and the amount of common rough salt needed is about half-a-pound per gallon, and this allows for the ordinary moisture in salt.

Well equipped modern laundries have largely adopted electrolysers with most gratifying results; the linen lasts longer, is a better colour, and is sterilised; on the laundryman's side, he improves his reputation and saves boiling and soap, it being practicable to add the electrolytic sodium hypochlorite to the soap and water in the machine as it does not curdle the soap, but, on the contrary, it promotes lathering, so that less soap is required.

The first essential for the effective working of an electrolyser is that the calculated flow of brine through it must be perfectly regular and constant. This demands that the level of the liquor in the apparatus shall be maintained, and it is difficult to reconcile these conditions with the movements of a ship at sea, but an electrolyser which cannot adapt itself to the inevitable pitching and tossing of

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the vessel is foredoomed to failure, as it is bound to give irregular results, because, if the electrolyser is fixed on a table the liquor would naturally sway to and fro, the flow would be irregular and a violent lurch would throw a quantity out, which would be replaced by a flood of fresh brine imperfectly electrolysed. There could then be no certainty as to what the final strength would be.

It is evident that on a ship at sea, if the electrolyser is to give a steady flow, it must be independent of the ship's motion, the "Reuss & Roberts" patent electrolyser, described in the pamphlet referred to complies with this condition.

The electrolyser is slung on a beam pivoted on a hook, so constructed that the latter may be moved towards one or the other end to give the electrolyser the requisite "dip" to secure the desired rate of flow; the porcelain spouts at either end serve as pivots, in addition to feed and outlet. The centre of gravity being low, and the weight of the electrolyser when filled considerable, any movement of the ship from whatever direction will be met by a swing of the electrolyser, thus the rate of flow of brine will not be affected.

The same necessity for swinging the electrolyser calls for swinging the automatic brine feed tank also, because the float controlling the tank would not act if the liquor surface on which it swims were not steady; in fact, the regular working of the electrolyser greatly depends upon the correct working of the supply tank, which was, we are informed, successfully demonstrated years ago by the inventor at the Cunard S.S. Co. laundry; accordingly the intermediate supply tank with float and adjustable supply cock is swung.

Lastly the collecting tank is slung, because electrolytic sodium hypochlorite is very unstable, and is soon decomposed, losing its strength.

The table under which the carboy is slung is intended to carry a sufficient length of delivery pipe to allow the electrolyser to swing to the fullest extent without being brought up short.

The patented arrangement, which includes the swinging of the electrolyser, enables it to be turned over on its bearings with ease and efficiently washed out; this mode of slinging, furthermore, insulates the electrolyser, a matter of the greatest difficulty hitherto, as the apparatus whilst at work too often stands in a pool of salt water, covered with a slight scale of brine thrown over the electrolyser by the effervescence, which forms an excellent conductor.

The Company will be pleased to forward upon application detailed circulars descriptive of both the textile and hygienic types of electrolyser, together with any other information required.

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ELECTRIC TRUCKS IN A BLIZZARD.

The American Express Co., which operates 245 electric trucks and 259 petrol trucks in New York, on a recent stormy day had 46 trouble calls from their motor trucks. Six of these calls were from "electrics" and 40 were from disabled petrol trucks. It was necessary to tow in two of the electric trucks and 14 of the petrol cars.

This creditable showing of the "electric" is only one of the good reasons why delivery companies are using electric trucks in large quantities. The great dependability of the electric truck puts it foremost in the handling of parcels, as well as in many other businesses requiring reliable transportation facilities. Comparative operating costs have proven the economy and efficiency of the "electric" in delivery work, and these are great assets. The electric commercial vehicle has made rapid strides during the last few years and is becoming more and more a factor in city transportation.

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THE ROUND TABLE.

By "KVA."

The recent appearance of "The Three (or was it Four ?) Osrams" as a music hall turn is symbolic of the spread of scientific knowledge. Later on, perhaps, we may find the "Wobbly Wotans" and the "Lektrik Troupe of Tumblers" as popular items in the programme of some of our variety theatres.

* * * *

Hot "Tricity," Meals for Munition Makers.
The hot cupboard "counter" at a North London Munition Works.

To manufacturers of electric fires (other than the short-circuit or fused-wire types) we offer the following suggestion for what it may be worth, and free of charge. Always employ, if possible, a red-headed assistant in the showroom. His presence will ensure a cheerful glow at all times and should increase the sales, as any rise in temperature due to his radiant locks will no doubt be attributed to the apparatus on view. (*Caution.*—Don't allow him to stand too close to a thermometer, else a fictitious temperature may be indicated, and a client might then rufus—I mean refuse—to buy.) If our suggestion be adopted, the sales enlivener will probably (out of business hours) be nicknamed "real-red-heat" or "Aurora," instead of "carrots" or "copper top."

* * * *

THE SMILE.

Nothing on earth can smile but man. Gems may flash reflected light, but what is a diamond flash compared to an eye-flash and a mirth-flash ? Flowers cannot smile ; this is a charm that even they cannot claim. It is the prerogative of man ; it is the colour which love wears, and cheerfulness and joy—these three.

It is a light in the windows of the face, by which the heart signifies it is at home and waiting. A face that cannot smile is like a bud that cannot blossom, and dries upon the stalk. Laughter is day and sobriety is night, and a smile is the twilight that hovers gently between both—more bewitching than either.

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A bold type line in an electrical contractor's advertisement shouts ELECTRIC FIRE LIST. This sort of thing may be O.K. where contractors are concerned, but it would not do with the general public. They would think it was a list of "fires due to the fusing of electric wires." Some people confuse dynamo with dynamite, and in these days of Hun retreats, Turkey Trots and the giving over of entire nations and continents to War, who would not think that a fuse was something that went bang !

* * * *

Mauvais Mot of the Moment : "Electricity is a convenience and not a necessity, and the question is whether we should have this A1 man fighting in the Army or helping a convenience. We don't use electric light in the trenches."—Major D'Albani, in hearing an appeal for a stoker at Newmarket Electricity Works. Had the Major any use for an Electrician Hot Plate I would give him one ; so anti-electric an individual does not deserve it.

* * * *

When in need of education
That will bring in L. S. D.,
Be sure you buy our booklet—
The well-known "L. L. C."

It tells of many methods
For economising amps.,
And shows some most convenient ways
Of controlling 'lectric lamps.

The methods are therein explained
In a very simple manner,
And everyone agrees that it's
Good value for a tanner.

* * * *

OUR HOT PLATES.

No. 235 to—

Mr. Arthur Goodwin, upon his election for the second year of office as Chairman of the Motor Traders' Association.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), March 23, 1880.]

The electric light has at last been adopted in the Crystal Palace, and certain chilly mortals have, of course, found it to appear disagreeably cold. "They miss the warm, comfortable appearance of gas." On the whole, however, the effect was a great improvement, and the eye will soon get accustomed to the change of the tint.

A "New" Electro-Magnet.—M. Chambrin increases the surfaces presented to each other on the core-end and armature of an electro-magnet by forming a projection on the latter, which enters a hollow of the core, or, conversely, a projection on the core is made to enter a hollow in the armature. By this means he increases the portative force of the magnet on the armature nearly 100 per cent. The residual magnetism, too, is weakened by this device.

Reprinting "The Electrician."—A contemporary seems to imagine that reprinting a large portion of The Electrician without acknowledging the source is no very grave matter. There is, however, we may inform him, a well understood literary law which strongly condemns the morality of such a proceeding. It may lessen the cost of production in the case of our contemporary to extract our City reports and reprint our notes, but it does not say much for his honesty when he allows the obligation to pass without acknowledgment.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

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IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
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Main Switchboards

Write for particulars to —

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HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W. 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
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HOME BRANCH ADDRESSES:
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BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—69 Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

FOR

High and Low Tension
SWITCHGEAR

THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

A NORTH LONDON MUNITIONS CANTEEN.

The employment of large numbers of men and women at munition works in factories of comparatively small area has presented catering problems of a character not experienced previous to the war. On every hand dining rooms, canteens, refreshment halls, kitchens, tea huts, or whatever they are called, have sprung up almost out of the ground to furnish accommodation for the workers while they restore their lost energies with hot meals and light refreshments at various times of the day.

Judging by the records of these establishments, they are planned on quite an extensive scale from the catering point of view. It also is apparent there is keen competition between gas and electricity for the cooking and service equipment.

From the electrical point of view such installations probably call for little or no comment in so far as the equipment is concerned, but it will be interesting in the future to have figures as to the operating costs under electric and gas conditions of these undertakings. There appears to be considerable organisation in the conduct of these canteens, and there should be no difficulty in obtaining such information.

We have just been afforded an opportunity of inspecting an installation in the North of London, the material for which was furnished by the British Electric Transformer Co. It has been put into a large canteen which provides seating accommodation for 1,000 workers, male and female, and 100 members of the factory staff. The building itself was built especially for the purpose of providing refreshment to the employees of the factory.

EXTERIOR OF NORTH LONDON ELECTRIC CANTEEN.

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

"Where order in variety we see,
And, though all things differ, all
agree."

POPE.

Just run your eye down the accompanying list and note the variety of our manufactures. Yet all agree in the point of Excellence—the B.I. touch that transmutes dull matter into the Inviting Efficient Thing.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM,
NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026 Grams: Vicmister, Sowest London

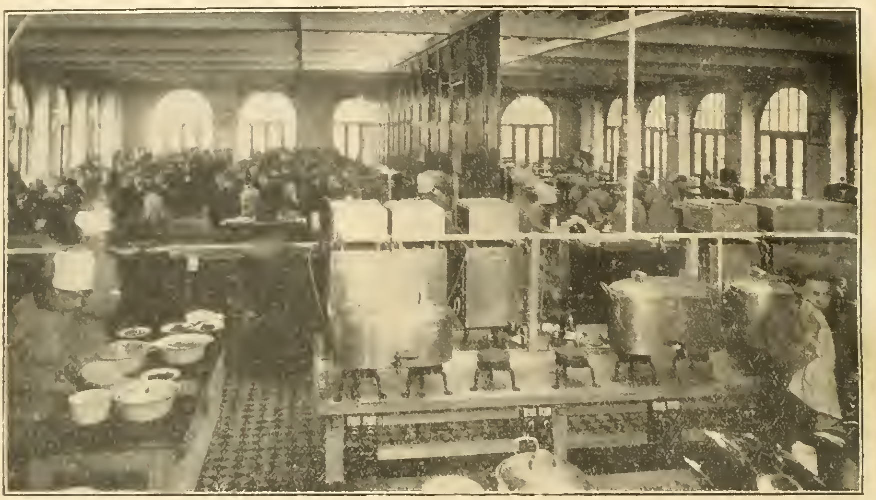
PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh.

See our Illustrated Advt. last week.

The "Tricity" cooking equipment was decided upon because experience in other canteens has proved its economy over both coal and gas in the roasting of joints. Some interesting facts are being collected in this connection by the many munition kitchens and Y.M.C.A. refreshment depots in various parts of the country. Before long it is hoped that valuable comparisons between the rival methods of cooking, on a scale which corresponds with restaurant and hotel practice will be available. At the moment the electrical method is making excellent progress. Surprise is often expressed by the superintendents and cooks in these large kitchens at the saving in meat per head which is possible with "Tricity" apparatus. None the less, the practical example at the Hayes works canteen of the British Electric Transformer Co. where 4 oz. of meat per head gives 3¾ oz. per head on the table, carries conviction in many cases; cooks who are used to coal and gas allow 7 oz. to 8 oz. per head. In these days of excessively high meat prices economies of this kind go a long way towards paying for the cooking installation. In the installation under review these gratifying results are to be looked for.



General View of "Tricity" Canteen.

The ovens and boiling plates are in the foreground, and the hot cupboards in the middle-ground. The men sit on the left and the women on the right.

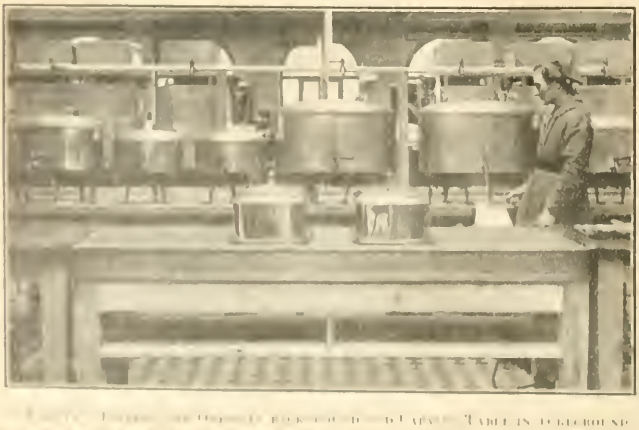
The canteen is open practically day and night, except for a few hours on Sunday, and the organisation of the cuisine is under the control of the Y.M.C.A., Miss Morse being the superintendent in charge.

The main feeder is carried up one of the end walls of the building into the roof and across the span girders to a point at about 3 parts the way down the hall, at which point it is dropped to a main switch and fuse box. From this box the main feeder cable is taken underground to an ironclad distribution board, which is placed below the main cooking table carrying ovens and boiling plates; the fuse-box is accessible for the replacement of fuses if necessary. The wiring of the main cooking table is carried in conduit down the longitudinal supports of the table, and tappings are taken off to two point control boards carrying on and off switch and indicating lamp and outlet socket. From these outlet points flexible conductors protected by flexible metallic tube convey the current to the hot-plates used either in the ovens or under the boiling pans. This arrangement tends to conserve the wiring and make the supply system compact. The main cooking table is divided electrically, there being an equal loading of hot-plates on each side of the 240-volt system, so that the supply voltage of each side is 120 volts. There is a main riser from the distribution board previously mentioned to the roof for the supply of an isolated boiling plate at some little distance from the main table. The whole of the cooking circuit wiring is done in steel conduit.

In a separate room which is entered from the outside of the building are two coke boilers, one of which, an "Ideal" No. 2B8, supplies the radiators for the heating of the building, and the other, a Beeston Domestic, which furnishes hot water for the urns and cooking generally. In connection with this boiler there is a large storage tank. It is interesting to note that the hot water for heating purposes is kept circulating by a small alternate-current motor direct coupled to a centrifugal pump.

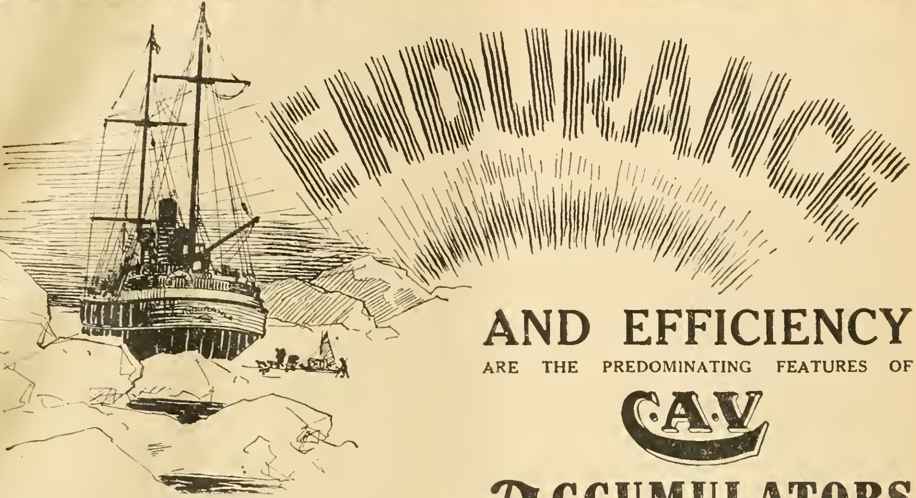
In addition to the main ovens there is a large carving table and four hot cupboards, which are used both for the warming of meals brought in by the employees themselves and also for the keeping warm of food cooked in the kitchen. The carving table and these hot cupboards are fitted with the latest pattern of Berry "Flaming-o" elements, these being placed in horizontal position, in the case of the carving table one below each dish and in the case of the hot cupboards a number fixed at the lower part of the cupboard and protected by a metal hood.

The carving table is of interest in that there is no hot cupboard below to cause discomfort to the carver by heating his or her legs. The hot cupboards also are set transversely near the first row of tables and they form counters upon which the hot food and warmed dishes are delivered to the customers.



[illegible] Carving Table in Foreground.

The carving table has no hot cupboard below and is therefore quite comfortable to work by.



"As Good as the BEST in '92."

"In the early days when I was a keen motorcyclist, I wanted a new accumulator and was offered one of Vandervell's. I had never heard of the name, but the seller told me it was made by a little firm which had just started business, but they were making a battery that was as good as the best. I bought it and never regretted the purchase."

—*Extract from ILLUSTRATED LONDON NEWS.*

AND EFFICIENCY
ARE THE PREDOMINATING FEATURES OF
C.A.V
ACCUMULATORS
British Made Throughout

Motorists are invited to write for full particulars.

C.A. Vandervell & Co., Ltd.,
ACTON. LONDON. W.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
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TRADE MARK. SEA CLIFF

CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

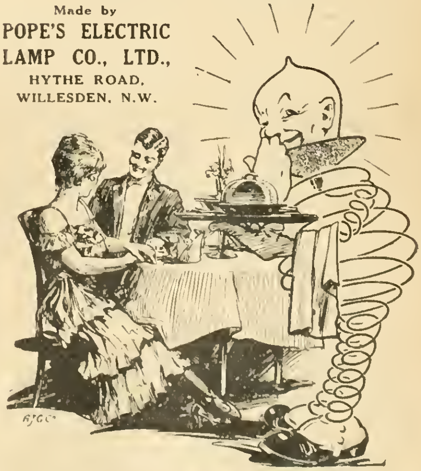
ALSO AT
BIRMINGHAM, GLASGOW, MANCHESTER, NEWCASTLE.

JUST AS THAT SPOT ATTRACTS YOU, SO WILL OUR PRICES FOR FANS. WRITE FOR NEW LIST TO-DAY OR PHONE AVENUE 5366.

ENTERPRISE MANUFACTURING CO.
(ASHDOWN & ROBERTS).
Gun Street Electrical Works, London, E. 1.

For Hotel Lighting
POPE
ELASTA
WIRE LAMPS

Made by
POPE'S ELECTRIC
LAMP CO., LTD.,
HYTHE ROAD,
WILLESDEN, N.W.



"Hotel Life suits me admirably."

Deliveries from Local Stock.

No matter where your business is situated, there is a "Z" Lamp Depot within easy reach, and ready and able to supply you promptly with any quantity of British-made "Z" Drawn Wire Lamps, irrespective of type.

Ask us for our new catalogue, and get in touch with our nearest address.

"Z" drawn wire Lamps

THE "Z" ELECTRIC LAMP MFG. CO., LTD.
OFFICES AND WORKS: SOUTHFIELDS, LONDON, S.W.
Depots in Principal Cities.

Following is a list of the "Tricity" apparatus supplied for the installation.

Two double ovens.

Two single ovens.

Twelve ribbed plates for same fitted with high and low switches (loading 900 watts each).

Twelve control panels consisting of fuse, D.P. Switch, lamp indicator and Plug connection.

Fourteen plain boiling plates fitted with high and low switches (loading 850 watts each).

Fourteen control panels as above.

Four hot cupboards 7 in. by 1 in. by 3 ft. 3 in. high, made of sheet steel and angle iron frame. Three fitted with eight shelves to take plates of meat and vegetables (64 in each), so that quick serving can be effected and one with five shelves for warming up men's own dinners. These cupboards are used as the counter. Each is controlled by three switches loading 3 kw.

One serving table 6 ft. 6 in. long by 2 in. deep by 5 in. high, ground and polished all over, complete with two tinned copper meat dishes and nickel plated covers. The whole stands on wood framing, loading $1\frac{1}{2}$ kw.

Four large boilers for potatoes, vegetables and puddings, fitted with wire baskets and draw off taps, sizes 26 in. by 15 in. by 12 in.

Three large boilers, no baskets, size 26 in. by 15 in. by 12 in., capacity 10 gallons each, used for boiling water to make tea.

Three ham boilers with draw off taps.

Two 12-pint saucepans.

Two 9-pint saucepans.

Two 6-pint saucepans.

INSULATION BEADS

The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS

HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

Two 6-pint linings for 6-pint saucepans.

Two cover plates used for standing over boiling plate so that several small pots can be used at one time.

The above utensils are used in conjunction with boiling plates.

We understand that 150 hot meals are served each day, and 150 light meals.

Needless to say, the kitchen section of the canteen is delightfully clean and free from noxious fumes. The "Tricity" ovens, in being placed on tables, are breast high, and are, therefore, most comfortable to work at. What cook likes kneeling at the door of a hot oven to handle heavy roasts of meat? In this respect there is a considerable saving of time, and obviously the kitchen staff are not likely to grumble at a feature which, while it is out of the ordinary, makes for their comfort. We can expect to hear in the early future that the workers in these canteens will be anxious for employment only where there is electric cooking apparatus installed.

The architect for the building and the electrical installation in this interesting canteen was Mr. A. Alban H. Scott, Lincoln's Inn-fields, London, W.C.

WESTINGHOUSE WEATHERPROOF LIGHTNING ARRESTER.

The "M.P." or "Multi-Path" lightning arrester, described in Leaflet No. 305/10B, has been designed for alternating or direct current circuits where the voltage to earth does not exceed 650. On three-phase circuits, where the neutral point is connected solidly to earth, the arrester may be used with voltages up to 1,100 across phases; where the neutral point is earthed through a resistance, or is not in connection with earth at all, the maximum voltage on which it may be used is 650 across phases. The "M.P." arrester has a discharge capacity many times greater than is the case with the usual forms of low voltage arresters. It is non-arcing in operation, consumes no energy except at the instant of discharge and its effectiveness is unimpaired after frequent and long service. It requires no re-setting, and, owing to the absence of moving parts, frequent inspection is not necessary.

The arrester consists essentially of a cylindrical block of specially prepared carborundum of high resistance. The material is granular in texture, with small air spaces distributed uniformly throughout its mass. When an excessive voltage rise takes place on the line, due to lightning or static surges, the charge passes to earth through the carborundum block, and, in its passage is split up into a large number of minor discharges by threading through the interstices of the granules. The intensity of the discharge is reduced to harmless proportions by being spread over the large surface of the block. The resistance of the path to earth is such as to prevent the line voltage maintaining an arc. The carborundum block is separated from that portion of the arrester which is connected to the line by a small air space. This completely insulates the line from earth except at the moment of discharge.

The apparatus is contained in a dust and weather-proof case of galvanised cast-iron which can readily be opened up for inspection. The arrester proper is completely insulated from the case by means of porcelain. When required in connection with overhead lines, it is advisable to have choke coils, in addition to arresters, at every point where the line enters a building in order to ensure the whole discharge taking place at the arrester and to prevent surges being conducted to the apparatus within the building. At points along the line choke coils are not necessary.

Further details from the British Westinghouse Electric & Mfg. Co., Ltd., Trafford Park, Manchester.

BASTIAN METERS FOR DIRECT CURRENT ONLY.

Made in ENGLAND with

BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

THE ROUND TABLE.

By "KVA."

One of the names suggested for The Engineers' Club, Manchester, was "The Joule Club." As Hill remarked in his recent Paper, this proposal must have been made by a "lunching" member, who had in mind the mechanical equivalent o' 'eat! I think that member must have foreseen the present food crisis, which threatens to develop into rationing in terms of calories or 'eat units.

* * * *

The annual dinner of the Engineers' Club, Manchester, held on Tuesday night last, was a most congenial gathering. "Jimmy" Dale (Vulcan Boiler Insurance Co.), who proposed the toast of "The Club," worked in a story, which I will risk as a chestnut. It was of a lady, anxious to conform to the new food regulations, who wrote to Lord Devonport, saying: "Yesterday I lunched at the Carlton, had tea at Princes, dinner at the Ritz, and supper at the Savoy. Did I do anything wrong?" Lord Devonport's answer was short and to the point: "Don't you remember?"

* * * *

Hill was in great form in the speech he made in response to his presentation and the toast of his health. He caused much merriment by his references to the "parents" of the club :—

Since I had the pleasure of opening one of our debates here five weeks ago, there has been a good deal of discussion as to who was really the Father of the Club. No one seems to be interested in finding out the Mother's name, and I think it just as well not to inquire further in that direction. Her child is strong and vigorous, and she may be pardoned much because she loved greatly, for if she had not greatly loved there would not be so many individuals and committees claiming to be the Club's father. It has been stated in a letter to THE ELECTRICIAN that the Institution of Electrical Engineers Local Committee stand in *loco parentis* to us. I cannot say if this is so or not. If it is a fact, then the Institution has done one thing to justify its existence!

* * * *

I ran into a good story up North this week. In a certain P.H. (no, not public house!), which shall be nameless, a new 3,000 kw. alternator, which shall also be nameless, has been installed. Since being put to work it has become very hoarse (damp steam and a wet air filter may be responsible for this), and it can be heard on a fine night with the wind in the right direction five miles away! When it started running the local Specials were called out to stand by for an air raid, for that alternator has got the same note as a Zepp. In order that there shall be no mistake when the enemy airships do come, the P.H. has agreed to shut the machine down!

* * * *

I thought that electricity would have to form a part of the present frenzied agricultural revival. "Punch" states that allotment holders have been warned to be on their guard against *wire-worms*.

* * * *

The rationing craze is effecting many changes in our methods of living. Doubtless with an eye to encouraging food economy, Price's Patent Candle Co. advertise "Tasteful Lighting"! But is it good taste?

* * * *

Starting as a ripple they have now become a wave,
And soon may develop to an ocean.
If anyone is desirous his energy to save,
We can tell him how to fructify his notion.

"La Rire," Paris, puts up a good joke anent the coal situation. Old Lady to the Vicar: "Oh, Vicar, I beg of you not to mention the 'fires of hell' in your sermon to-day. It would only lead us into temptation during this terrible shortage of coal." What Bastian would describe as a "Real Red Heat" joke.

* * * *

The following letter from Japan is taken from the advertisement of A. J. Greenly & Co. (entitled "The Business of Engineering") in last week's "Engineer" :—

"Regarding the matter of escaping penalty for non-delivery of the bar machine, there is a way to creep round same by diplomat, and we must make a statement of strike occur in our Factory (of course big untrue).

"Please address my firm on enclosed form of letter and believe this will avoid penalty of case. As Mr. B. is most religious and competent man, also heavily upright and godly, it fears me useless apply for his signature. Please attach same by Yokohama Office making forgo, but no cause to fear prison happening as this is often operated by other merchants of highest integrity. It is highest unfortunate Mr. B. is so godlike and excessive awkward for business purposes. I think much better to add little serpent-like wisdom to upright manhood and thus found good business edifice."

* * * *

THE APOTHEOSIS OF THE POINT.

Oh, gentlemen, listen, I pray, for 0·0833 of an hour!
I walked in the street yesterday, and I sighted a beautiful tower;
Its height I computed to be (I express it in metrical fashion)
Just 76 metres 0·3. Now to climb high with me is a passion;
So I hastened my steps till I came to its base, where a person unsightly,
Demanded 0·1666 of a bob, ere he very politely
Allowed me to start the ascent, which I did; and I found very shortly,
That before I had got more than 0·333 of the way, I was portly.
And when I at last reached the top, I was night at the end of my powers,
So I looked at my watch—it was 5·9166666 hours!
Then I promptly descended and went to the Feathers Hotel, which was near.
My thirst to assuage I demanded 0·568 litres of beer.
Which greatly refreshed me, but cost me 0·208 of a sov'r'in.
Then homeward I turned. At the back of my mind there were pleasant thoughts hov'rin',
Of the beautiful way in which decimals fitted the shackles of metre,
For when you are short in your feet, all you do is to use a repeater!

W. R. M.

(Reference to the Electrical Trades' Directory Conversion Table will elucidate the facts, which appear to be that you are asked to listen for five minutes whilst the scribe tells that he saw a tower 250 ft. high, paid 2d. admission, got tired before he had climbed a third of the way, found it was five to six, came down and had a pint of beer, price 5d.)

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), March 27, 1880.]

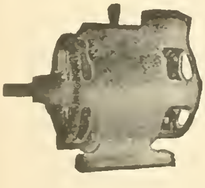
A DISCLAIMER.—We learn with some surprise that our description of an incident which occurred at the last meeting but one of the Society of Telegraph Engineers has been misinterpreted. The use of the word gentlemen was, indeed, simply descriptive of the kind of amenities we were desiderating. Perhaps the sentence would have been sufficiently clear without that word: and as it appears to have given pain we regret that it was used.

THE TYSON MOTOR. This little portable and ornamental motor, doing 1,000 foot-pounds of work per minute, might be found useful in the laboratory and elsewhere for driving small dynamo-electric machines. The "Scientific American" says that "it is a steam engine with a non-explosive steam generator, and without a steam gauge, water gauge, or safety valve, and its boiler or generator has but one-fiftieth the cubical capacity of an ordinary boiler adapted to the same engine." Either gas, coal, oil or gasoline may be used as fuel; or in the larger forms of the engine, wood and coal may be employed. When the gas is turned on, all that is necessary is to pour into the machine a few quarts of water every four or five hours. If this supply be omitted the engine stops, but cannot explode. A practical comparison of this motor with the best forms of gas engine would be interesting.

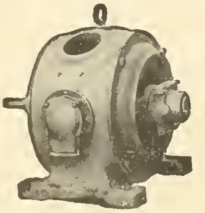
'IGRANIC'
HEAVY DUTY STARTERS
overcome the most troublesome starting problems.
EXPERIENCED ADVICE
is always available free.
No. 25. Face-plate type.
IGRANIC ELECTRIC Cº LTD
147, Queen Victoria Street, London.
No. 30. Multiple Lever Type.

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

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Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
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Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—69, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood [Bldgs.
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

ELECTRIC ALLOY STEEL PLANT.

The Latrobe Electric Steel Co., of Latrobe, Pa., U.S.A., are engaged in the production on a tonnage basis of ball-bearing, die, magnet and high-speed steels. Their plant includes two 6-ton Héroult electric furnaces and one of 3-tons capacity, as well as a 1 ton experimental electric furnace. The major part of the output goes into chrome, chrome-nickel and chrome-vanadium steels, but high-speed steel is also a conspicuous article of manufacture. A 12 in. and a 16-in. rolling mill constitute the finishing end of the plant, which can produce rounds from 3/16 to 5 in. in diameter, squares from ¼ in. to 4½ in. on the side and flats from 9/32 by ¼ in. to 1 in. by 8 in. A 12 in. mill does not seem the most useful mill for 3/16 in. round, but possibly existing plant is being utilised.

The electric furnaces are arranged along the centre line of the main or original foundry building, which is 60 ft. wide and they are located toward one end, with the scrap-bins near to them. A railway siding brings the scrap cars alongside the bins, and a narrow-gauge track provides for carrying to the furnaces the charges made up from the material in the different bins. The bins are covered for protection from the weather, and a similar group of bins, reached also by the railway siding, provide for the storage of bricks and [illegible] for the furnaces. The main part of the works has [illegible] aisle on each side, but longitudinal as well as lateral [illegible] made, and an extension to the main bay gives space for building up spare tops of the furnaces and for storing and lining ladles and [illegible] the slag. Beyond the lean-to containing the transformers for the furnaces and the different heating furnaces to the rolling mill proper, all departments in direct communication [illegible] of the manufacturing departments virtually all under one roof.

As regards materials used, furnace charging sheets, selected at random, show that for making a steel running about 0·98 per cent. carbon, 0·3 per cent. manganese and 0·35 per cent. chromium, the charge would be made up about as follows:—Pig-iron, 1,300 lb.; punchings, 2,800 lb.; tool scrap, 2,200 lb.; drop-forging trimmings, 7,000 lb. Similarly the composition of the charge for steel made in, one of the larger furnaces, to run, say, 1·06 per cent. carbon, 0·32 per cent. manganese, and 1·38 per cent. chromium, would be about as follows:—Pig-iron, 2,150 lb.; chromium scrap, 2,500 lb.; carbon scrap, 1,000 lb.; drop-forging trimmings, 1,000 lb.; punchings, 6,350 lb.; chromium trimmings, 1,000 lb.; limestone, 600 lb., and burnt lime, 200 lb.

The steel is cast in split moulds, 4 in. to 14 in. in diameter, and hot refractory tops are used. For forging the ingots a 3-ton steam hammer and a 600-ton high-speed steam forging press are provided, and a 2,500-lb. and an 800-lb. finishing hammer are also included in the equipment. The stripped ingots are heated in coal-burning furnaces near the hammer and the press as indicated. Each of these furnaces is of three-door size, and is equipped with steam-jet burners. As ordinarily operated, the forged ingot is cut in the middle into two billets. Before passing into the heating furnaces of the rolling mills, the billets are, of course, ground on the surface wherever folds, slivers or other blemishes are discernible, and for the etching processes there is a group of stationary and swinging grinders of the individually-motor-driven type seen in foundry cleaning rooms.

The arrangement of the rolling mills comprises five stands of three-high 12-in. mills with the heating furnaces near by and the 16-in three-high mill, which is of three stands. Both mills are electrically driven. Overhead light trollies provide for bringing the billets from the billet-heating furnaces to the mills, but the rolling mill is also served by a travelling bridge controlled from the floor. The 12-in. mill delivers a product from the smaller sizes up to 3¾ in. diameter in the case of rounds and to 5 in. by ½ in. in the case of the flat bars. In octagonal and hexagonal shapes the top size is equivalent to about 1½-in. hexagons. The 16-in. mill produces from 2-in. rounds upward to the maximum sizes already mentioned.

A railway track entering the rolling mill toward the finishing end provides for the ready delivery of products, and a wagon road gives facilities for automobile truck transportation. A warehouse is in course of construction, in which is to be a heat-treating department, with gas furnaces and oil, brine and fresh water for quenching. A completely equipped laboratory for scientific investigation and research work forms an important part of the plant. It is equipped with testing machines for the examination of physical characteristics and a special heat-treating plant is included. The finishing equipment in the rolling mill includes an annealing furnace, and special tube containers allow for packing the bars to be annealed against exposure to atmospheric influences within the furnace. Two hot saws for the 16-in. mill and two straighteners and a polisher and a straightener for flat bars are provided. Electric current for the furnaces is purchased.—"Iron Age."

SMOKELESS FUEL.

It is interesting to note that prominent electric power engineers are being interrogated by the lay press upon matters of national importance. The publication of interviews similar to that recently issued by the "Yorkshire Observer" will do much to guide and influence public action and opinion in the economising of our resources. A few extracts from the interview are given below.

Mr. William B. Woodhouse, the engineer of the Yorkshire Electric Power Co., who is a member of the British Association Committee as well as of the National Electricity Supply Joint Committee, in the course of a statement to a representative of the "Yorkshire Observer," said that two important factors in recent years had tended to fuel economy—namely, the development of the public supply of electric power by municipalities and power companies, and the increased production of coke from by-product ovens in which the valuable chemical products were extracted from the coal such as ammonia, benzol, toluol, &c. The progress in the use of electric power was being made at an ever-increasing rate, though

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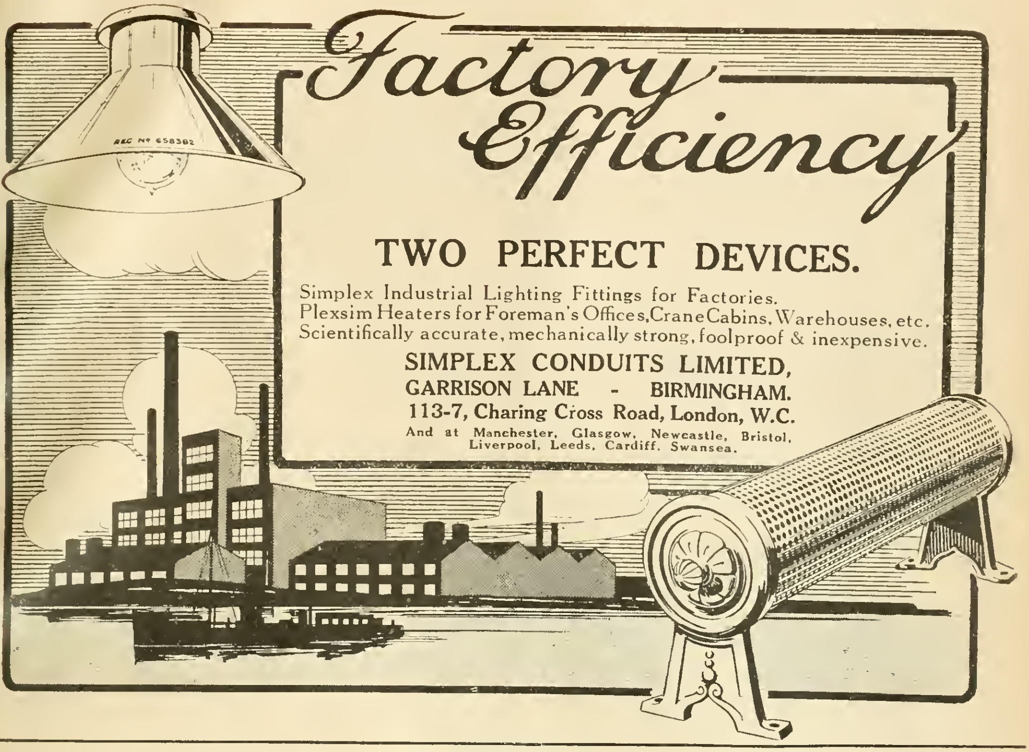

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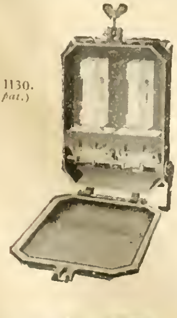
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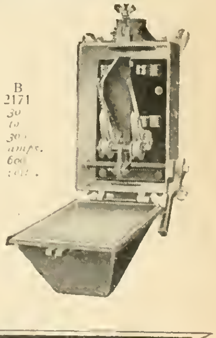
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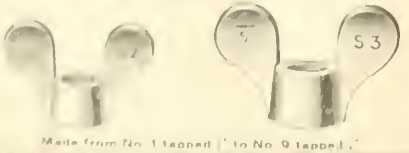
at the present time public power supply was only dealing with one-tenth of the power used in this country. The extension of public supply, it was estimated, would effect a saving of some 40,000,000 tons of coal a year, which would be available for export.

"An extension of the processes of carbonising coal would represent," said Mr. Woodhouse, "an increase in the value of the coal of at least one-third, so that if all the coal used in this country were carbonised before being used as a fuel there would be a substantial increase of value to the nation, as the home consumption for all purposes amounts to very nearly 200 million tons per annum. Of this quantity the gas undertakings and the coke ovens are already carbonising a large proportion, but of the remainder the greater part is used in a most wasteful manner. Electric power supply is the most important link in the chain of future economy—first, because the actual consumption of coal to produce power in large stations is less than one-half of that used by the average power user who produces his own; and next, because economical processes of coal carbonisaton can only be carried out successfully on a large scale, which implies that the power produced must be distributed from large carbonisation, and generating stations over wide areas.

"The most wasteful use of coal, however, occurs in the domestic fireplace; not only does the greater part of the heat go up the chimney, but the resultant smoke and acid produced have a most detrimental effect on human and vegetable existence. The use of gas and electric heating and cooking is extending, but the Englishman's love of the open fire is so strong that we cannot hope to abolish it by these means alone, at least for some years. The solution of this difficulty seems to be in the production of a smokeless fuel from which the valuable chemical constituents have first been extracted. In this connection the developments being made by the Yorkshire Electric Power Co. may be of interest. The company's area of supply includes the Yorkshire coalfield, and their developments in recent years have had the twofold object of extending the use of electric power and co-operating with the collieries in producing the power from low grade fuel and waste heat from coke ovens. The latter development led some years ago to the erection of a power station on the Barnsley coalfield in which the fuel used was the surplus gas from a large battery of coke ovens. In the next few months a further development will be set to work—namely, a plant to produce smokeless fuel for domestic purposes, from which plant the Power Co. will take the surplus gas and convert it to electric power."

"The Fuel Research Committee has a great work before it. But the lines of progress are fairly well defined and the machinery for economy exists in the colliery, electric power and gas supply undertakings of the country. It only remains to co-ordinate the various interests. The electricity supply industry is actively interesting itself at the present time in a consideration of the economies to be made by linking up the various municipal and company undertakings throughout the country. There can be no doubt that by this means an immediate and considerable saving can be made, and it is to be hoped that the good will and friendly feeling necessary between the various industries concerned in the fuel economy will rapidly bring us to the days when there will be no smoke from either factory or domestic chimneys, and clean air and sunshine will return to the industrial portion of the West Riding, not to mention the enormous money saving that will result."



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FERODO APPLICATIONS.

The abnormal conditions of present day manufacture are responsible for many new problems which are arising in engineering and other works, and new methods are being employed to solve these problems. Quite recently the makers of Ferodo friction surfaces supplied their material for the lining of vice jaws for holding shells, with most satisfactory results. Another more recent instance is the use of Ferodo fabric on the brakes of cloth wringing machines. The engineer of a large railway company also reports that he has fitted a Ferodo fabric lining of a crab dredger crane brake, with the result that it is still working after 14 months, whereas leather lasts only three months. The Herbert Frood Co. (Ltd.), of Chapel-en-le-Frith, who are the makers of Ferodo fabrics, will willingly advise on any matter relating to friction surfaces, and will also test free of charge any material of which engineers may desire information.

PASSENGER ELECTRIC VEHICLE MAKES GOOD RECORD.

The new model of an electric passenger vehicle manufactured in Detriot, in a recent run from New York City to New Haven, Conn., made a highly commendable record. There were three passengers carried and the distance of 88·2 miles, from Columbus Circle, New York City, to the Hotel Taft, New Haven, Conn., over an extremely hilly, although smoothly constructed road, was accomplished in 3 hours and 45 minutes, including all stops, traffic delays and reduction of speed through thickly populated centres, and on a single charge of the battery. While an average speed of 23·4 miles per hour over a distance of 88·2 miles may not arouse the interest of the speed fiend, yet when it is remembered that this speed is maintained over average roads, the speed is about as great as can be maintained by either a petrol or electric car with comfort to the riders and with safety to pedestrians.

The new model is furnished with a control system which provides for the safety of the driver and other occupants. It consists of an automatic device which, by the pressure of the foot on a pedal, even though the car is travelling at full speed, instantly cuts off the current and applies both brakes, regardless of the position of the

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control lever. It is impossible to start the car again until the control lever has been returned to neutral position.

This run is an evidence of the "electric's" ability to make an average long run, covering the ground at a comfortable speed, with the fears of possible breakdowns practically eliminated. A series of runs have recently demonstrated the fact that an electric automobile can be very satisfactorily used for inter-urban travel. These runs averaged distances of about 90 miles per trip, and were conducted with absolutely no trouble of any sort. One of the longer runs was from Chicago to Milwaukee, a distance of 101 miles.

ELECTRIC MOTOR CARS FOR INDIA.

Mr. Fred. L. Milne, engineer-in-charge of Simla municipal electricity department, recently prepared a specification of the features of an electrically-propelled car for use in India. The following is an abstract of it.

Amongst the requirements are the following: Compactness and light weight, capability of ascending and descending gradients of 16 to 25 per cent. and ability to turn in a small radius. Maximum dimensions 4½ ft. wide by 9½ ft. long. Two-seater with decking or small platform for attendant. Battery to stand high discharges to overcome emergency gradients. Motor to stand temporary overloads of 300 to 400 per cent. Control gear may be either direct or electromagnetic. Steering gear preferably of horizontal lever type on account of its big leverage and quick action. Solid tyres. Car to start or stop on 12 per cent. grade. Motors to give maximum torque in the starting position. It is essential that the car be capable of turning in an exceedingly small radius. This may be done by the affixing of a duplicate set of control gear behind the driver's seat, the seat being arranged to revolve, which would enable the driver to manipulate his car by a reversal in direction of motion and at the same time he would always be facing the direction in which the car is travelling. If electromagnetic control is adopted, it would only be necessary to duplicate the steering gear, provided the electromagnetic control apparatus is put in such a position as to be accessible when facing either the front or the back of the car. Either electrical speed control of the motor with a series parallel arrangement may be adopted provided the arrangement is such as to give maximum torque on the low speeds of a constant speed motor. The chassis should be arranged for a maximum speed of eight miles per hour and an automatic arrangement should be fitted to apply either the electrical or mechanical brakes immediately this speed is exceeded. The car should be equipped with two foot-brakes alongside the driver's seat, and two hand-brakes fixed near the passenger seat; in addition, electric brakes may be furnished, these being operated from the driver's seat. The electric brake should be arranged so as to short-circuit the motor armature through resistance energising the fields from the battery. The connection for accomplishing this should preferably be arranged so that it operates when the controller handle is brought slightly beyond the "off" position. As the controller handle is brought back still further, it should operate a hand brake on the motor pulley. It would be beneficial if advantage is taken of the long gradients for regenerative control. It may be necessary to arrange for the battery carriage to be suspended by swivels, so that the battery itself will always hang perpendicularly. This matter, however, depends on the type of battery adopted.

PORTABLE OUTFIT FOR WELDING.

The need for a light portable outfit for electric welding rail bonds to the rails has been met in the portable welder recently put on the market by the Electric Railway Improvement Co., of Cleveland, Ohio. The outfit consists of an electric furnace, weighing 65 lbs. and a rheostat weighing 200 lbs. By means of these two pieces of apparatus, current may be taken from the trolley and utilised in welding the copper rail bond to the rail. It is claimed that when the weld is completed the copper of the bond and the steel of the rail are so firmly united that there is no likelihood of a depreciation of the electrical contact thus made.

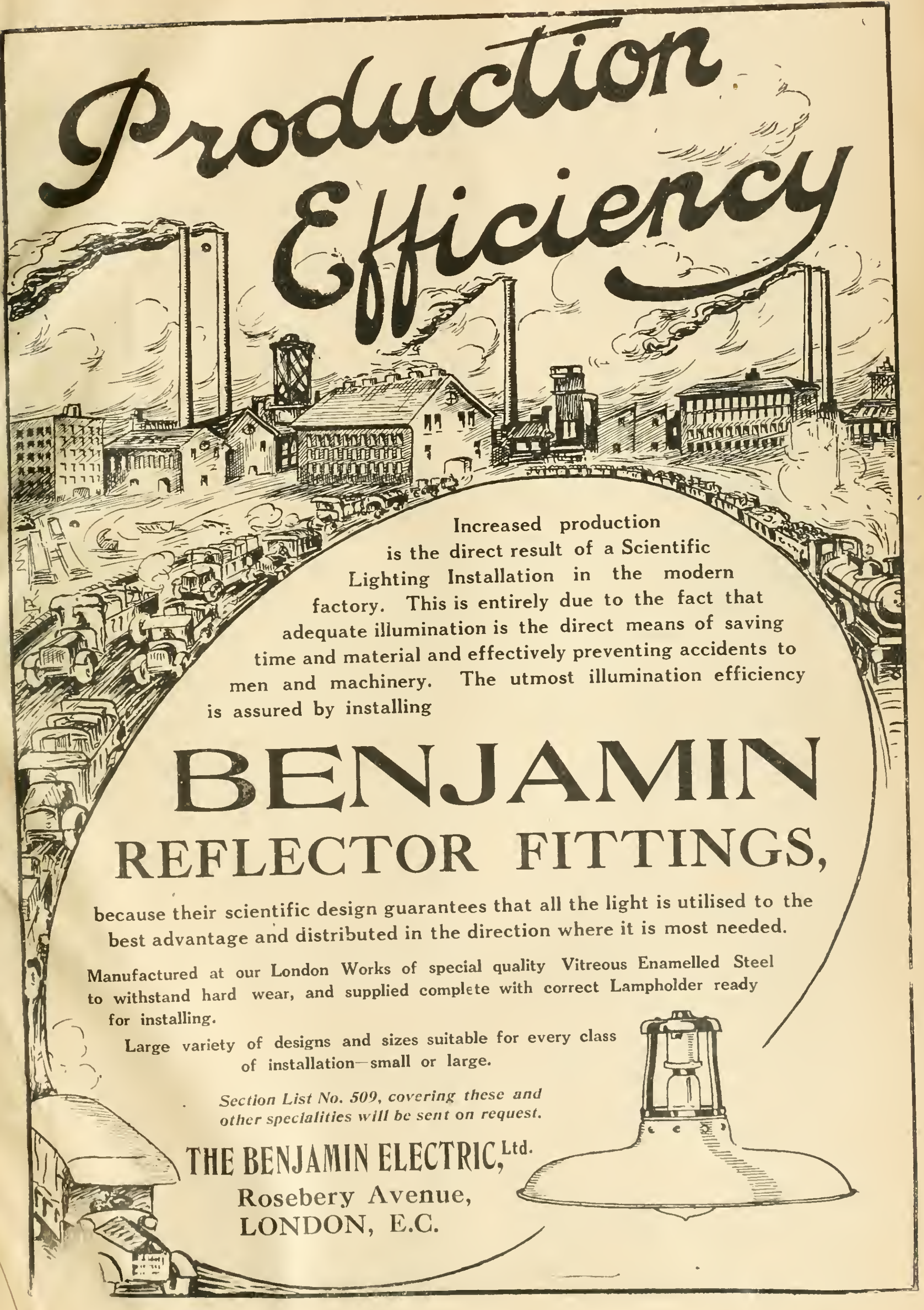
ELECTRIC TRAMWAYS IN AUSTRALIA.

The following table is taken from some statistics relating to electric tramways in the Commonwealth of Australia, published in a recent issue of the "Commonwealth Engineer." Compared with 1915, there was an increase of 39.3 route miles of line opened and in the number of cars employed. There was a slight increase in the mileage of steam lines, but a drop of 5 miles occurred in the horse-operated lines. 311 miles of the electric lines are on the standard gauge, 71 miles are on a 3 ft. 6 in. gauge and the remainder on a 5 ft. 3 in. gauge.

State.	Mileage (route) open.	Capital cost.	Current generated (Kw. hrs.)	Tram miles run.	Gross revenue.	Working expenses.	Passengers carried (thousands).	No. of cars.
New South Wales	140·04	£7,349,866	81,689,000	25,407,000	£1,831,023	£1,169,226	269,634	1,430
Victoria	70·57	1,061,067	7,500,000	4,436,000	204,671	151,513	30,676	193
Queensland	86·20	1,137,550	10,002,000	4,112,000	347,437	193,367	48,162	151
South Australia	77·00	1,517,148	11,584,000	4,914,000	309,915	191,070	42,287	170
Western Australia	48·75	1,092,285	4,984,000	2,782,000	181,340	129,422	17,501	121
Tasmania	20·00	336,214	1,368,000	925,000	62,317	43,514	7,183	52
Total (or Commonwealth)	[illegible]	£12,494,130	117,127,000	42,576,000	£2,939,703	£2,178,142	415,443	2,120

In the Commonwealth area, the following steam, cable and horse lines are in operation: Steam (miles): N.S.W., 73½; Victoria, 1; Queensland, 7. Cable (miles): Victoria, 46. Horse (miles): Victoria, 6; South Australia, 20¾; Western Australia, 29.

The route mileage of the various tramway services are: Government (miles): N.S.W., 219¾; Victoria, 5¼; S. Australia, 11½; Western Australia, 31. Municipal (miles): Victoria, 32; Queensland, 7; S. Australia, 60½; W. Australia, 11; Tasmania, 20. Private Companies (miles): N.S.W., 3½; Victoria, 80¼; Queensland, 38¼; W. Australia, 14¾.



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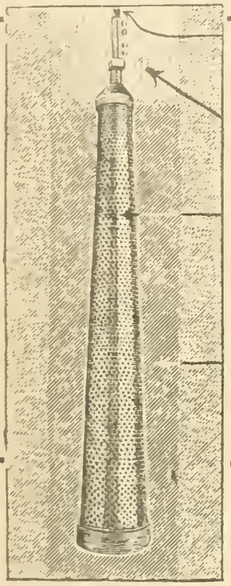

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ELECTRIC FURNACE PROGRESS.

In a note on the progress of the electric method of melting by the Sheffield steel manufactures, the "Iron and Coal Trades Review" states that Messrs. Kayser, Ellison & Co. recently placed an order for a 10-ton electric furnace of the Greaves-Etchells type, in addition to one of 30 cwt. capacity, which it is expected will soon be running.

One of the same type of 3 tons capacity has been ordered by Messrs. Jno. Hy. Andrew & Co., and 30-cwt. furnaces have also been ordered by Thos. Andrews & Co. and Accles & Pollock (of Birmingham). A small type of Greaves-Etchells furnace at the works of Messrs. Spear & Jackson has now made over 1,050 heats of high-speed steel, and the lining has only once been renewed. A further larger furnace of the same type was successfully started up for the firm last week, and also a furnace at Messrs. Samuel Osborn & Co's. The makers of the furnace (Messrs. T. H. Watson & Co.) are negotiating for many more furnaces. Already the number at work or about to be installed exceeds 20 and there is no doubt that the electric furnace has a great field before it. It is the only type of furnace that can readily melt the whole of its charge in the shape of turnings, &c. All other furnaces can only use a very limited quantity of turnings, and the remainder must be new raw materials, pig-iron, &c., which require ship room and rail carriage. The electric furnace can make sound steel or castings directly from turnings, and the ideal scheme would be to erect these furnaces wherever there is an accumulation of turnings or steel scrap and a supply of electric current.

A new steel foundry has been designed by Messrs. Thwaites Bros., of Bradford. The melting plant at present consists of two Snyder electric furnaces, each of a nominal capacity of 30 cwts. They are employed exclusively for melting scrap and when in full blast give seven melts in the 24 hours. A third similar furnace will shortly be installed.

Arrangements were recently made by the Imperial Munitions Board and the Harbour Commission of Toronto for the erection of an electric steel plant with a capacity of 300 tons per day. It is hoped that the plant will be in operation by July.

CLEANING TURBINE BLADES AND CONDENSER TUBES.

Exhaust steam from two 1,000 kw. reciprocating engines is being utilised to operate a 2,000 kw. mixed-pressure turbine at the power station of the Des Moines City Railway Co. Since considerable suspended oil is carried over in the exhaust steam, means had to be provided for removing the deposit and scale formed on the turbine blades and tubes of the surface condenser used with the mixed-pressure unit. The following arrangements, according to the "Electrical World," have been made :—

A 2 in. pipe was installed to connect the circulating pump with a 2 in. header at one end of the condenser. From this head five pipes, tapering from 2 in. to 0·75 in. in diameter, were connected across the section of the condenser above the turbine room floor. Each pipe was tapped into the condenser through nine small bore pipes. About every three months, when a machine is shut down, the hot well is pumped dry and a barrel of kerosene oil dumped into the handhole in the condenser. The discharge pipe on the hot-well pump leading to the heaters is closed and the valve in the pipe leading up to the header over the condenser opened. The hot-well pump is then used to force the kerosene from the hot well through the spray nozzles. The circulation is continued for two to three hours and the kerosene then drained off and the deposit allowed to settle. The light oil, which rises to the top, is drawn off for treating the turbine. The kerosene treatment is given to the turbine in 50 gallon quantities once a week through a 0·75 in. pipe with numerous needle-point holes in it. This pipe is inserted across the steam intake pipe. Since the kerosene is carried into the condenser with the steam it helps to keep the tubes free of deposit. This procedure, supplemented by the thorough cleaning of the condenser every three months keeps the turbine and condenser in good condition. Determination of the condenser condition is made frequently by means of the vacuum gauge, which is connected so that it may be made to read the pressure at the intake and outlets separately, the difference giving a good indication of the condition of the condensing surfaces when compared with the same reading taken when the tubes are clean.

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